Home Distillation of Alcohol

Summary
A collection of personal experience and useful resources I have found on the web & in the discussion groups to further the fun & science of making homemade alcohol.

I'm still learning about the art of distilling - I've only been running for a couple of years now (since '97), first using a Still Spirits 20L Reflux still to knock up neutral spirits, then moving up to a "offset head" design to make it at 190 proof. I'm a Chemical Engineer by trade, with home brewing as a somewhat limited sideline hobby - a dangerous combination. Distillation is simply the collection of the ethanol (alcohol) that was made during fermentation. It is the process of heating up the liquid so that it becomes a vapor, then condensing the vapor on a cold surface & collecting it. This works due to the fact that the vapor will contain more alcohol than the liquid it is boil off, because of the different physical properties of water and ethanol. We can then make the vapor more pure by letting it be "stripped" of its water content by passing it up through a packed column which has some condensed vapor running back down through it as liquid. When the two pass each other, the vapor will absorb alcohol from the falling liquid, and the liquid will take some of the water from the vapor. Distilling doesn't "make" the alcohol, nor turn some of it "bad" into something that will blind you; it's only collecting the alcohol that was made during fermentation.

The following pages will guide you on how to prepare the feedstock, distill its, then dilute, age & flavor it. They also cover how to make a still and where to buy them.

There's two ways to go with home distillation;

- Use a wash of just sugar, water, nutrients & yeast to distill a tasteless & odorless vodka, using a **REFLUX** still. This is then flavored using either essences or fruits (see the links about Liqueurs). Many of the commercially available flavorings are near spot-on, and hard to tell from the real thing. Real easy.
- Get a little fancier, and use grains (corn, rye, barley, wheat ..) to try and duplicate your favorite whiskey, bourbon ...etc, using either a **POT** or **REFLUX** still.

Ferment these up like you do home-made beer, then pass it through a still to collect the alcohol, and you're ready to party.

Tony's Steps to Making Homemade Alcohol

For full details, read the rest of http://homedistiller.org/

1. Check that its legal to distil in your country (it probably isn't).
2. Make sure you clearly understand what you're doing.
3. Make or buy a decent still. Only use a POT still if you intend on making whiskey/schnapps etc (i.e. flavored by the mash). Use a REFLUX or FRACTIONATING still to make neutral (tasteless) alcohol to flavor up later.
4. To prepare 18-20 L of wash for use ....
    - Whiskey : Heat 4 kg cracked or crushed malt with 18 L of water to 63-65°C, and hold there for 1-1.5 hours. Heat to 73-75°C, then strain off and keep liquid, using 250 mL of hot water to rinse the grains (should have an initial specific gravity of 1.050).
    - Vodka : dissolve 5 kg of sugar & 60 g of nutrients in 20 L of water
    - Rum : as per vodka, but use some brown sugar or mollasses, to give an initial specific gravity (SG) of around 1.06 - 1.07.
5. Cool the wash to below 30°C, then add hydrated yeast.
6. Ferment the wash at a constant 25°C until airlock stops bubbling.
7. Let settle for a day, then syphon carefully into the still.
8. Bring up to boiling temperature (start the cooling water through the condensors once you get to about 50-60°C), then once it has started distilling;
    - Discard the first 50 mL's (this may contain some methanol),
    - Collect the next 2-3L of distillate.
    - Segregate the distillate into 500 mL containers as you collect it.
    - Stop distilling once the temperature gets to 96°C (else the flavors get nasty).
    - Set aside any distillate which smells of tails/fusels. This can be added to the wash of the next run, and cleaned up then.
9. Turn off the power, then the cooling water. Open the lid, so that it doesn't create a vacuum inside the still & crush it. Wash up the still, dry it well, and then store/hide the pieces.
10. If you've made a neutral spirit, dilute it down to 30-50 % purity, then soak it with carbon for a week or two to help clean up any flavors still present.

11. Dilute it down to drinking strength (20-40%), then age and flavor the spirit, using either commercial essences, oak chips, fruits.
12. Find a comfortable spot to sit, put on your music of choice, then sip & enjoy with the ones you love.
13. If you have any questions, ask them on the email newsgroups.

Words of Wisdom

An interesting topic on the newsgroup was one of "if there were just three bits of advice to pass onto someone starting distilling, what would they be ?" The replies are listed below.

Patience + Persistence = Results
1. read every word of "homedistiller.org" at least three times.
2. wait till the enthusiasm wears off a little prior to getting confused/asking questions.
3. ease into it slow & take notes (just like your building your first customized harley)

1. READ, READ, READ! There is so much good information available that there is no excuse for getting a bad start. You are NOT alone!
2. Fermentation. Sanatize everything involved in the fermentation process. Boil all of the water used to make a mash. Perform aeration (aquarium pump & stone) prior to adding yeast. Use enough yeast. Keep fermenting wash below 30 C, 20 to 25 is better yet.
3. Use a PROVEN still design (experiment later, when you have a quantity of your own hootch to help sort out ideas).
4. RELAX! ENJOY! SHARE WITH FRIENDS! Keep records. Start a 3 ring binder, and stuff it with notes and recipes. Keep it next to the throne and read it often.
5. Avoid "my still is bigger than your still" discussions.

instructions on operating a reflux still in PDF format
http://www.moonshine-still.com/
http://homedistiller.org/
http://www.moonshine.co.nz/
http://www.stillspirits.com/indexnz.htm

1. Read everything you can find about what distilling and fermentation and the products that you intend to make. A good web search engine is a life saver here. Using the search feature on the yahoo group works well too. http://archive.nnytech.net/index.php?list=distillers this webpage has all of the messages from the distillers, new distillers, and also 2 or 3 biofuels yahoo groups. Lots of information available with a better search function than yahoo provides
2. Decide what kind of product that you want to make. If you want to make schnapps, brandies or grain whisky's a pot still is better suited for your goals. If you want to make vodkas and gins then a packed column will suit your goals better.
3. Develop a plan to accomplish your goals.
4. Ask questions from people who have done it before. Then ask some more questions. 3 people can read a question written by somebody else and see three whole different ways to answer it.
5. Avoid buying a whole bunch of expensive fancy equipment until you know that this hobby is what you expected it to be. Lots of equipment can be substituted with less expensive (or free) items. Ask what equipment is absolutely necessary.
6. Keep notes about what did and did not work. Sometimes even when everything seems to have gone wrong, something will have gone right and you might want to duplicate the effort.
7. Recycle all projects that did not meet your expectations. Ethanol is ethanol is ethanol and it is never wasted until you dump it down the drain. I made my best batch of whisky/rum hybrid mixture one time from recycling stock of batches that did not work out. I wish I knew what all was in those jugs because the finished product was sure tasty. There was corn whisky, sorghum molasses rum, fermented mellon, fermented watermellon, ect ect, and that is just what I remember.
8. Use a proven design. The time for new designs if for after you gain some experience actually accomplishing your goals.
1. Learn how to ferment something drinkable BEFORE you even think about building a still.
2. Learn from every mistake ever made---yours and others.
3. Figure out why it is that you want to distill, and see if distilling is really for you---or if it would be better to just buy a few bottles of Vodka and

learn to make drinks that way.
Mine would be:
1. Keep trying.
2. Do not be put off by failures.
3. Your product will improve.
4. Take it slow and do not rush.
5. Use all 5 senses. Smell, taste, hear, see and feel it.
#1....read #2....read #3....read
#4....ask questions about what you cant comprehend from reading
#5....distill your wash,utilizing your most valuable asset,common sense....:>)

1. Get a basic understanding how distillation works.
2. Check your needs, what kind of liquor would you like to do?
3. Don't build a monster machine if you don't need huge amounts of liquor, see it from a practical view.
4. Relax, if it didn't turn out the way you wanted to, try again, you'll get it right in time. Learning is the fun process.
5. Don't be afraid to ask, no one knows it all, not even the ones who claims to.

pick someone's else success and repeat it

1: Read and re read homedistillation.org.
2: Ask questions here (Distillers newsgroup at www.yahoogroups.com).
3: Don't build a still without advice from the group.
4: Do quite a few sugar washes before attempting grain/mollasses type washes.
5: Listen to the group even if you don't like the answers.

Read as much as you can from a wide variety of sources. Get a good book or two with illustrations of how to build and operate a still. Build a small one first, not too large. You can practice your workshop skills. Join a club or news group and LISTEN to all opinions, ask questions, and after awhile, filter out the stuff that you don't believe fits in with the your accumulated experience. Believe in your own abilities, and get on and do it.

New Distillers FAQ

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"NEW DISTILLERS" Frequently Asked Questions (Feb'03)

Posted near the 1st of each month, to the NEW_DISTILLERS newsgroup at www.yahoogroups.com

Please email any additions, corrections, clarifications required, etc regarding the FAQ to Tony Ackland (Tony.Ackland@comalco.riotinto.com.au), however please direct any general questions to the newsgroup itself.

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1) Is distilling hard to do ?

Nope - if you can follow instructions enough to bake scones, then you can sucessfully distil. To distil well however, will require you to understand what you're doing, so read around and get a bit of information under your belt before you begin.

2) Is it legal ?

Probably not. It is only legal in New Zealand, and some European countries turn a blind eye to it, but elsewhere it is illegal, with punishment ranging from fines to imprisonment or floggings. This action against it is usually the result of either religous beliefs (right or wrong), but more generally due to the great revenue base it provides Governements through excise taxes. So if you are going to distil, just be aware of the potential legal ramifications.

3) Will it make me blind ?

Not if you're careful. This pervasive question is due to moonshine lore, which abounds with myths of blindness, but few actual documented cases. The concern is due to the presence of methanol (wood alcohol), an optic nerve poison, which can be present in small amounts when fermenting grains or fruits high in pectin. This methanol comes off first from the still, so it is easily segregated and discarded, and easily observed via changes in the vapour temperature. A simple rule of thumb for this is to throw away the first 50 mL you collect (per 20 L mash used). Probably the greatest risk to your health during distilling is the risk of fire - collecting a flammable liquid near a heat source. So keep a fire extinguisher nearby.

The cases where you do hear about people poisoned by "illict spirits" have been the terrible situations where adulterants such as methanol, antifreeze, battery acid etc have been added to the spirits afterwards by unscrupulous sellers (for what misguided reasons ??). If you have had a healthy fermentation take place, it is infact very difficult to make methanol. The other problems have been lead poisoning when people have used lead-based products (ie lead solder) when constructing their still, instead of something more appropriate for food-grade vessels. The rules should infact be "dont buy spirits from an unknown supplier" - but its very safe to distill for yourself.

4) Whats the difference between a pot still, reflux still, and fractionating column ?

A pot still simply collects and condenses the alcohol vapours that come off the boiling mash. This will result in an alcohol at about 40-60% purity, with plenty of flavour in it. If this distillate were put through the pot still again, it would increase in purity to around 70-85% purity, and lose a bit of its flavour.

A reflux still does these multiple distillations in one single go, by having some packing in a column between the condensor & the pot, and allowing some of the vapour to condense and trickle back down through the packing. This "reflux" of liquid helps clean the rising vapour and increase the % purity. The taller the packed column, and the more reflux liquid, the purer the product will be. The advantage of doing this is that it will result in a clean vodka, with little flavour to it - ideal for mixing with flavours etc.

A fractionating column is a pure form of the reflux still. It will condense all the vapour at the top of the packing, and return about 9/10 back down the column. The column will be quite tall - say 600-1200mm (2-4 foot), and packed with a material high in surface area, but which takes up little space (pot scrubbers are good for this). It will result in an alcohol 95%+ pure (the theoretical limit without using a vacuum is 96.48 %(by volume)), with no other tastes or impurities in it.

5) How do I get or make a still ?

If you're after a pot still, these are generally home made using what-ever you have at hand - say copper tubing and old water heaters or pressure cookers. You don't really need any plans for these - just follow any of the photos about.

Reflux stills can be made from plans on the net, or bought from several manufacturers. For reflux still plans see

- The photos section at http://homedistiller.org/photos-ns.htm for "Offset head" designs, and http://homedistiller.org/photos-reflux.htm for general reflux stills.
- Alex's designs at http://groups.yahoo.com/group/Distillers/files/OFTS/
- StillCookers http://us.geocities.com/stillcooker/
- Stillmakers "Build a World Class Distillation Apparatus" at http://www.Moonshine-Still.com (Free!) or
- Gert Strands : http://partyman.se/Engelsk/default.htm (US$5).
- Ian Smileys "Making Pure Corn Whisky" at http://www.home-distilling.com , with full design details.
- For an excellent book on all aspects of still design, see "The Compleat Distiller" at http://www.amphora-society.com.
- See the list of "web resources" below for links to sites selling ready-made stills.
- For fuel alcohol stills see the Mother Earth Alcohol Fuel manual at http://journeytoforever.org/biofuel_library/ethanol_motherearth/meToC.html, and the The Manual for the Home and Farm Production of Alcohol Fuel by S.W. Mathewson at http://journeytoforever.org/biofuel_library/ethanol_manual/manual_ToC.html

Regarding the choice of heating for the still - if you have 240V available it is usually easiest to control & safer (particularly with internal elements). Gas can be used, but more care is needed to keep the collection container further away and not letting it overfill.

For more details on design, see http://homedistiller.org/designs.htm and http://homedistiller.org/refluxdesign.htm.

6) How do I make a whisky / vodka / rum / gin ?

Whiskey : Heat 4 kg cracked or crushed malt with 18 L of water to 63-65 °C, and hold there for 1-1.5 hours. Heat to 73-75 °C, then strain off and keep liquid, using 250 mL of hot water to rinse the grains. Cool to below 30 °C (should have an initial specific gravity of 1.050). Add hydrated yeast & leave to ferment (maintain at 26 °C) until airlock stops bubbling and final SG of around 1.010. Let settle for a day, then syphon carefully into a pot still. Discard the first 50 mL's, collect the next 2-3L of distillate or until you start noticing the tails coming through. Many people also have sucess starting with a beer-kit instead of using grains.

Vodka : dissolve 5 kg of sugar & 60 g of nutrients in 20 L of water, cool to below 30C and add hydrated yeast. Leave to ferment at 25 °C until below an SG of around 0.990, then settle for a day. Syphon into a reflux or fractionating still, and collect as per usual.

Rum : as per vodka, but use some brown sugar or mollasses, to give an initial specific gravity (SG) of around 1.060 - 1.070. Run through either a pot still, or a de-refluxed reflux still.

Gin : make a very pure vodka, then add the following essence. Simmer 35 g of juniper berries in 350 mL of 50% vodka for ten minutes with the lid on, let cool overnight, then filter through coffee filters. Use 5-10 mL of this essence per bottle of vodka.

When doing any fermenting, take a lot of care to ensure that any items used are clean/sterile (soaking them in a water + bleach (10 mL per litre)), or else the wash can start growing other things. Use a closed fermenter with an airlock too, to let the CO2 out without letting wild yeasts, bugs etc in. For more information about fermenting, see beer or wine homebrewing sites.

7) Should I use sugar or grains/fruit ?

It depends on what sort of still you have, and what you are trying to make. If you have a reflux or fractionating still, only use whatever is cheapest (usually sugar), as the refluxing will strip out all the flavours anyhow. If you have a pot still, and are after a bourban or whiskey, then you need to go the grain route, or mollasses if after a rum. If you are trying to make a neutral spirit for flavouring, go for sugar.

Basic guidelines for using them are ..

SUGAR. Wine yeast can use no more than 2.5lbs of sugar/1imp gal or 2.2lb/1U.S.gal or 1.25kg/5litres of must. This will produce 14%a.b.v. Honey and liquid malt extract are 80% sugar so you need 1.5kg/5l must or mash. Molasses is 50% sugar so you need 2.5kg/5l must or mash. Maple syrup is 32% sugar. Carob beans are 45% sugar. Sugar beets are 15% sugar Grain malt is 60% sugar (starch converted to sugars) so you need 1.5kg/5l mash. Cooked grain contains 60% convertible starch so you need 1.5kg/5l mash

FRUIT - Grapes contain the ideal sugar, water, acid balance. A sugar content of

17-23% and a water content of about 80%. 8kg of grapes produces 5l of wine. Most common fruits (apples, plums, apricots) contain about 10% sugar and 85% water. Cherries and figs contain 15% sugar. A fruit mash could be 4kg fruit, (400g sugar content), 2l water (3l in pulp already), 800g additional sugar.
Bananas are 17-24% sugar, 75% water. Acid content 0.3%. A banana mash could be 4kg of cooked bananas, 2l water (3l in pulp already),400g sugar. Add 3lemons/5l for correct pH.
Dates are 70% sugar, 20% water. Add acid to a date mash.
Raisins and sultanas have a water content of about 15% and a sugar content of 60%, grapes have a water content of 75% and a sugar content of about 20%, so using 1.5-2kg/5l of water appears about right if we want to reconstitute them.

ACID - 5g of citric acid (1tsp)/5l must raises acidity by 0.1%. 3g of calcium carbonate powder lowers acidity by 0.1%. A pH of 5 is 0.4% acidity. Winemakers aim for 0.6% acidity. Most common fruits are about 0.6% acid content. For distilling, a higher acidity in the mash helps to suppress bacteria. A high tannin content doesn't matter as we are not making wine. Meaurements are logarithmic, so a pH of 4 is 10 times more acidic than a pH of 5.

YEAST - Brewers (& possibly baker's yeast) can tolerate only 8% alcohol. A bottom fermenting lager yeast ferments out all the sugars better than a top fermenting ale yeast. A good wine yeast (Champagne, in the right conditions, can tolerate 15%a.b.v. (up to 18%a.b.v. in optimal conditions - no need to use expensive turbos). Wild yeasts vary, but some are very low - this is a risky path. Whisky distillers often use a combination of yeasts - initially a brewer's yeast because they believe it effects the flavor.

8) Can I use fruit wine ?

Sure, if you have it available. Again, using a pot still will result in a brandy/grappa/schnapps, whereas a reflux still will just strip it down to neutral spirit.

9) How do I make a Turbo-all-sugar wash ?

The first trick is to locate the "Turbo" yeasts - either try the New Zealand sites, or www.brewhaus.com. Then, dissolve 5-6 kg of sugar with 2-3 L of boiling water, top up to 25 L with cold water, wait until its cooled below 24 °C, and then stir the yeast in, and close the lid with an airlock. Keep at 24 °C until the SG has dropped below 1.010 Its then possible to add extra sugar (1 kg at a time, dissolved in a little water) each time the SG has dropped below 1.010. You should be able to add an extra 3-4 kg this way over a week. It should finish around 0.980 - 0.990

10) How do I run a Pot Still ?

See http://homedistiller.org/dtw.htm#use_pot for details. A pot still is fairly straight forward to use. Turn it on. Once the temperature is up to about 60 °C turn on the cooling water to the condensor. Make sure you throw away the first 1 00 mL per 20L wash, as this will contain any methanol that might be present. Segregate the distillate into 500 mL lots as it comes off. Only keep (for drinking) that which doesn't contain fusels (smell off) - probably below about 92 ° C, however you should keep distilling past here, untill about 96 ° C, as this fraction, although high in tails and not good for drinking this time, can be added back to the next wash and cleaned up OK then.

11) How do I run a Reflux / Fractionating Still ?

See http://homedistiller.org/dtw.htm#use_reflux for details +/or variations. It is best to first equilibriate the column under total reflux for 10 minutes or so. This will concentrate up the foreshots so that they can be removed first. Collect them one drip at a time, for approx 50 mL per 25L wash, and throw away. You can then collect the remaining run at a quicker rate. Adjust the reflux ratio (the ratio of how much of the total vapour is returned as reflux) by varying either the rate of collection or rate of cooling water (depending on still design) to maintain the purity you want. You can judge the purity by measuring the vapour temperature. Target around 78.2 - 78.4 °C . Towards the end of the run it will be hard to get a high enough reflux ratio to maintain the high purity / low temperature. When the temperature has nudged up to around 80 °C quit collecting for drinking, and collect the remainder as tails (for redistillation in the next run) up to around 96 °C .

12) Can I use a Reflux Still to make Rum or Whisky ?

Yes you can. To do so, you need to carefully monitor the various transitions between the foreshots, heads, middle run, and tails, and time the collection of the middle run precisely. The reflux still allows you to more precisely judge the changes between the various stages, and hence target them accurately. A typical rum or whisky would be obtained by discarding the foreshots, then collecting the heads, middle run, and then begin the tails, until the purity has dropped to around 58-60% (82 °C). By altering when to start collecting, and how late to time the final "cut", various flavour profiles will result. You'd collect it faster and at a slightly lower reflux ratio than for a neutral spirit, as you want the flavour present.

13) How do I measure the strength of it & dilute it ?

You need a hydrometer. This is a wee float, with a scale inside it. The more alcohol that is present, the lighter the density of the liquid, so the hydrometer sinks a bit lower. You then just read off the scale how much alcohol is present. You need a seperate hydrometer for measuring the density of the mash, as this is generally > 1.0, whereas the spirit is < 1.0, and they can't accurately do both ends of the scale.

14) How do I get rid of that "off-taste" ?

That "rough moonshine edge" or "off-taste / wet cardboard smell" is due to impurities such as the higher order alcohols, known as cogeners or fusel oils. These will be present more when using a pot still, less if using a reflux still, and just about absent if using a fractionating column. So one way is to use a taller packed column and increase the amount of reflux occuring. They can also indicate that you've tried to collect too much of the alcohol, and have run into the "tails"; so finish collecting a little bit earlier next time. Soaking tainted alcohol with activated carbon for a week (or even months) will help remove some of this flavour - this is known as "polishing" the spirit. I'm also suspecting that you need a little bit of copper somewhere in the still where it can come in contact with the vapour. The copper helps catalyse some of the sulphur, esters & organic acids, reducing their odour & taste.

15) Why do my spirits turn cloudy when diluted ?

With neutral spirits, either you have pushed 'tails' into your product (eg collected too much product from the still - quit earlier next time), or you are using poor tap-water (high in calcium carbonate). If it happens when diluting your gin, sambuca or the like, its because there is too little alcohol/too much oil present and the oils are no longer dissolved. Either drink it cloudy or increase the % alcohol present.

16) How do I flavour/turn the vodka's into something else ?

There are now many commercial flavourings available, which turn vodka or neutral alcohol into pretty decent gin or whiskey, or all manor of liqueurs. See the commercial sites, like Des Zines http://homepages.ihug.co.nz/~topkiwi or Ray Toms http://moonshine.co.nz/ for details. Or you can soak it with oak chips and make whiskey, or soak fruits in it to make your own liqueurs. There are many websites describing how to make liqueurs - see http://homedistiller.org/liqueurs.htm or http://www.guntheranderson.com for a starting point.

17) What web resources are there ?

For more details, see :

Tony Ackland's http://homedistiller.org
Aaron Smiths's http://www.go.to/distillation
Steve Spence's http://webconx.green-trust.org/ethanol.htm
StillMaker's http://www.Moonshine-Still.com
Biofuels Library http://journeytoforever.org/biofuel_library.html

18) How do I contact the NEW DISTILLERS news group ?

Both the NEW DISTILLERS and the DISTILLERS news groups are available via YahooGroups, at http://www.yahoogroups.com . NEW DISTILLERS is, as the name suggests, intended for those of you new to distilling and after simple, straight-forward answers to questions, whereas the DISTILLERS group discussions are a bit more advanced, throwing in bits of design philosophy, theory, and alternative ways of achieving the results. Both tend to overlap to some extent.

19) Can I run my car on it ?

You can run your car on alcohol over about 80% purity. Because any water present will seperate out in the presence of the gasoline (and become a problem), you either need to exclusively use the alcohol, or dry it right out (eg 99%+ purity) if using it to mix with gasoline. See Steve Spences site for more details, the Mother Earth Alcohol Fuel manual, or the The Manual for the Home and Farm Production of Alcohol Fuel. In addition, in the USA, you can get a "small fuel producer" permit, which allows small scale distilling for "motor fuel" purposes. A nice advantage is that they don't require denaturing for "fuel" used on the premises. The regulations are posted at http://webconx.green-trust.org/ethanol.htm

20) How do I convert between gallons and litres and ....

To convert between SI & Imperial units, multiply the first unit by the conversion factor to get the second. Divide back to do it in reverse

eg 1L = 0.264 US gal, so 20 L = 20 x 0.264 = 5.28 US gal, and 20 US gal / 0.264 = 75.76 L
1 L = 0.264 US gal = 0.221 UK gal
1 L = 1.057 US qt = 0.880 UK qt
1 kg = 2.204 lbm = 32.15 oz (troy) = 35.27 oz (av)
deg F = ((9/5) x deg C)+ 32
1m = 1000 mm = 39.37 inch = 3.28 ft = 1.09 yd

21) What is a "Thumper" ?

A "thumper" is an extra chamber sometimes fitted to a pot still. It can be as simple as a glass jar with two holes in the lid. The off-take from the still is fed into it, with the pipe running almost all the way to the bottom of the jar; the jar is half filled with liquid (water or mash or tails) so that the vapour from the still will bubble up through it; then the vapour coming off it is collected & cooled as per normal. It acts as a second distilling chamber using just the heat from the vapour, and lifts the purity from 50-60% to 70-80%, hence improving what might otherwise be a very mediocre design. Don't make the thumper too small, and start it off with liquid already high in alcohol.

22) Can Methylated Spirits be made safe to Drink ?

No. Methylated spirits (aka meths) is a mixture of ethanol and (poisonous) methanol, with a denturant added to make it foul tasting. There is no effective way of seperating them, be it by distilling, using carbon, or filtering through bread (old wives tale). Do not add meths to anything you ever intend to distill or drink, and don't try using it in any form - it will still be poisonous. Keep it for cleaning and starting the BBQ with. Likewise, you cant "clean up" antifreeze in your still.

Types of Stills

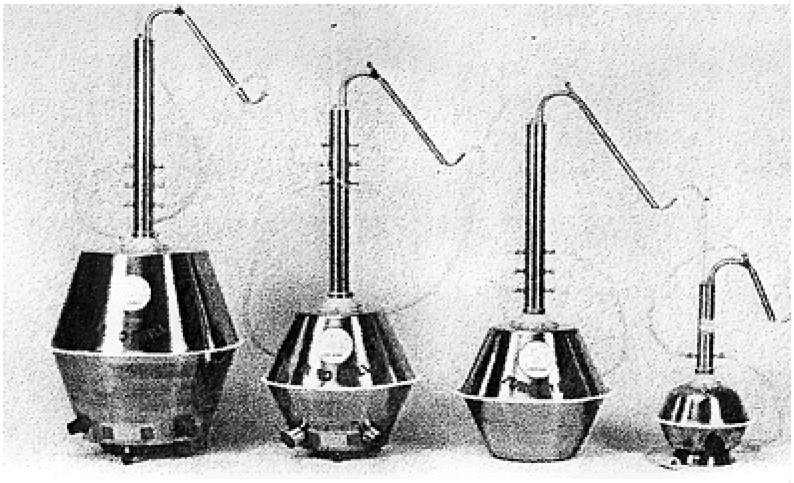
Whats the difference between a pot still, reflux still, and fractionating column ?

A **POT** still simply collects and condenses the alcohol vapours that come off the boiling mash. This will result in an alcohol at about 40-60% purity, with plenty of flavour in it. If this distillate were put through the pot still again, it would increase in purity to around 70-85% purity, and lose a bit of its flavour.

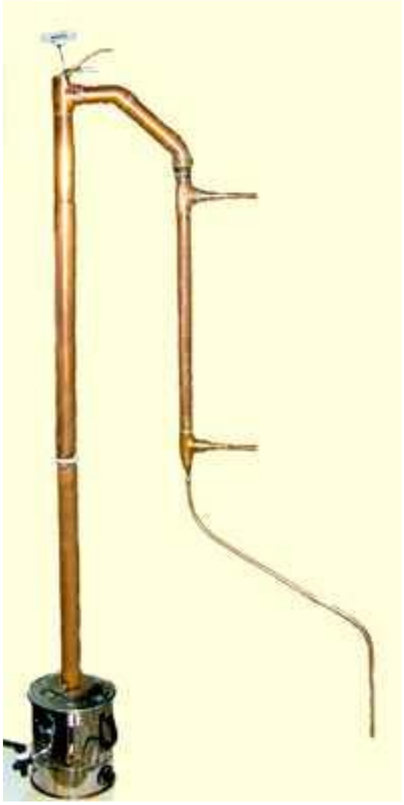
Examples of Pot Stills	
	

A **REFLUX** still does these multiple distillations in one single go, by having some packing in a column between the condensor & the pot, and allowing some of the vapour to condense and trickle back down through the packing. This "reflux" of liquid helps clean the rising vapour and increase the % purity. The taller the packed column, and the more reflux liquid, the purer the product will be. The advantage of doing this is that it will result in a clean vodka, with little flavour to it - ideal for mixing with flavours etc.

Examples of Reflux Stills



A **FRACTIONATING** column is a pure form of the reflux still. It will condense all or most of the vapour at the top of the packing, and return about 9/10 back down the column. The column will be quite tall - say 600-1200mm (2-4 foot), and packed with a material high in surface area, but which takes up little space (pot scrubbers are good for this). It will result in an alcohol 95%+ pure (the theoretical limit without using a vacuum is 95.6%), with no other tastes or impurities in it. Note that both reflux and fractionating stills can still be used to make whisky, rum etc, as they allow a very precise "cut" between the heads, middle, and tail runs.

Examples of Fractionating Columns		
		

Safety

Summary
Will home-distilled alcohol make me go blind ? Not if you're careful. This pervasive question is due to moonshine lore, which abounds with myths of blindness, but few actual documented cases. The concern is due to the presence of methanol (wood alcohol), an optic nerve poison, which can be present in small amounts when fermenting grains or fruits high in pectin. This methanol comes off first from the still, so it is easily segregated and discarded. **A simple rule of thumb for this is to throw away the first 50 mL (reflux still) you collect (per 20 L mash used), or 100-200 mL from a pot still.** There is no safe way of denaturing methylated spirits. The other impurities, which form the tails (known as cogeners or fusel oils) are quite a complex collection, but mostly just smell/taste bad rather than are actually unsafe towards you.

Basic Safety Guidelines when Distilling

- Don't distill in a closed room. Try and keep some through-draught (eg both a window and door open)
- If your still leaks (liquid or steam) - fix it instead of using it
- Collect the alcohol securely - dont put yourself in a position where its easy to knock over the collection vessel etc, or bump the tube out of it. This means having enough space to work in, well lit, tidy.
- Keep a fire extinguisher with you (and on your side of whatever is going to catch fire)
- If using electrical heating, have an RCD on the line (residual current device - a fancy circuit breaker)
- Check your still with water-only the first time you use it, to make sure your condensor is up to the job. You dont want vapour coming out of the collection tube.
- Be sober - its not a time to be making drunken mistakes.
- Pay attention to the still - check it regularly (cooling water still flowing, no leaks, collecting nicely, all temperatures OK)
- Do the maths - don't boil the still dry
- Make sure the outlet tube is free flowing - not crimped or blocked in any way.
- Make sure the still design is such that you can't pressurise the still - it should always be able to vent somehow to atmosphere. There shouldn't be valves such that you can fully close the column off
- Don't smoke - you dont want ignition sources around a liquid as flamable as gasoline

Ethanol Toxicity

The greatest risk to anyone who drinks alcohol is the stock-standard pissed-as-a-newt high school student style of alcohol poisoning. It tends to come from our culture of binge drinking, rather than the more moderate consumption sometimes observed in Europe. Jack has the details ...

> *The fatal dose of ethanol is 300-400 mL of pure ethanol (600-800 mL of 50% spirits), for the average adult if consumed in less than one hour.*
>
> *Chronic users develop a tolerance to ethanol. Ethanol depresses the central nervous system irregularly in descending order from cortex to medulla, depending on the amount ingested. The range between a dose that produces anesthesia and one that impairs vital functions is small. Thus, an amount that produces stupor is dangerously close to a fatal dose. Effects are potentiated by concomitant ingestion of barbiturates and other depressant drugs.*
>
> *Intoxication levels (broadly) are found in this manner:*
>
> - *Mild (Blood alc content 0.05%-0.15% - one fourth of the people at this level are clinically intoxicated) results in decreased inhibition, slight visual imparement, muscular incoordination, and slowed reaction time.*
> - *Moderate: (BAC: 0.15%-0.3% - 50 to 95% of the people at this level are clinically intoxicated)- results in definite visual imparement, sensory loss, muscular incoordination, slurring of speech.*
> - *Severe (BAC 0.3%-0.5% -fatalities begin to occur in this range)- marked muscular incoordination, blurred vision, approaching stupor.*
> - *Coma (BAC above 0.5% - death is common in this range)- Unconsciousness, slowed respiration, complete loss of sensations.*
>
> *Treatment of acute poisoning begins with the removal of unabsorbed ethanol by gastric lavage with tap water or by emesis (induced vomitting). The airway must be kept clear- artificial respiration may be needed. Give 2grams of sodium bicarbonate in 250ml of tap water every 2 hours to maintain neutral or slightly alkaline urine, avoid administration of excess fluids. Avoid all depressant drugs. In the presence of hypoglycemia, give 5-10% glucose intravenously plus thiamine, 100mg intramuscularly. Hemodialysis is needed if the blood ethanol level is above 5mg/ml. Survival for 24 hours is ordinarily followed by recovery.*

I know most of the readers of this website are responsible enough to not need this information, but we just had another college student have a "21 drinks for 21 years" birthday party, and it killed him.

BAC ☐ %

Weight 80 ● kg ○ lb
Gender ● Male ○ Female

Total Consumed 750 ● mL ○ oz
Beverage 6 % alcohol
Time spent Drinking 2 hr

The calculator is intended to give you a rough idea of what blood alcohol content might be after consuming specific quantities of alcohol within a given period of time. It is NOT intended to convey the belief that any quantity of alcohol is a safe quantity if one intends to operate a vehicle or equipment.
Legal limits usually 0.05 - 0.08 depending on local laws.
Calc from http://www.cnn.com/interactive/us/0010/blood.alcohol.calc/

Fire

The next greatest risk to distillers is that of fire. You're producing a liquid which is on a par with gasoline with flammability, yet doing so around heating elements (or even gas flames).

Make sure that there is no way you can build up pressure inside your still - say by blocking the outlet piping (accidently crimping it ?). Make sure your equipment is in good condition when you use it, that its clean (don't want the packing material clogging up & blocking), and that there are no leaks. Don't bury the outlet tube under the surface of the liquid level in the collection jar, rather have it dripping into it openly. If using gas, keep the collection jar quite away from it. Don't set up your collection jars so that they are easily knocked over, and cap them when not in use. Keep your area well ventilated, and never leave the still unattended.

At all times keep a fire extinguisher close.

Will I go Blind ?

A big fear for many new distillers is that they are risking poisoning themselves with methanol - a toxin that can cause blindness. There is little basis for this fear however; if formed, it is only in small amounts, and can be easily discarded with the "heads" collected first (see here) during distillation.

A simple (but effective) rule of thumb for this is to throw away the first 50 mL you collect (per 20 L mash used) for a reflux still. If using a

potstill, make it more like 100-200 mL. Do this, and you have removed all the hazardous foreshots, including the methanol. To get a really clean distinction between the foreshots and the rest of the alcohol, increase the reflux ratio to the point where you're taking off this first 50 mL at a very slow rate (eg 1 drop per second). This will give a very stable equilibrium within the column to allow all the methanol to collect at the top of the column and be in this first portion.

If you are doing a double or triple distillation with a pot still, don't worry about removing the heads & tails on the first pass. Wait for the second run, when they are more distinct & easier to seperate. Once you have removed them, they are gone, so much less will need to be discarded from the subsequent runs, other than that dictated by taste, and any improved seperation that may result from running a more pure distillate through the still.

How dangerous are the various fusel oils ? I've got some of them listed below. **The ones with toxicity data listed are ...**

- **Methanol : usual fatal dose 100-250 mL**
- **1-Pentanol : LD50 (rat) 3030 mg/kg**
- **3-Pentanol : LD50 (rat) 1870 mg/kg**

Compare this to the amounts present in distilled spirits. The data in Wheeler & Willmotts "Spirits unlimited - a complete guide to home distilling" gives :

- **Home distilled spirit (untreated)**: methanol 0.0067%, ethanol 99.632%, fusils 0.361%
- **Commercial vodka**: methanol 0.013%, ethanol 99.507%, fusils 0.48%
- **Poor quality home distilled spirit** : methanol 0.0186%, ethanol 98.453%, and fusils 1.528%

If you're talking about untreated spirits as being dangerous, then to reach the LD50's that are published, you'd need to consume 149 L to be affected by the methanol, or for a 90kg bloke, about 58 L for the pentanol, from the "good" homemade stuff. That would be one hell of a session ! Even on their "poor quality" brew you'd need 11 L for the fusels. Stock standard pissed-as-a-newt high-school-student alcohol poisoning is the greater problem.

Now their "home distilled spirit" was at a time when their best design was only putting out roughly 75% pure ethanol. What's the story from like a Nixon-Stone or Euro doing 95%+ purity ?

Compare that to the levels of methanol etc that you get via other sources ...

Methanol & Other Impurities

Methanol is formed when fermenting beverages high in pectins - eg grapes and berries. Starting with a grain or sugar based wort, in a clean fermentor with a yeast culture from a well aereated source will result in small/none formed.
Carl from Hambletonbard (makers of Alcotec yeasts) details ..

> *Methanol, you will typically get around 2 or 3 parts per million (or milligrams per litre if you prefer) of methanol produced during fermentation of a standard 6kg type Alcotec - this is extremely low even compared to commercial products. We don't have a great deal of data on methanol because whenever we have tested for it we have got extremely low results.*

Mike explains about the pectin ..

> *The methanol comes from the pectin, which mainly composed of methyl esters of galactose. When pectin breaks down, by enzymes introduced by microorganisms, or deliberately introduced, the methyl esters combine with water to produce methanol, so the aim should be to leave the pectin well alone if you can.*
>
> *I think Jack would agree that what he means is that fermenting at a high temperature, or adding pectin enzyme, or trying for an abv higher than 12% all increase the risk of methanol being produced, so his advice about low temperature fermentation, adding no exra enzymes, and a target lower than 12%abv is all good stuff.*

You are already being exposed to methanol from other sources. Some fruit juices are naturally high in methanol - for example apple juice can have 0.2-0.3% methanol, or if derived from pulp by enzymatic degradation, the levels can be 2 to 3 times higher.

Johan found ..

> *In http://archive.food.gov.uk/maff/archive/food/infsheet/1993/no17/17orange.htm* ***orange juice contains 10 to 50 times as much methanol as sugarmash.***

> *The lethal dose of methanol is at least 100 ml that is equal to about 80000 mg or you need 27000 liters of mash at least to get that amount.*
>
> *also from the webpage: "Dietary surveys have shown that an extreme consumer of orange juice drinks slightly over 2 litres/day. The estimated maximum intake of methanol based on this consumption would be 455 mg for a 60 kg adult which is below the maximum advisory intake of 600 mg per day for a 60 kg adult, recommended by the Department of Health."*
>
> *So if we stay under 600 mg per day we are safe, that's the same as 200 liters of mash per day or about 70 liters of 40% alcohol per day if you weight is 60 kg.*
>
> *total amount of methanol in mash expressed in ml is about 0.1 ml = nothing.*

Jack comments ...

> *The Long Ashton Research Station did some studies that showed that ciders and apple juices clarified with pectic enzymes are higher in methanol due to the demethylation of juice pectins. The methanol content varied from 10 to 400 ppm in the test samples. I don't know which fruits are highest/lowest in pectin content, but apples are commonly considered the highest.*
>
> *This is why all the old books on cider making refer to a condition called "apple palsey" - it's the massively painfull hangover from the high methanol content. In order to prevent this (I'm sure distilling the pectin turns it into methanol) distillers must fully clarify any fruit wine before cooking it. Rather than use clarifiers, put the wine into 2 or 4 liter plastic jugs (only filled half full) and freeze them solid, then thaw them out, this will result in perfectly clear (and chill- stabilized) wine ready for distilling. After the thawing is complete or maybe as much as a week after, the wine will be crystal clear.*

Stephen Alexander reports that commercial spirits contain small levels of methanol. 'Food Chemistry' by Belitz&Grosch list an assay of about 50 different components of about 10 different distilled beverages. The US and Scotch whiskies had methanol levels around 0.2 to 0.3 %. Kevin Brown has scanned in some MeOH chromatograms from a column application guide published by Supelco of Bellefonte, PA. (a vendor for chromatography supplies). Check out http://amlc.uvi.edu/distill/meoh.html for details.

See also "Increasing Direct Marketing for Fruit Farmers by Connecting Producer to Producer through Research and Development of a Value-Added Product" at http://www.ams.usda.gov/tmd/FSMIP/FY2001/MO0341.pdf for quite a detailed report into the compostion & quantities of impurities present etc in fruit brandies, and the factors affecting their production.

The Food and Drug Administration (FDA) advised ATF that 0.1 percent of methanol by volume in wine was a safe level. Any wine containing methanol in excess of this amount is deemed adulterated pursuant to the Federal Food, Drug and Cosmetic Act, 21 U.S.C. 34l(a)(2)(C) and 348.

From http://www.polishvodkas.com/fr_vodka-tech.htm - it reckons that a molasses wash won't have any methanol present !

> *"....Molasses spirit can also be rectified and then used to produce vodka. In some countries it is even preferred, since it contains no methyl alcohol at all. Crop-sourced spirit contains infinitesimal amounts of methyl alcohol which have no effect on health, but some people, victims of their own overconcern, insist on molasses spirit. I should add that the presence of these tiny amounts of methyl alcohol have no effect whatever on the aroma of even unflavoured vodka. It is simply undetectable. In neutral grain or potato spirit the methyl alcohol has practically disappeared....."*

"DBall" asks .. If Methanol is poison and is removed at the beginning of distillation... Question: When/how is methanol removed from wine or beer?

Brad answers ...

> *It's not tricky at all. Methanol is a by-product of fermentation; more methanol is produced in fruit fermentation than in grains. Brewers do not remove the methanol in beer and wine because methanol is not especially toxic at low concentrations. You are looking at between 0.4%-1% methanol in wines and brandies and smaller amounts in beers. Distillers remove almost all the methanol in most cases. Ever notice how vodka produces clean hangovers and wines (particularly reds) give you very nasty hangovers? Methanol. That, and dehydration!*

> *Methanol is an especially nasty type of alcohol because the body tries to break it down the same way it metabolizes, or breaks down, ethanol, the type of alcohol in beer, wine and other drinks. Metabolizing ethanol produces chemicals less toxic to the body than alcohol. Unfortunately, if the same chemical action is performed on methanol the result is formic acid, lactic acid and formaldehyde.*
>
> *Formaldehyde attacks nerve cells, especially the optic nerve and can damage the liver and kidneys. Formic acid and lactic acid also attack the kidneys and liver. Most people who have drunk methanol die of severe and sudden kidney and liver failure.*
>
> *Chronic methanol drinking will cause optical damage. The stories of moonshine causing blindness comes from U.S. prohibition times where some bootleggers used to cut moonshine with methylated spirits to increase profit.*

Gregory writes:

> *It isn't the yeast that controls methanol, it's what you're fermenting. I believe yeast has very limited metabolic pathways around methanol. Quoting from -*
>
> *"Basically it can be produced biologically in 2 ways; through the oxidation of methane by methane monooxygenase, or by the reduction of formaldehyde, by methanol dehydrogenase (and this reaction normally works in the reverse direction).*
>
> *It's true that some methanol can be produced during fermentation, but this is not derived from the ethanol or by carbohydrate oxidation. It is produced in small amounts, either by non-enzymatic reactions or through the reduction of formaldehyde."*
>
> *Methane isn't present in our washes, so the culprit is formaldehyde. I believe the pectins in fruit are methylated and can break down in the wash into formaldehyde. But so long as your wash has only pure fermentable carbohydrates, you can expect essentially zero methanol. There's a bit more in this discussion of methanol here: http://yarchive.net/med/methanol_poisoning.html*

> *Ethyl acetate, OTOH, is produced spontaneously whenever acetate is present with ethanol. There are several possible sources of acetate during fermentation. In general, acetate is formed by oxidation of ethanol. (In fact, acetate is the 'end-product' of our own metabolism of ethanol). In fermentation, oxidation of ethanol into acetate can happen as a result of desperate yeast metabolizing its own ethanol, or by contamination with other yeasts or bacteria.*
>
> *See http://en.wikipedia.org/wiki/Wine_fault*

Methanol Toxicity

Ups advises about methanol toxicity :

> *The fatal dose of methanol is 60 to 250 mL. Death depends on the size of the individual, their general health and stomach contents. The exposure limit is 200ppm. The highly lethal nature of methanol (compared to ethanol) has not been fully researched, but it is believed to be the result of the byproducts of metabolism, which turn methanol into formic acid and formaldehyde, and formaldehyde has been proven to have selective injurious effects on retal cells- this is the reason for it's ability to cause blindness.*
>
> *Methanol is metabolized and excreted at a rate about one-fifth that of ethanol, and a single dose may take up to 4 days to leave the body (provided the drinker isn't already dead)*
>
> *Symptoms fom acute poisoning of a moderate dose- Severe headache, dizziness, nausea and vomiting, and central nervous system depression. Vision may fail temporarily or permanently after 2-6 days. In higher doses the above occurs much faster and turn into rapid shallow breathing, blood pressure falling, dilation of pupils blurring of vision, cyanosis. More than 25% of those who reach this level, even in a hospital, still die.*
>
> *Chronic poisoning tends to result in visual imparement as the first symptom. The only treatment from chronic poisoning is to halt all exposure.*
>
> *Treating acute cases must be done within 2 hours of ingestion: give syrup*

of ipacac. Lavage thoroughly with 2-4L of tap water with sodium bicarbonate (20G/L) added. This is to treat acidosis of the blood)

Antidote: Give ethanol, 50%, 1.5ml per kilo of body weight, orally, diluted to no more than a 5% solution, followed by 0.5-1ml/kg every 2 hours orally for 4 days. ethanol interferes with the absorbtion of methanol by the body and allows it to be excreted with less damaging effects. Also give up to 4 litres of water daily to maintain adequate urine output. Control delirium by giving 10mg valium slowly by injection in order to prevent respiratory depression.

Prognosis:in acute methanol poisoning approx 50% do not recover. Visual imparement will show no improvement after 1 week.

Looking up medical and drug testing labs in the phonebook will help you find someplace to send a sample of the stuff your making (say you found it in a friend's room and your worried about what he's drinking) to see how clean it is.

Lead Poisoning

One real problem can be if you use lead based solder in building your still. A very bad practice that use to be prevalent was the use of old car radiators as the vapour condenser. THIS SHOULD NOT BE DONE. Car radiators are lead-soldered, and the lead will leach out and poison you. Any still construction should be welding, brazing, or silver soldering.

From "Moonshine & lead poisoning" : http://www.cdc.gov/mmwr/preview/mmwrhtml/00016616.htm May 01, 1992 / 41(17);294-295

> ***Elevated Blood Lead Levels Associated with Illicitly Distilled Alcohol -- Alabama, 1990-1991***
>
> *The use of automobile radiators containing lead-soldered parts in the illicit distillation of alcohol (i.e., "moonshine") is an important source of lead poisoning among persons in some rural Alabama counties.*
>
> *From March 5 through October 26, 1991, eight persons were diagnosed with elevated blood lead levels (BLLs) at a local hospital and were reported to the*

notifiable disease surveillance system maintained by the Alabama Department of Public Health (ADPH). None of these patients had known histories of occupational or other potential sources of lead exposure, but all reported recent histories of moonshine ingestion. This report summarizes the results of an investigation of these cases conducted by the ADPH during December 1991.

A case-patient was defined as any person aged greater than or equal to 17 years who presented to the hospital from January 1, 1990, through December 31, 1991, and had a BLL greater than or equal to 15 ug/dL. Laboratory records of specimens submitted for blood lead determination, and medical records were reviewed at the hospital. In addition to the eight patients reported to the ADPH, review of laboratory records identified one patient with a BLL of 35 ug/dL during November 1990.

Patients ranged in age from 28 to 64 years (median: 33 years); five were female. Five patients resided in the county in which the hospital is located, and four lived in adjacent counties.

All nine patients had been evaluated for alcohol-related medical conditions at the hospital. Manifestations included generalized tonic-clonic seizures (six), microcytic anemia (five) (hematocrit mean: 32.1%), encephalopathy (two), upper extremity weakness (one), and abdominal colic (one). BLLs ranged from 16 ug/dL to 259 ug/dL (median: 67 ug/dL).

Seven patients required hospitalization for 48 hours or longer (range: 2-18 days). Three of these received chelation therapy; initial BLLs were 67, 228, and 259 ug/dL. One patient, whose BLL was 67 ug/dL, died during hospitalization from alcohol-withdrawal syndrome complicated by aspiration pneumonia.

*Patients reported moonshine ingestion ranging from 0.2 L per day to 1.5 L per day. No specimens of moonshine consumed by the patients were available for analysis. However, the lead contents of specimens of moonshine confiscated from two radiator-containing stills in the county in 1991 were 7400 ug/L and 9700 ug/L, compared with nondetectable amounts (less than 1.0 ug/L) in municipal water from the county. Consumption of 0.5 L per day of moonshine containing 9700 ug/L lead would result in a steady state BLL of approximately 190 ug/dL. **

Reported by: T Dix, S Walker, MD, Crenshaw County Hospital, Luverne; D Cosby, Alabama Alcohol Beverage Control, Andalusia; CH Woernle, MD, State Epidemiologist, Alabama Dept of Public Health. Div of Field Epidemiology, Epidemiology Program Office; Lead Poisoning Prevention Br, Div of Environmental Hazards and Health Effects, National Center for Environmental Health and

Injury Control, CDC.

Editorial Note: The findings in the ADPH investigation underscore the adverse health effects associated with consumption of moonshine. Specifically, this problem can result from the leaching of lead from solder used in radiators or the adjoining copper pipe during distillation; moonshine may contain up to 74 ug/L of lead (1).

In adults, manifestations of lead intoxication include gastrointestinal, hematopoietic, renal, reproductive, and neurologic findings (e.g., peripheral neuropathy and encephalopathy) (1-3). Because signs and symptoms of lead poisoning may be nonspecific, the relative contribution of lead and alcohol toxicity to illness in these patients could not be determined. However, overt signs and symptoms of neurotoxicity rarely occur in adults when BLLs are less than 40 ug/dL (1). Thus, the seizures observed in these patients with BLLs less than 40 ug/dL may have been related to alcohol withdrawal rather than lead toxicity.

This cluster of patients with elevated BLLs was detected through review of notifiable disease surveillance data. In Alabama, elevated BLLs (greater than or equal to 15 ug/dL) have been a notifiable condition since December 1990. In 1991, 612 persons aged greater than or equal to 17 years with BLLs greater than or equal to 15 ug/dL were reported to the ADPH notifiable disease registry. Of these, the two highest values (228 ug/dL and 259 ug/dL) were from patients in this cluster.

The nine patients identified in this cluster may underrepresent the number of lead toxicity cases related to moonshine ingestion in the counties involved in this study and in others throughout Alabama. Although the number of illegal stills operating in Alabama is unknown, Alabama Alcohol Beverage Control destroyed 94 stills in 1991, including 50 stills in the county where the hospital is located and in two adjacent counties (D. Cosby, Alabama Alcohol Beverage Control, personal communication, 1992). Since a typical four-barrel still can produce 75-95 L of moonshine per week, a substantially higher number of persons may be at risk for lead toxicity from moonshine ingestion. Ongoing surveillance efforts are directed toward further characterizing risk factors for elevated BLLs and may assist in determining the scope of lead poisoning from moonshine ingestion among Alabama residents.

Because of the illegal source of the alcohol, patients may be reluctant to admit to moonshine ingestion. Therefore, clinicians, particularly in rural areas, should suspect moonshine ingestion when treating alcohol-abusing patients, both to detect and treat the adverse effects of lead poisoning and to direct alcohol-

prevention efforts.

References

Agency for Toxic Substances and Disease Registry. Toxicologic profile for lead. Atlanta: US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, 1992.

Baker EL, Landrigan PJ, Barbour AG, et al. Occupational lead poisoning in the United States: clinical and biochemical findings related to blood lead levels. Br J Ind Med 1979;36:314-22.

Goldman RH, Baker EL, Hannan M, Kamerow DB. Lead poisoning in automobile radiator mechanics. N Engl J Med 1987;317:214-8.

Assuming an equilibrium blood lead/dietary intake slope of 0.04 ug/dL per ug/day.

Denatured Methanol

Why can't we get commercial methylated spirits and just distill it to make it safe to drink ?

Methylated spirits (a.k.a. denatured spirits) is ethanol or methanol with various chemicals added to make it undrinkable (well unless you're desperate). Some commercial distilleries sell their foreshots as metho after denaturing them with the pyridine and wood naptha group[s]; two of the most obnoxious, toxic/poisonous compounds in that family. The whole point of denaturing it is to add chemicals that can't be easily removed, then it can be sold without excise tax.

The additives chosen have vaporisation properties almost identical to ethanol so can't be separated by distillation and/or chemical methods. The Australian/New Zealand Food Authority Act has chosen pyridine & wood naptha because they BOND in an ethanol/water solution most delightfully to the point that to separate this evil concoction you would need rising/falling film distillation equipment which worked under vacuum as well and then the result after one pass may only be marginal. This cost for this sort of equipment starts around 6 figures

Fusel Oil Composition

Thanks to Brad, heres a bit more detail on what has been found in the fusels, and can be present in your distilled product:

Quotes from the MERCK INDEX 10th Ed. 1983 (entry number given):

4195. Fusel Oil.

A by-product of carbohydrate fermentation to produce ethyl alc. The material varies widely in composition, depending on the fermentation raw material used, but contains chiefly isopentyl alcohol and 2-methyl-1-butanol as well as isobutyl alcohol(20%), n-propyl alcohol(3-5%), and small amounts of other alcohols, esters and aldehydes. Described as an oily liq with a disagreeable odor; 60% boils at 122-138°. Amyl alcohol (commercial) obtained by chemical treatment and refining of fusel oil contains about 85% isopentyl alcohol and 15% 2-methyl-1-butanol. Ref: Industrial Chemicals, W.L. Faith et al.

5816. Methanol.

Methyl alcohol; carbinol; wood spirit; wood alcohol. Flammable, poisonous, mobile liq. Slight alcoholic odor when pure; crude material may have a repulsive, pungent odor. Burns with a non-luminous, bluish flame. bp 64.7°. mp -97.8°. Caution: Poisoning may occur from ingestion, inhalation or percutaneous absorption. Acute Effects: Headache, fatigue, nausea, visual impairment or complete blindness (may be permanent), acidosis, convulsions, mydriasis, circulatory collapse, respiratory failure, death. Death from ingestion of less than 30ml has been reported. Usual fatal dose 100-250ml. Chronic: Visual impairment, cf.Patty's Industrial Hygiene and Toxicology vol. 2C, G.D.Clayton et al. pp 4528-4541.
The alcohols of interest in the same MERCK: (just the boiling points at atmospheric pressure, some basic characteristics and all the alternative names for each alcohol)

212. Alcohol, Anhydrous. Ethanol

; ethyl alcohol. Clear, colorless, very mobile, flammable liquid; pleasant odor; burning taste. Absorbs water rapidly from air. bp 78.5°. mp -114.1°. Solidif below -130°.

4978. Isobutyl Alcohol.

2-methyl-1-propanol; isopropylcarbinol; 1-hydroxymethylpropane; fermentation butyl alcohol. Colorless, refractive liq; flammable; odor like that of amyl alcohol, but weaker. bp 108°. mp -108°.

5042. Isopentyl Alcohol.

3-methyl-1-butanol; isoamyl alcohol; isobutyl carbinol; primary isoamyl alcohol; fermentation amyl alcohol. Liquid; characteristic, disagreeable odor; pungent, repulsive taste. Vapors are poisonous! bp 132.0°. mp -117.2°. Caution: May be moderately irritating to mucous membranes. High concns may cause CNS depression, narcosis; lower concns, headache, dizziness.

5906. 2-Methyl-1-butanol.

Active amyl alcohol; dl-sec-butyl carbinol. One of the major components of fusel oil. Liquid, bp 128°.

5907.3-Methyl-2-butanol.

dl-sec-Isoamyl alcohol; sec-isopentyl alcohol; isopropyl ethyl carbinol. Liquid, bp 113-114°. Fusel oil component.

211.Alcohol, 95%.

Binary azeotrope having a distillate composition of 95.57% ethyl alcohol (by wt) and bp 78.15°C. Also specified as containing 94.9% by vol or 92.3% by wt of ethyl alcohol at 15.56°C. See U.S.P. XVIII, 20, 1067(1970). d 0.816 at 15.56°C (60°F).

6985. 1-Pentanol.

Pentyl alcohol; n-amyl alcohol; n-butyl carbinol. Liquid, mild characteristic odor. bp 137.5°C. mp -79°C. Slightly soluble in water (2.7g/100ml at 22°C); misc with alcohol, ether. LD50 orally in rats: 3030mg/Kg, P.M.Jenner et al., Food Cosmet. Toxicol. 2, 327 (1964). Toxicity: Irritating to eyes, respiratory passages. Narcotic: E.Browning, Toxicity and Metabolism of Industrial Solvents (Elsevier, New York, 1965)pp 356-367.

6986. 2-Pentanol.

dl-sec-Amyl alcohol; methyl propyl carbinol. Liquid, characteristic odor. bp 119.3°C. Slightly soluble in water (16.6g/100ml at 20°C). Miscible with alcohol, ether. Caution: see 1-Pentanol.

6987. 3-Pentanol.

Diethyl carbinol. Liquid, characteristic odor. bp 115.6°C. Slightly soluble in water (5.5g/100g at 30°C); sol in alcohol, ether. LD50 orally in rats: 1870mg/Kg, Smyth et al., Arch. Ind. Hyg. Occup. Med. 10, 61 (1954). Caution: see 1-Pentanol.

Brad also commented :

As you can probably see from these brief descriptions, methanol appears to be one of the most toxic of all. In fact the other alcohols by and large appear to have much the same effct as ethanol when consumed (with much greater activity/toxicity), except methanol which has some toxic metabolite (formaldehyde) which is somehow toxic to the optical nerves of the eye. Ethanol *administration is actually used to slow down the metabolism of methanol when it's accidentally consumed!! Note the Merck note about Chronic effect (long-term use) of methanol being visual impairment; does this occur to heavy drinkers?!?*

Theory

Summary
When you heat up a mixture of liquids, the more volitile components will tend to come off first. There is a bit of overlap (so it is never pure), but generally we can seperate the ethanol from the water and other impurities present. The more alcohol in the liquid, the more alcohol will be in the vapour, so multiple distillations allow us to increase the strength & purity right up to 96.5%

Distillation Theory

The concept of distillation is really quite simple.

- Mike Nixon has compiled an excellent pdf "Distillation - How it Works" explaining all this a lot clearer than what i have below. Right down to plate theory for heat exchangers, without making it complicated. Either e-mail Mike for it, or download it from me here (95 Kb, 16 Nov 99). A more detailed explanation is in his new book "The Compleat Distiller" at http://www.amphora-society.com.
- Another explaination, geared towards distilling ethanol from agricultural products,is Purdue University's http://persephone.agcom.purdue.edu/AgCom/Pubs/AE/AE-117.html note "Alcohol distillation : basic principles, equipment, performance relationships, and safety".
- The University of Akron has a slide show covering the basics too.
- See also : "The Brewery's" Technical Library for articles on brewing related topics (extremely comprehensive)., and
- AllTech's company homepage has much good literature.

Here's a some-what simplified explaination ....(thanks to Mike)

When you have a mixture of liquids, each with its own boiling point when pure, then the boiling point of the mix will lie somewhere in the middle, and this will depend on the relative concentrations of each liquid. Pure water boils at 100 deg C, and pure ethanol boils at 78.5 deg C, but a mixture of water and ethanol will boil at some point in between. The major point about distillation is that when a mixture like that boils, then the vapour given off is richer in the most volatile component, and when that vapour condenses then the resulting liquid has a lower boiling point than the mix it came from. By repeating this boiling and recondensation process up a column, using packing to hold the condensed liquid at each stage, you can separate the components more and more.

So if you have a mixture of liquids each with a different boiling point, then you heat the mixture, it will heat up until the new intermediate boiling point is reached. When you first start a distilling run, the packing in the column will be at room temperature, so vapour given off by the boiler condenses on the first cool packing it reaches. In condensing, the vapour gives up a lot of heat, and this warms that packing until the liquid on it boils again. However, this liquid is richer in volatiles than the mix in the boiler, so its boiling point is lower. When it does boil again, from the heat given off by more condensing vapour, what you get is even richer in those most volatile components. This process of boiling and condensing continues up the column and, because the condensed liquid is always getting richer in volatiles, the temperature gradually falls the higher you go. The temperature at any point is governed solely by the boiling point of that liquid mix, and any attempt to interfere with that process will disrupt the separation that Nature is carrying out automatically.

In contrast, the boiling point of the mix left in the boiler will very slowly start to rise as it is left with less and less of the most volatile components.

If you started with a mixture (fermented wash) that is mostly water & ethanol, with trace amounts of methanol, propanol, etc. then the net result will be that the most volatile components will tend to rise in greater quantity up the column than their less volatile cousins, and will be found in greatest concentration at the top. This would mean that methanol, the most volatile of the lot, will win the race and you will able to collect it and set it aside. This continues until you have collected all of the "heads" (components that are more volatile than ethanol), and you can then collect just ethanol with a trace of water. You cannot get rid of that small amount of water, as once you reach a mix of 96.5% ethanol/water, with a boiling point of 78.2 deg C, then you have reached a stable mix that no amount of re-boiling and re-condensation can change (at normal atmospheric pressure).

Once you have collected the main bulk of ethanol, then the components that are less volatile than ethanol, such as propanol and the bigger organic molecules, will start to reach the top, and you will have arrived at the stage called the "tails". These "tails" may be recycled in the next batch you do, for they still contain a lot of ethanol, or a proportion may be retained as they contain many of the compounds that give a spirit a distinctive flavour, like whiskey or rum.

Note that you are not changing any part of your original brew - you're not "making" the alcohol, or converting it to something else or nasty. All you are doing is concentrating off the original brew into its various parts. There is no more methanol after you finish than what you started with. What does happen though, is that because most of the methanol comes off at once (first up), it is highly concentrated, and can damage you. You definately don't want to be sampling the first portion of distillate that you collect. But once you have thrown away this part, you have guaranteed that the remaining distillate is safe enough to partake of.

Distillate Strength

You can use the graph below (thanks to Grant D) to relate a liquid's % alcohol and its boiling point. It also shows the % alcohol of the condensed vapour. (The data for the graph (and heaps of other stuff) is on my Calculation page if you're interested in drawing it yourself.)

Physical Properties

Value	Units	Ethanol	Water	Reference
Liquid density	g/mL	0.789	1.000	Perry 3.2
Vapour density @ 90C	g/mL	0.0015	0.001	PV=nRT
Molecular weight	g/mol	46.0634	18.0152	Perry 3.2
Liquid Heat Capacity	J/gK	2.845	4.184	Perry 3-183
Heat of Vapourisation	J/g	855	2260	Perry 3-178
Vapour Pressure @ 90C	torr	1187	525	Perry 13-4
Liquid Viscosity	kg/ms	0.00037	0.00032	Perry 3-252
Vapour Viscosity	kg/ms	108×10^{-7}	125×10^{-7}	Perry 3-311
Surface Tension @ 20C	mN/m	22.39	72.75	Kay & Laby
Vapour Diffusivity ethanol/water	m^2/s	?		?
Vapour Diffusivity ethanol/air	m^2/s	102×10^{-7}		Perry 3-319
Liquid Diffusivity ethanol/water	m^2/s	128×10^{-11}		Perry 3-319

For example: A liquid of 10% alcohol will boil at 93 degrees (ie the point on the blue line directly above 10 on the Alc by Vol axis). If you head horizontally from the 93 degree point until you hit the red line, then drop down to the alcohol axis, it strikes 55%.
So, for a simple still, a 10% alcohol wash will boil at (initially) 93 degrees and the vapour, once condensed, will contain 55% alcohol by volume. Likewise, redistilling a 40% spirit should result in a brew around 80%.

At 11 % alcohol (liquid) the vapour will be 57,6 % alcohol

At 12 % alcohol (liquid) the vapour will be 59,9 % alcohol
At 13 % alcohol (liquid) the vapour will be 61,9 % alcohol

At 14 % alcohol (liquid) the vapour will be 63,5 % alcohol

At 16 % alcohol (liquid) the vapour will be 66,2 % alcohol
At 17 % alcohol (liquid) the vapour will be 67,3 % alcohol
At 18 % alcohol (liquid) the vapour will be 68,2 % alcohol

At 20 % alcohol (liquid) the vapour will be 69,5 % alcohol

At 15 % alcohol (liquid) the vapour will be 65 % alcohol

Note that only 96.5% ethanol can be obtained by regular distillation of alcohol & water. Absolute ethanol (100%) is made by distilling with benzene (poisonous) (an azeotropic mixture of benzene, alcohol & water distills at 65C and removes the last few percent of water), by vacuum distillation, or by chemical means (eg using drying agents like molecular seives - which with holes of 3 Angstrom (one Angstrom is one ten billionth of a meter) can separate water (which has a diameter of 2.5 Angstroms) from ethanol (which has a diameter of 4.5 Angstroms)). **Update** Phil advises me that most major commercial distilleries in Australia use Cyclohexane rather than Benzene.

Reflux Still Design

Summary
To increase the purity of the alcohol, and hence reduce the amount of "off-flavours" in it, you need to use a taller column, packed with something which has a large surface area (scrubbers are best), and have some of the vapour condensing and being returned back down over the packing as a liquid (reflux). For a certain height of packing (called the HETP), the purity will improve - roughly 1x = approx 85% purity, 3x = 90%, 5x = 93%, and 7-9xfor 95%+. Just make it as high as what you want pure. For scrubbers the HETP is about 10cm (4 inches), whereas it is 24-38 cm (10-16 inches) for raschig rings or marbles.

See my Detail of the Equations used if you want to get into the detail of this.

Purity is improved during distillation by allowing the rising vapour to mingle with some liquid at a slightly cooler temperature. In doing so, some of the water rich vapour will condense, supplying a bit of energy to allow some alcohol rich vapour to form from the liquid , and join the existing vapour. Each time this "mingling" is sufficient to reach equilibrium, the purity takes a "step" on the graph below:

Thanks to Chris Noonan for helping do this Applet.

This graph is of the "ethanol-water equilibrium" eg a liquid of 15% alcohol will be in equilibrium with a vapour at 65% alcohol. If this 65% vapour is then cooled to form a liquid (it will remain at 65%), the new liquid would then be at equilibrium with a 84% vapour, and so on. If you have a pot still, just set the plates to one.

You can see that due to the shape of the curve, most of the gains are early on; to get to the really high % purity, you need to take lots of steps later on. There is no way around this. If you want high purity, you have to work hard for it. Also note (particularly for inefficient columns with the equivalent of only 1-2 plates) that the starting % can also affect the final % achieved - hence a good idea to use the better yeasts.

Each of these "steps" represents an "ideal plate" where enough mingling of liquid & vapour allows them to come to equilibrium. If you don't allow enough mingling (equilibrium), then you won't achieve a full step, but end up a little shy of the target. You get the first step free - its the boiler/pot.

Basically, off a 10% wash
1 = 53%
2 = 80%
3 = 87%
4 = 90%
5 = 92%
6 = 92.6%
7 = 93.3%
8 = 93.8%
9 = 94.2%
10 = 94.4%

One way of doing these steps is to do many single distillations, collect the vapour that comes off, condense it, clean out the still, and run it through the still again. This why pot stillers do double & triple distillations to get into the 80+ % range. But a Reflux column allows this to happen continuously; if given enough surface area to equilibrate on, the vapour can have gone through multiple distillations by the time it gets to the top of the column.

For each plate to work, it has to be at a particular temperature, slightly cooler than the one below, and warmer than the one above. Only then will it achieve its equilibrium and an increase in the alcohol purity. The differences are really fine too – its all happening only between 78.1 C and 82.2 C – quite a tight band to walk between.

Mike Nixon explains in a bit more detail ...

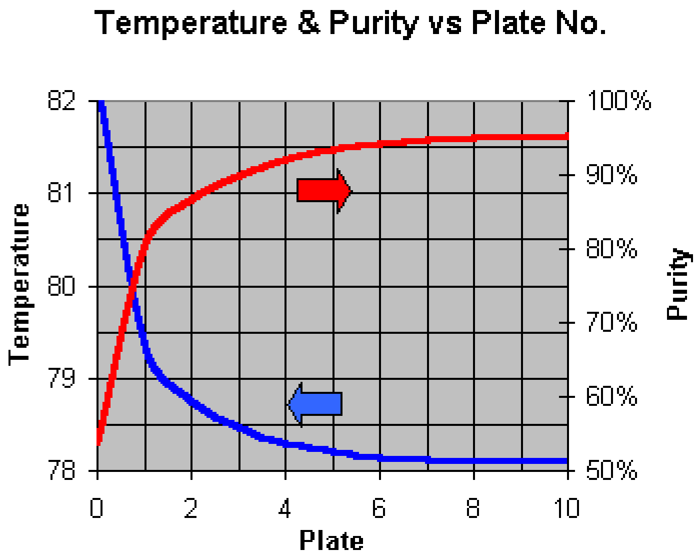
> *The process of separation depends on two facts:*
>
> *1) when a vapor condenses then the resulting liquid has the same composition as the vapor, and the temperature at which this occurs is the same as the boiling point of that mixture. The boiling point lowers as the proportion of volatiles increases, so the temperature as you go up a column naturally decreases. One sticking point is that many think that a vapor only condenses when it encounters a surface that is cooler than the boiling point, but this is not so. Condensation occurs when there is a path*

for the latent heat of vaporization/condensation to be removed from the vapor, and the resulting liquid will remain at its boiling point if no further heat is removed.

2) when this liquid re-evaporates then the resulting vapor is richer in the most volatile components.

The packing is there simply to hold intermediate distillate in place so it can be bathed in hot, rising vapor and allow this second process to occur. As volatiles are further extracted from the intermediate distillate, the boiling point of what remains increases and the depleted liquid builds up, eventually dripping down the packing to a hotter level where it can again be stripped of more volatiles.

A cooling tube placed near the bottom of a column simply interrupts this natural progression and serves no useful purpose in the separation process. In contrast, the top cooling tube IS useful as it helps to return some of the vapor arriving at the top of the column to the packing, where it has a further chance of being stripped more thoroughly. This is what a condenser placed on top of a compound column does, but with more efficiency.



This is where the various designs that have cooling tubes running through their columns at all different heights (eg Labmaster) come adrift – they don't allow the required sequence of temperatures to develop fully, and thus won't work at their full potential. They also don't allow all the refluxed liquid to do its job over the packing – the less liquid/vapour contact the poorer the "polishing" of the vapour will be.

This is why you should also (see my interactive Heat & Mass Balance page to play with these and see it for yourself):

- Insulate the column well (don't want breezes causing additional cooling out of sequence),
- Let the column run at total reflux for a while (to allow the packings to heat up to their equilibrium temperature). This is also important so that the methanol is given a chance to all work its way to the top of the column, so that it will all come off in the first off-take,
- Only have condensors for reflux above the packing, and
- Use a stable/continuous heat source (you don't want it switching off & on all the time causing surges of vapour going up the column then periods of nothing; it has to be a steady continuous flow of vapour & liquid)

So you can easily work out what is required to get a particular % purity; just look up the number of ideal plates needed, eg 2 plates = 87%, 3=90%, 4=92% and so on. Remember you get the first one free - its the pot.

A pot still is the equivalent of a single plate; if it has "thumpers" attached to it, each of these can act as an extra plate.

Why call them plates ? In large distillation columns, they are exactly that; large metal plates or trays, which the liquid flows over, and the gas bubbles up through holes in them. However they are quite tricky to design & build, and not really suited for small column diameters (say less than 1 ft diameter) - they're just too fiddly. Below this size, its easier to use a Packed Column; where the packing can be random (eg just dumped in there and given a shake), or carefully positioned & stacked . For any particular type of packing, we can estimate how much of it is required to make one of these "ideal plates". See http://www.5continentsusa.com/cer-pack.htm for examples of different commercially available types of packing. These commercial packings are quite difficult to source, then expensive to purchase. They're designed for an industrial operation, where they're expected to be run continuously 24/7 for weeks or months at a time without fouling up. For a hobby distiller it is far easier, and with higher performance (%purity), to use common pot scourers (non-rusting stainless steel or copper) instead for packing, as we'll be cleaning them frequently (like after every 20L run).

Jim adds:

> *While gathering materials for my (first) reflux still, I came across an interesting material used for making batteries. It's a fine-mesh expanded metal made from copper by the Exmet Corporation. They make expanded metal from a variety of metals besides copper in sheets varying in width from .099 in. to 60 in.*
> *Their spec sheet is found at: http://www.exmet-corp.com/chart.html*
> *I don't know how you would calculate the void to surface ratio to get optimum results. I leave that to the "experts".One could roll a 30" wide sheet, for example, into a single piece that could be inserted into the column. It would have a very consistent internal structure. It would be easy to remove and clean.*

Phil suggests a cheap supply of ceramic packings though ...

> *Have you checked the aquarium shops for ceramic rings used for pre filtration. I recently bought 2 litres for change from £10 (£4.85/l). I suspect they would do the same job. They also come in hex or tube shapes. There are also similar rings for bio filtration that have an open surface area so would perhaps be more efficient, though could be a bugger to clean*

More about using plates (rather than packed columns ...

> *Ken : The idea with a fractionating column is a temperature gradient (falling of course) as you go UP the column, but a constant temperature ACROSS the column at any height. As the diameter of the column increases, it gets harder to achieve the constant temperature at a given height if you continue to use a packing material -- hence the plates. Plates give you resistance to flow in an upwards direction, but very easy "spreading" horizontally.*
>
> *George : From what I have read, a general rule of thumb is; up to 4" you would be better off with scrubbers, anything bigger than 4" and scrubber will tend to channel, from 4" up to 8" you would do well with packing like pall rings and the like, from 10" and up you would do well to use plates. However I have seen plans for a 4" still with bubble cap plates and they claim to be the most efficient still made. Their claim not mine. To make the 10" bubble cap plate type still work you would need somewhere around a 10 hp boiler or around 350,000 btu input. It would*

also produce up to or around 30 gallon of ethanol per hou using a 10% wash. I have gleaned this information from a lot of different sources and complyed it myself, none of it is to be considered absolute. Their has been some writings about using some sort of perforated plate with the packing on the 6 to 8 inch stills to help even out the vapor flow.

On spacing I read once, and do not remember where that the spacing should be double the diameter as a rule of thumb. But the heat input, the quanity output, and the wash percent all effect this so it is hard to say. Their is no set rule to follow. Perforated plates require a lot of drilling and the bubble caps are hard to construct. Anything over a 6 to 8 inch would require quite the effort to bring up to speed. Unless you have a cheap source of heat, a motor of some type that runs constancely , the expense of bringing one of the bigger one up to steam would be very high.

One other thing that effects the plate type stills is wheather or not you are going to filter out the solids in your wash. If you are not then your plates would have to be designed to be self cleaning. If you do then the solids need to be compressed to get as much alcohol recovered as possible.

Gaw : Using the photos ... of a bubble type plate still in Holland I built a four inch eight plate still which seems to work quite well on top of a six gallon electric water heater with benefit of a thermostat which I added. To further the experiment of continuous distilling I added a thirty gallon pot with a connection three plates above the smaller unit and after the complete system reaches operating temps the unit seems to function quite well at 94-95 per cent. I used ss plates which I found in a salvage yard and soldered the bubblers into separate units which I then bolted together, believe it or not, with ss bolts and neoprene gaskets on each end of the four inch pieces.

Hennie writes:

I think the best solution for an ethanol distillation would be a packing of copper rings. These should not be too difficult to manufacture. Winding a copperwire on a thin rod with an electric drill and cutting the created spring to rings shouldn't be too difficult.

The height of packing needed in order to do the same job as an ideal plate is called the **HETP** - **H**eight **E**quivalent to a **T**heoretical **P**late. Smaller HETP's are better than large ones, as it means that for a given column height (say 1m) you end up with more ideal plates, eg only 2 plates (87% purity) if the HETP= 0.5m, but 4 plates (92% purity) if HETP = 0.25 m. If you don't have an exact number of plates, that's still OK; you'll end up somewhere proportionally between the two.

So an empty column, with no packing, ain't going to do a lot. Sure, you might get a little liquid running down the sides of it, but this has got nowhere near the same surface area as using packing.

The HETP for a packing depends on its:

- Size (smaller objects pack together better). The size also needs to be in proportion to the column diameter too
- Voidage (need to allow room for the gas & liquid to flow around them, don't want to block the column off)
- Surface area (eg how many square meters of surface you have per cubic meter of packing – the more surface area, the more places for the liquid & vapour to mingle)
- The amount of liquid & vapour flowing around it

Typical HETPs for common packings are :

Packing	HETP
Stainless Steel Wool Scrubbers	0.13 m
Marbles (10mm diameter)	0.33 m
6mm Ceramic Raschig Rings	0.24 m
13mm Ceramic Raschig Rings	0.38 m

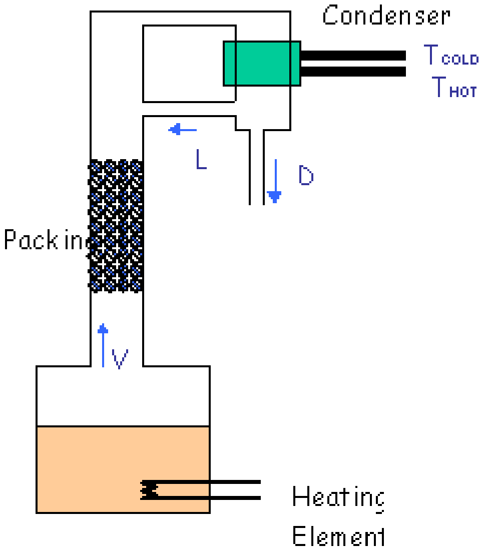
Zoran suggests that in some cases marbles may be as effective as a 0.2m HETP.

These HETPs change depending on how much liquid & vapour are flowing around them. This ratio can be described by the **Reflux Ratio** - the ratio of Liquid flowing down the column over the amount of distillate drawn off :

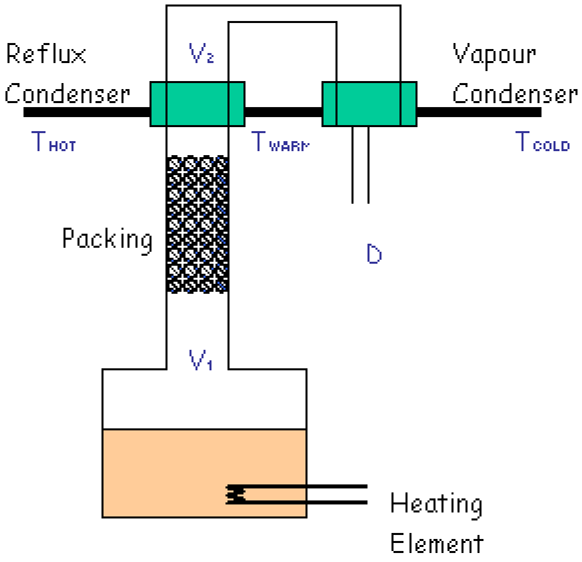
$$R = L / D = (V-D) / D$$

This can be easily measured if the still design is like Stone & Nixon's where all the vapour is condensed separately, and you control the amount withdrawn vs returned (refluxed). It's a little harder with the Stillmaker design where the refluxing liquid is determined by the amount of cooling done by the first condensers, and you never get to single it out, but you should be able to estimate the amount of vapour from the amount of heat you apply.

Reflux with Single Condenser

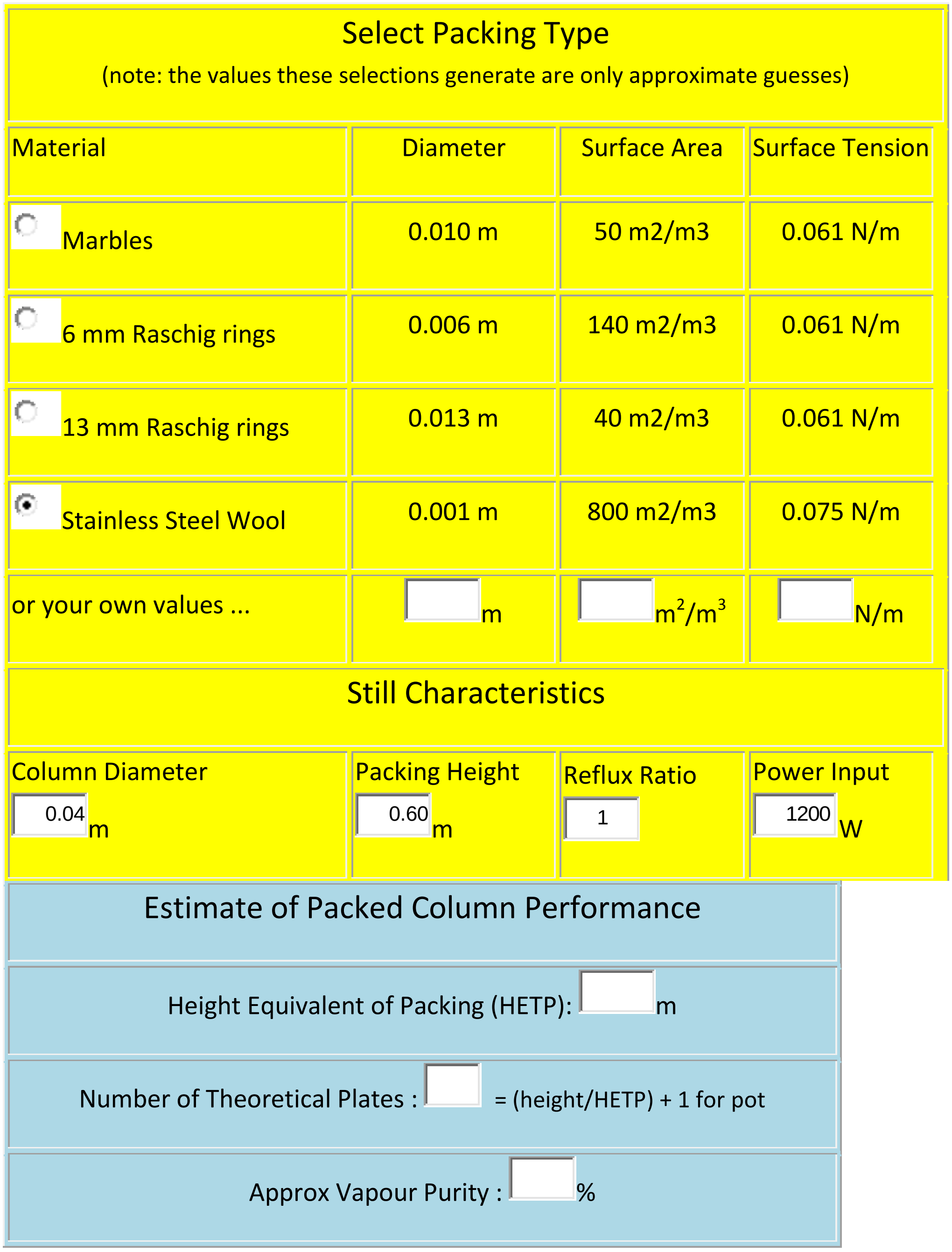


Reflux with Two Condensers



As the reflux ratio increases, so the HETP improves. Generally though, you can see that choosing the right packing to start with does the greatest improvement; increasing the Reflux ratio only squeezes the last extra bit out of it (at the cost of having to wait longer too). Where you will notice it is when the design is poor to start with - increasing the reflux ratio will help out quite a bit.

Calculate the HETP for your still ...



Select Packing Type

(note: the values these selections generate are only approximate guesses)

Material	Diameter	Surface Area	Surface Tension
○ Marbles	0.010 m	50 m2/m3	0.061 N/m
○ 6 mm Raschig rings	0.006 m	140 m2/m3	0.061 N/m
○ 13 mm Raschig rings	0.013 m	40 m2/m3	0.061 N/m
● Stainless Steel Wool	0.001 m	800 m2/m3	0.075 N/m
or your own values ...	m	m^2/m^3	N/m

Still Characteristics

Column Diameter	Packing Height	Reflux Ratio	Power Input
0.04 m	0.60 m	1	1200 W

Estimate of Packed Column Performance

Height Equivalent of Packing (HETP): m

Number of Theoretical Plates : = (height/HETP) + 1 for pot

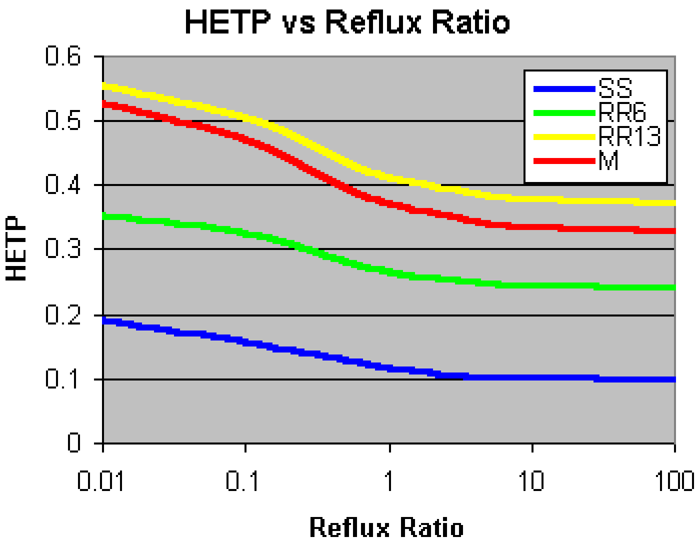
Approx Vapour Purity : %

See http://www.raschig-rings.com for more information on other column packing details. Note also that when real plates are used in a column, you also need to do a similar calculation - they are often far from ideal in operation, and you may need several to achieve one HETP.

Jan Willem of http://www.geocities.com/homedistilling/ experimented with this ...

> *I get 94% at a rate of ~ 500mL/hour. My column is 115cm long and 42mm wide Filled with potscrubbers from the undersite to just under the precooling coil.* (Tony - ie its of a good design already - heaps of HETP)
>
> *At my latest distilling escapade I turned the reflux ratio up. Just as a test that would show me how pure it could get AND if there was a taste difference (after diluting of course) Collected the good stuff at 100mL/hour (a long wait) Then the score was initialy 95.?% and was going down a bit to 94.5% (Dunno if it was 94.3 or 94.8 so I say 94.5%) After the taste test I noticed NO difference, but I'm no expert at vodka tasting.*

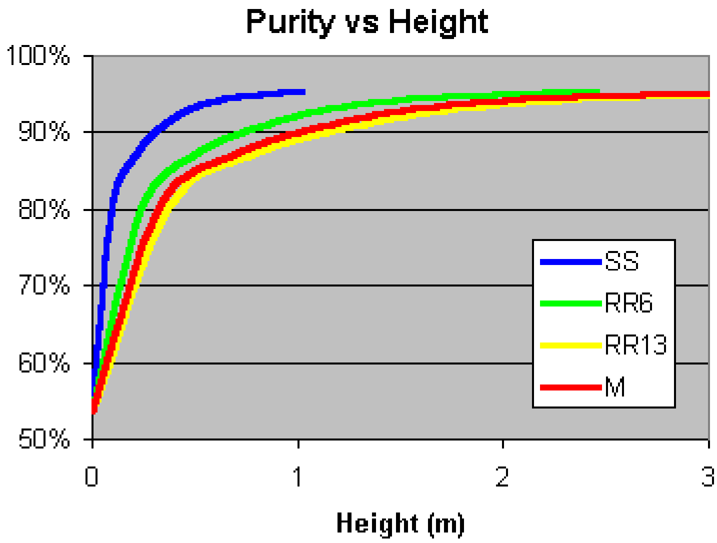
The improvement isn't linear either - you can halve the HETP for Stainless Steel Wool (SS below) by going from "bugger-all" reflux to "some" reflux, but there is little improvement winding it up too far past there.



SS = Stainless Steel Wool Scrubbers, RR6 = 6mm Ceramic Raschig Rings, RR13 = 13mm Ceramic Raschig Rings, M = 10mm Marbles

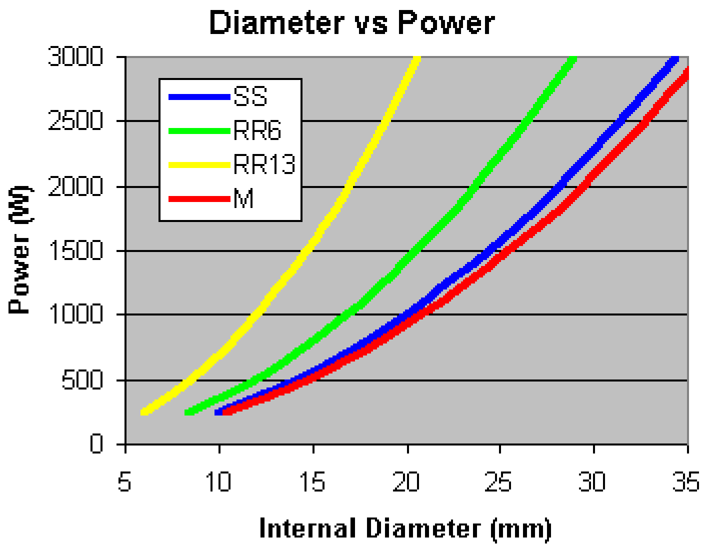
So, put these together to work out your still performance;

- Determine the HETP for the packing you are using, then
- Work out for the height of packing you have, how many Ideal Plates you have, then
- Look up the purity expected for that number of plates.



SS = Stainless Steel Wool Scrubbers, RR6 = 6mm Ceramic Raschig Rings, RR13 = 13mm Ceramic Raschig Rings, M = 10mm Marbles

But what diameter should the column be ? This needs to be worked out from the amount of heat you are putting in. The more heat, the more vapour you generate. If the vapour rate is too great, then instead of having your refluxing liquid flowing down the column, it will be blown out the top. You also need to consider how much space the packing is taking up too. The following diagram is based on the calculations - unfortunately the sizes are about 50% smaller than what appears the actual limit, so scale up the calculated result if you plan on following them.



SS = Stainless Steel Wool Scrubbers, RR6 = 6mm Ceramic Raschig Rings, RR13 = 13mm Ceramic Raschig Rings, M = 10mm Marbles

Instead, I scale up/down for what I know works for me ... using scrubbers for packing, a 1.5" diameter column can handle 1800W. So .. for constant vapour rate per cross-sectional area ...

Maximum Power for a Given Column Diameter

1.00" = 800 W
1.25" = 1250 W
1.50" = 1800 W
1.75" = 2450 W
2.00" = 3200 W
2.25" = 4050 W
2.50" = 5000 W

Note that these figures are roughly the maximum power that you would want to use for any given column diameter. Mike argues that you should use quite a lot less power ...

> *All these figures above equate to a vapor speed up the column of 119 cm/sec (47"/sec) Assuming for ease a column length of 119cm, that means that vapor will traverse the column in one second, and during that time it is busy condensing and being reboiled many times.*
>
> *Tony reported that a 25mm diameter column at 1350W gave very poor results, but a 36mm diameter column handled that power well. Vapor*

speed through the 25mm column would have been 211 cm/sec, so it's not surprising that it didn't work well as the vapor had only 0.56 seconds to traverse the column. Increasing the column diameter to 36mm brought the speed down to 101 cm/sec, so the transit time increased to 1.2 seconds. This is on the 'safe side' of the recommended figures in the table.

I personally favor lower power settings, and the reason lies in measurements I did with column stability, measuring the temperature gradient at steady state for different power settings, and first using a simple reflux column that relied solely in internal condensation for reflux. (A not-to-scale schematic has been posted in the Photos section of Distillers. It's called 'Temperature gradients')

I used a 2" diameter column and found that at 750W the temperature gradient settled out 2/3 of the way up the column, at around 80cm. This told me that vapor moving at 28 cm/sec had fully separated after spending 2.5 seconds in the packing. Increasing the heat input raised the point at which the straight line met the curve, but when the curve reached the top of the packing, the curve switched to the straight line sharply, not asymptotically, and the temp in the top rose to match the increasing temp at the top of the packing. So using 1350W with a 25mm column would result in full separation occurring at a point right at the top of the column, with little or no leeway.

Adding imposed reflux with a compound column did little to change the temperature gradient up the column, but what it did do was add that touch more separation in the region above the top of the packing. I could detect no change in the 'asymptotic' nature of the temp gradient when the straight section still lay inside the packing, but when power was increased to raise that point to the tip of the packing then the more I increased the power a sharp 'step' began to appear. The straight line went down to the top of the packing, then quickly jumped to meet the temp in the top section of packing. This indicated to me that the composition of the cycled vapour in the void between the top of the packing and the top condenser was the result of further separation imposed by the imposed reflux operation in that region. In effect, I had two stills one on top of the other, the bottom being a simple reflux still relying on internal reflux, and a recycling still that took what the reflux

> *still gave it and used that as its starting point. This held true until either the power was increased to a point when the curve would have settled down itself in a longer column (about a quarter extra length) or the take-off ratio was increased to a stage when the sharp step suddenly broke down and the old asymptotic curve re-asserted itself, and quality instantly dropped.*
>
> ***OK ... so what has all this got to do with those figures in the table? Essentially, it is that the figures in the table are good for indicating the maximum you can push a simple reflux column to and attain full separation ... just!***
> *If consistent results are wanted, then the aim should surely be to allow some leeway and try to get that curve settling down before the top of the packing is reached. That way, the reflux column has a chance to do its job as fully as it can before either taking off product, as in a simple reflux still, or passing on the results to a secondary top section that operates with imposed reflux for that final touch of separation. My personal 'cautious old fuddy-duddy' approach would be to reduce all those wattage figures in the table to 1/4 of what they are now and regard that as a good guide for reliable operation. This sounds drastic but, when you think about it, gives much greater assurance of high quality with simple reflux stills, and greater flexibility in take-off rates with a compound still. Maybe I'm just an aging Sunday Driver, but I find that I get to where I'm going with less hassle than a Boy Racer, and both my passengers and booze samplers enjoy the ride better!*

Generally, a 2" (50mm) diameter is an ideal size to use. This will happily run from 750W up to 2500W without any trouble. If in doubt, go for 2".
It's this amount of energy that you put in which will determine the rate at which you make and collect the distillate. If collected at the condenser at say 95%, it works out roughly to the following figures. If you run a reflux ratio of 4 (e.g. return 40 mL for every 10 mL you keep - typical for SS scrubbers) - then the second figure is the flowrate you'd expect to collect at ...

1000 W = 52 mL/min (max, no reflux) or 10 mL/min (if RR=4)
1500 W = 78 mL/min (max, no reflux) or 16 mL/min (if RR=4)
2000 W = 105 mL/min (max, no reflux) or 21 mL/min (if RR=4)
2500 W = 131 mL/min (max, no reflux) or 26 mL/min (if RR=4)
3000 W = 157 mL/min (max, no reflux) or 32 mL/min (if RR=4)

3500 W = 183 mL/min (max, no reflux) or 36 mL/min (if RR=4)
4000 W = 209 mL/min (max, no reflux) or 42 mL/min (if RR=4)

Note though that you are probably going to be limited in how much power you can deliver to the still. Many homes only run 10 amp fuses in their fuse boxes. This will limit you to 240 V x 10 A = 2400 W before you have to have a safety chat with your electrician about upgrading the wiring.

The risk of making the column diameter too small is that the column will "flood", as discussed in "Chemical Engineering - June 2002" pp 60-67 by Simon Xu and Lowell Pless about flooding in distillation columns. These guys have been using "gamma scanning" to work out where abouts various distillation columns are flooding, and why. I'll quote a few paragraphs about "packed columns" for ya (they also did a fair bit on trayed columns) ....

> *For a given packed column, at the high end of liquid and vapour rates we encounter flooding as liquid backs up the column and fills all the void space in the packing bed. Poor disengagement between vapour and liquid (back mixing) reduces the separation efficiency, and the high liquid hold-up in the bed increases the pressure drop.*
>
> *The traditional approach to analysing flooding in packed columns relies on measuring pressure drop. At low liquid rates, the open area of the packing is practically the same as for dry packing. In this regime the pressure drop is proportional to the square of the vapour flowrate. As the vapour rate continues to increase, eventually a point is reached when the vapour begins to interfere with the downward liquid flow, holding up liquid in the packing. The increase in the pressure drop is proportional to a power greater than 2.*
>
> *At this point, the pressure drop starts to increase rapidly because the accumulation of liquid in the packing reduces the void area available for the vapour flow. This area is called the "loading region". As the liquid accumulation increases, a condition is reached where the liquid phase becomes continuous .....*
>
> *The problem with this traditional approach is the difficulty in differentiating between the transition points of the loading or flooding in the pressure drop curve. Some suggestions for the definition of when a*

packed column become fully "flooded" are :
** the slope of the pressure drop curve goes to infinity*
** the gas velocity is so great that efficiency goes to zero*
** pressure drop reaches 2 in.H2O per foot of packing*
** pressure drop rapidly increases in a region, with simultaneous loss of mass-transfer efficiency ......*

There are two forms of liquid hold-up in packed columns. One is referred to as static hold-up. Static hold-up is the amount of liquid that is held onto the packing after it has been wetted, then drained - the film of liquid or droplets of liquid that adhere to the packing. This amount jointly depends upon the physical properties of the liquid and the type and material of the packing.

The second aspect is the operating or dynamic hold-up. Dynamic hold-up is the amount of liquid held in the packing by the interaction of the vapour and liquid flows. Dynamic hold-up must be measured experimentally. To measure this amount, instantaneously stop the liquid and vapour flows, then collect and measure the volume of liquid that drains from the packing. The total liquid hold-up in packing is the sum of these two forms of hold-up.....since the static hold-up is constant, the operating or dynamic hold-up changes in proportion to changes in liquid and vapour rates. The void fractions in a packed bed may change across the bed due to fouling or damage, and vapour-liquid loads may be different along the bed for different operating conditions. The peak loading could occur anywhere in a packed bed, or a liquid distributor could initiate the flooding......

An interesting phenomenon for random packing and most corrugated sheet packing is that the separation efficiency of an "initial flooding" bed could be better than a "normal" bed, because of high liquid hold-up and intimate vapour-liquid contact in the "frothing" regime..... But at the high-efficiency state it is difficult to keep the column stable, and the column could go out of control as a result of any slight process turbulence. For this reason it is always recommended to avoid designing a packed column close to the initial flooding point. In operation we would not then be overly concerned with some liquid accumulation or hold-up, as long as the column could be kept stable and under control......

Stainless Steel Wool Scrubbers/Scourers

From the above analysis, I figure that Stainless Steel Wool Scrubbers (pot scourers) are 2-3 times better than rachig rings with the typical small diameter columns we use in this hobby.

Using these as the best type of packing will allow you to use a smaller column or a lower reflux ratio to get the same purity. Or keep the same height & reflux ratio, and have improved purity. Are you happy with the existing purity, or do you want cleaner alcohol ?

The stainless steel scrubbers are probably only good however up to about 2-3 inch diameter columns. Beyond this, they will be difficult to keep in place & have even liquid flow over them (e.g. don't want areas where they are really packed tight or spread too thin - it has to be uniform). It is at the larger diameters that the more regular packings like rachig rings come into their own (as they won't compact up or seperate to leave holes), and for even larger diameters, that you'd consider structured packings (i.e. carefully stacked into a regular pattern). One rule of thumb I've heard of for raching rings is to size them 1/10th the diameter of the column; e.g. the small 6mm rachig rings are really only suitable down to about 60mm (2.4") diameter columns (and they're expensive!).

So for columns up to 2-3 inches in diameter (50-75mm), you might as well go for the better performing, cheaper option of scrubbers. Bigger than this though, and you might need to start using what commercial units do.

David comments ...

> *I use 3M ones myself as I have found them the best quality. Use a good quality one preferably. On a 1.5 or 2" column each should fill 55mm to 75mm (max) of column (less on 2"). Even less if you prefer. I tend to work in the vicinity of each filling somewhere between 55 and 63mm. At 55mm on a 36" column this equates to almost 17 from which I deduct 1 to allow for space at the top ie. =16. Allow at least 2" to 2.5" of clear space between the top of the scrubbers and the takeoff point for the vapour to expand into and so the reflux falls back into the scrubbers.*
>
> *Do not unravel but tease them out by hand a bit so they fill the whole column diameter rather than just a part of it. Most of the ones I have seen in NZ do not have rubber bands around them. Place them into the*

> *column from the bottom one at a time using some sort of restriction at the top and bottom to prevent them going further or dropping out back into the boiler.. I use a 2" pall ring which works well.*
>
> *On a slightly longer column (1m = 39.37") I use 19 off memory so 17 is probably around the right number. You dont want them too loose or too tight. If too tight they will compact more. The main thing is to have an even constant heat so you dont get surging. Surging causes compaction.*

Calculations

I've developed a couple of interactive pages which do all these calculations for you :

- Physical data for Ethanol & Water
- Pot Still calcs
- Reflux Still calcs.
- Detail of the Equations used
- Interactive Heat & Mass Balance model

Calculation of a Pot Still Distillation Run

Heres a rough stab I've had at this....

One assumption is that all the heat input is used to vaporise the vapour, eg no heat losses, but this should be a minor error. (I'll just claim that all pot stills are extremely well insulated ...

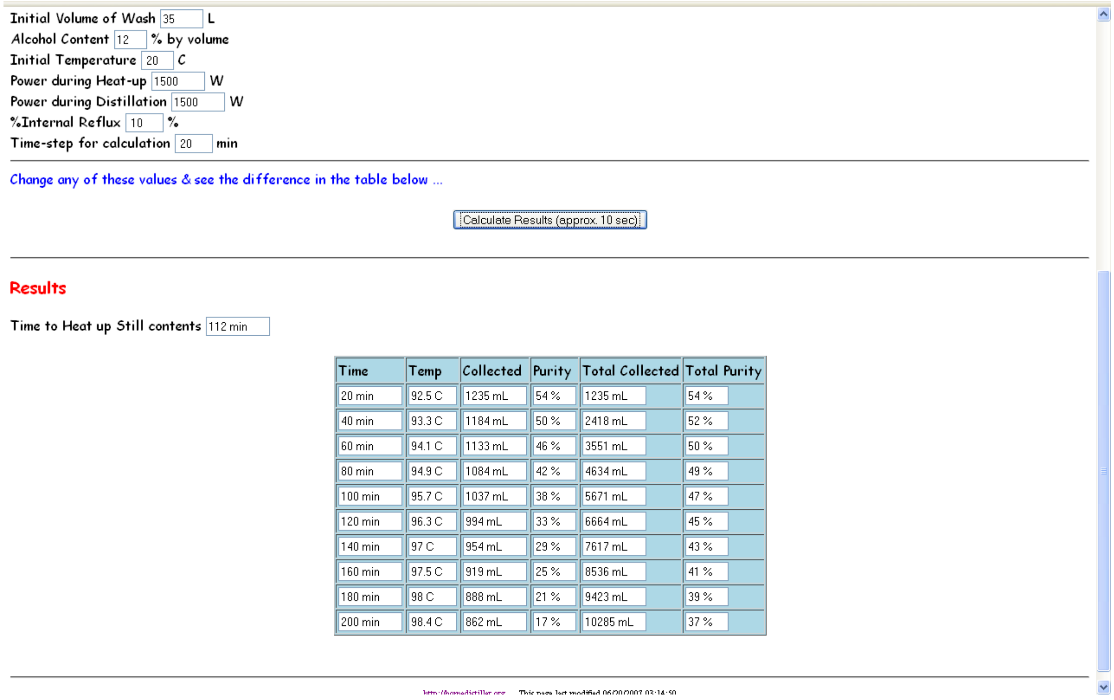
If you don't know what your power input is (say you are using gas heating instead), adjust the value used until the "time to heat up" is close to what you expect.

This can also be used for double & triple distillations, eg

- 20L of 15% will give around 6L of 45% (use say a 25% cut-off)
- feed this back in & see that you'll get around 4L of 68%, then
- distilling this gives about 3.4L of 80%

It's not quite such an accurate calculation at the higher %alcohols, because the timesteps are too large. An indication that that calculation has got where it's going is when the sample purity first goes -ve.

Input your Pot still characteristics



Initial Volume of Wash 35 L
Alcohol Content 12 % by volume
Initial Temperature 20 C
Power during Heat-up 1500 W
Power during Distillation 1500 W
%Internal Reflux 10 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 112 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	92.5 C	1235 mL	54 %	1235 mL	54 %
40 min	93.3 C	1184 mL	50 %	2418 mL	52 %
60 min	94.1 C	1133 mL	46 %	3551 mL	50 %
80 min	94.9 C	1084 mL	42 %	4634 mL	49 %
100 min	95.7 C	1037 mL	38 %	5671 mL	47 %
120 min	96.3 C	994 mL	33 %	6664 mL	45 %
140 min	97 C	954 mL	29 %	7617 mL	43 %
160 min	97.5 C	919 mL	25 %	8536 mL	41 %
180 min	98 C	888 mL	21 %	9423 mL	39 %
200 min	98.4 C	862 mL	17 %	10285 mL	37 %

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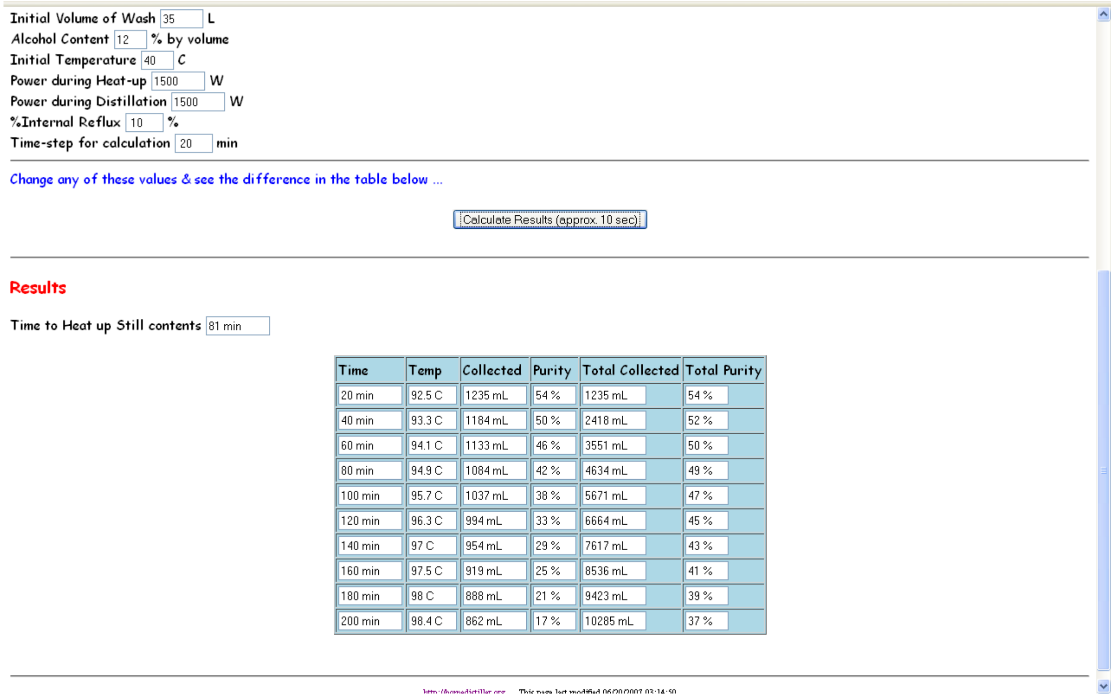

Initial Volume of Wash 35 L
Alcohol Content 12 % by volume
Initial Temperature 40 C
Power during Heat-up 1500 W
Power during Distillation 1500 W
%Internal Reflux 10 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 81 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	92.5 C	1235 mL	54 %	1235 mL	54 %
40 min	93.3 C	1184 mL	50 %	2418 mL	52 %
60 min	94.1 C	1133 mL	46 %	3551 mL	50 %
80 min	94.9 C	1084 mL	42 %	4634 mL	49 %
100 min	95.7 C	1037 mL	38 %	5671 mL	47 %
120 min	96.3 C	994 mL	33 %	6664 mL	45 %
140 min	97 C	954 mL	29 %	7617 mL	43 %
160 min	97.5 C	919 mL	25 %	8536 mL	41 %
180 min	98 C	888 mL	21 %	9423 mL	39 %
200 min	98.4 C	862 mL	17 %	10285 mL	37 %

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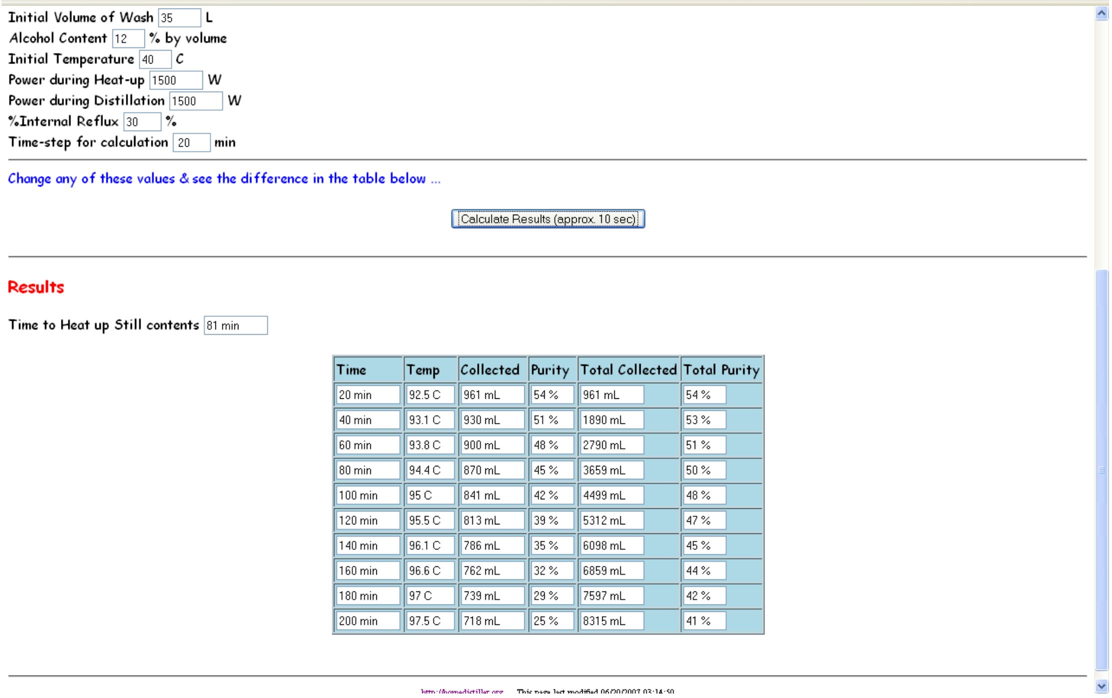

Initial Volume of Wash 35 L
Alcohol Content 12 % by volume
Initial Temperature 40 C
Power during Heat-up 1500 W
Power during Distillation 1500 W
%Internal Reflux 30 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 81 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	92.5 C	961 mL	54 %	961 mL	54 %
40 min	93.1 C	930 mL	51 %	1890 mL	53 %
60 min	93.8 C	900 mL	48 %	2790 mL	51 %
80 min	94.4 C	870 mL	45 %	3659 mL	50 %
100 min	95 C	841 mL	42 %	4499 mL	48 %
120 min	95.5 C	813 mL	39 %	5312 mL	47 %
140 min	96.1 C	786 mL	35 %	6098 mL	45 %
160 min	96.6 C	762 mL	32 %	6859 mL	44 %
180 min	97 C	739 mL	29 %	7597 mL	42 %
200 min	97.5 C	718 mL	25 %	8315 mL	41 %

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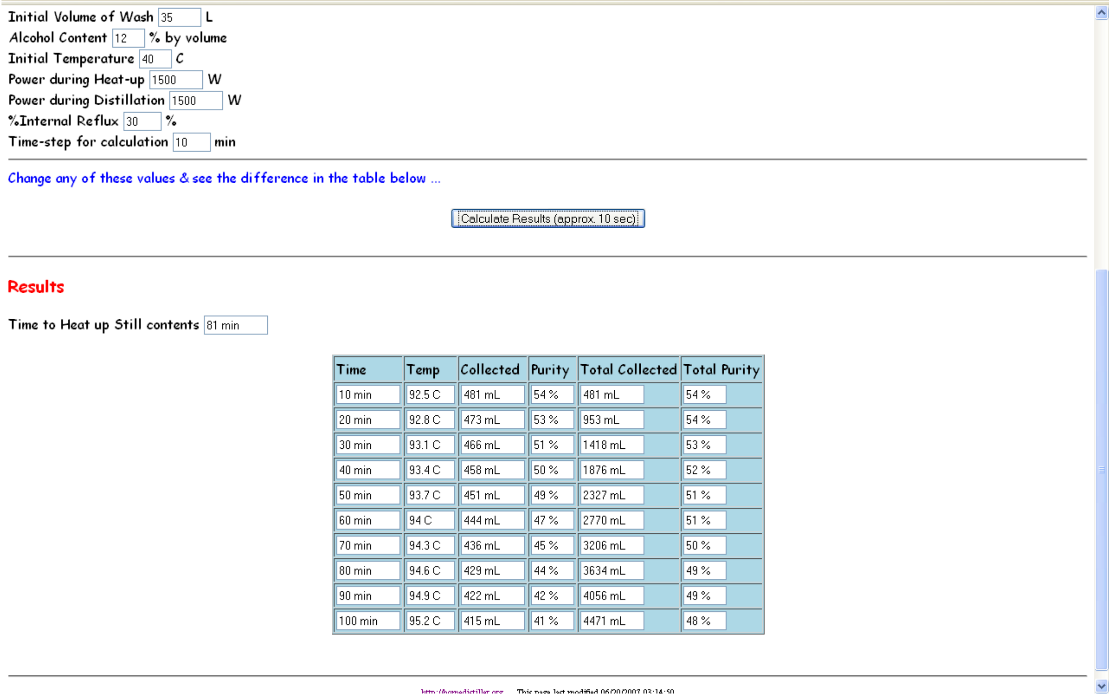

Initial Volume of Wash 35 L
Alcohol Content 12 % by volume
Initial Temperature 40 C
Power during Heat-up 1500 W
Power during Distillation 1500 W
%Internal Reflux 30 %
Time-step for calculation 10 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 81 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
10 min	92.5 C	481 mL	54 %	481 mL	54 %
20 min	92.8 C	473 mL	53 %	953 mL	54 %
30 min	93.1 C	466 mL	51 %	1418 mL	53 %
40 min	93.4 C	458 mL	50 %	1876 mL	52 %
50 min	93.7 C	451 mL	49 %	2327 mL	51 %
60 min	94 C	444 mL	47 %	2770 mL	51 %
70 min	94.3 C	436 mL	45 %	3206 mL	50 %
80 min	94.6 C	429 mL	44 %	3634 mL	49 %
90 min	94.9 C	422 mL	42 %	4056 mL	49 %
100 min	95.2 C	415 mL	41 %	4471 mL	48 %

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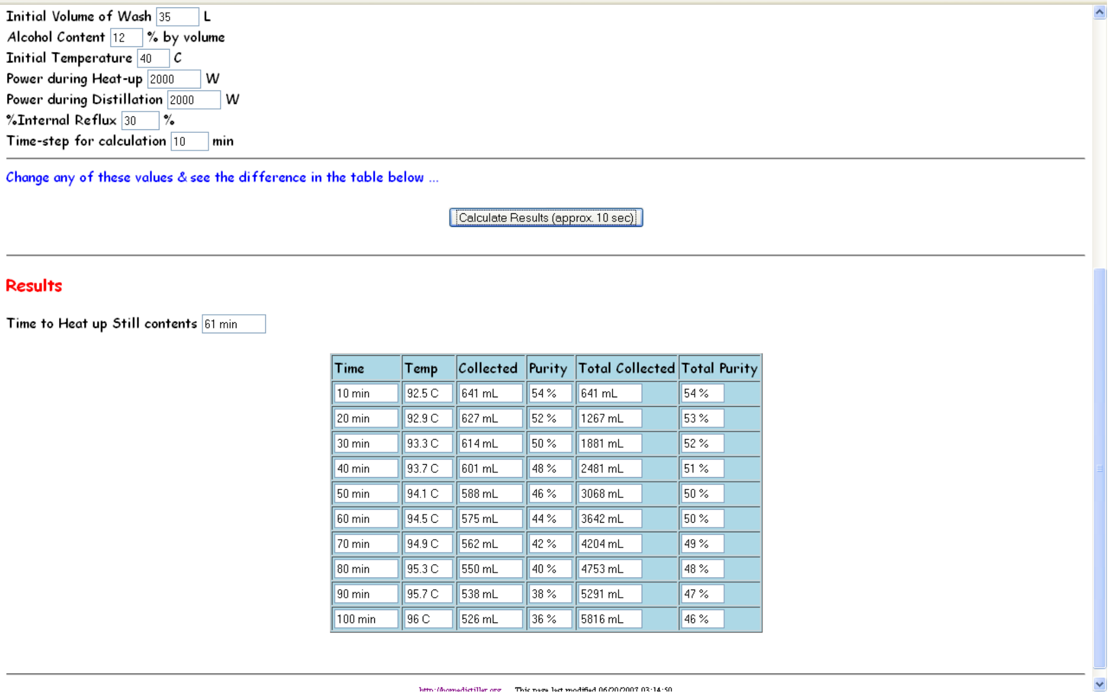
Initial Volume of Wash 35 L
Alcohol Content 12 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 10 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 61 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
10 min	92.5 C	641 mL	54 %	641 mL	54 %
20 min	92.9 C	627 mL	52 %	1267 mL	53 %
30 min	93.3 C	614 mL	50 %	1881 mL	52 %
40 min	93.7 C	601 mL	48 %	2481 mL	51 %
50 min	94.1 C	588 mL	46 %	3068 mL	50 %
60 min	94.5 C	575 mL	44 %	3642 mL	50 %
70 min	94.9 C	562 mL	42 %	4204 mL	49 %
80 min	95.3 C	550 mL	40 %	4753 mL	48 %
90 min	95.7 C	538 mL	38 %	5291 mL	47 %
100 min	96 C	526 mL	36 %	5816 mL	46 %

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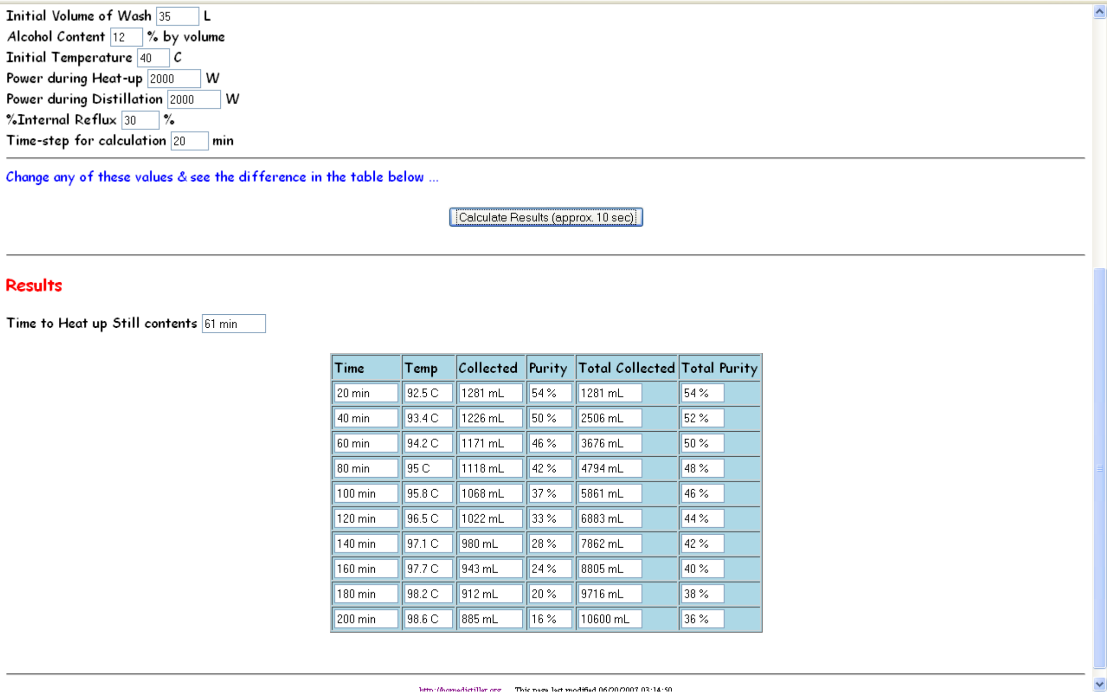
Initial Volume of Wash 35 L
Alcohol Content 12 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 61 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	92.5 C	1281 mL	54 %	1281 mL	54 %
40 min	93.4 C	1226 mL	50 %	2506 mL	52 %
60 min	94.2 C	1171 mL	46 %	3676 mL	50 %
80 min	95 C	1118 mL	42 %	4794 mL	48 %
100 min	95.8 C	1068 mL	37 %	5861 mL	46 %
120 min	96.5 C	1022 mL	33 %	6883 mL	44 %
140 min	97.1 C	980 mL	28 %	7862 mL	42 %
160 min	97.7 C	943 mL	24 %	8805 mL	40 %
180 min	98.2 C	912 mL	20 %	9716 mL	38 %
200 min	98.6 C	885 mL	16 %	10600 mL	36 %

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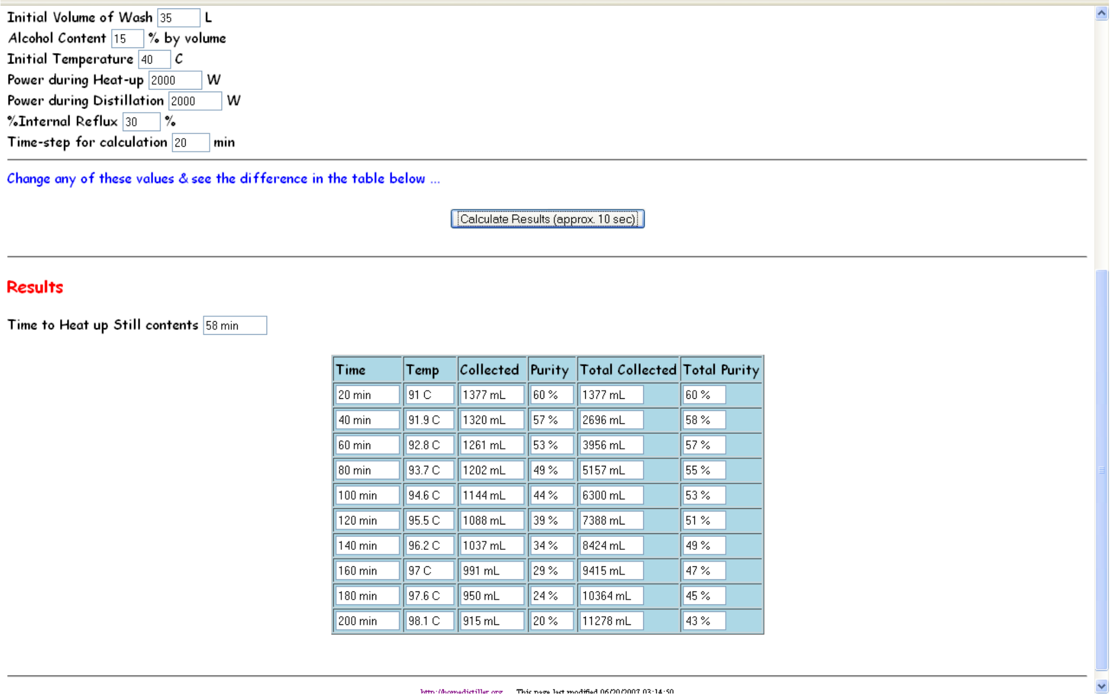

Initial Volume of Wash 35 L
Alcohol Content 15 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 58 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	91 C	1377 mL	60 %	1377 mL	60 %
40 min	91.9 C	1320 mL	57 %	2696 mL	58 %
60 min	92.8 C	1261 mL	53 %	3956 mL	57 %
80 min	93.7 C	1202 mL	49 %	5157 mL	55 %
100 min	94.6 C	1144 mL	44 %	6300 mL	53 %
120 min	95.5 C	1088 mL	39 %	7388 mL	51 %
140 min	96.2 C	1037 mL	34 %	8424 mL	49 %
160 min	97 C	991 mL	29 %	9415 mL	47 %
180 min	97.6 C	950 mL	24 %	10364 mL	45 %
200 min	98.1 C	915 mL	20 %	11278 mL	43 %

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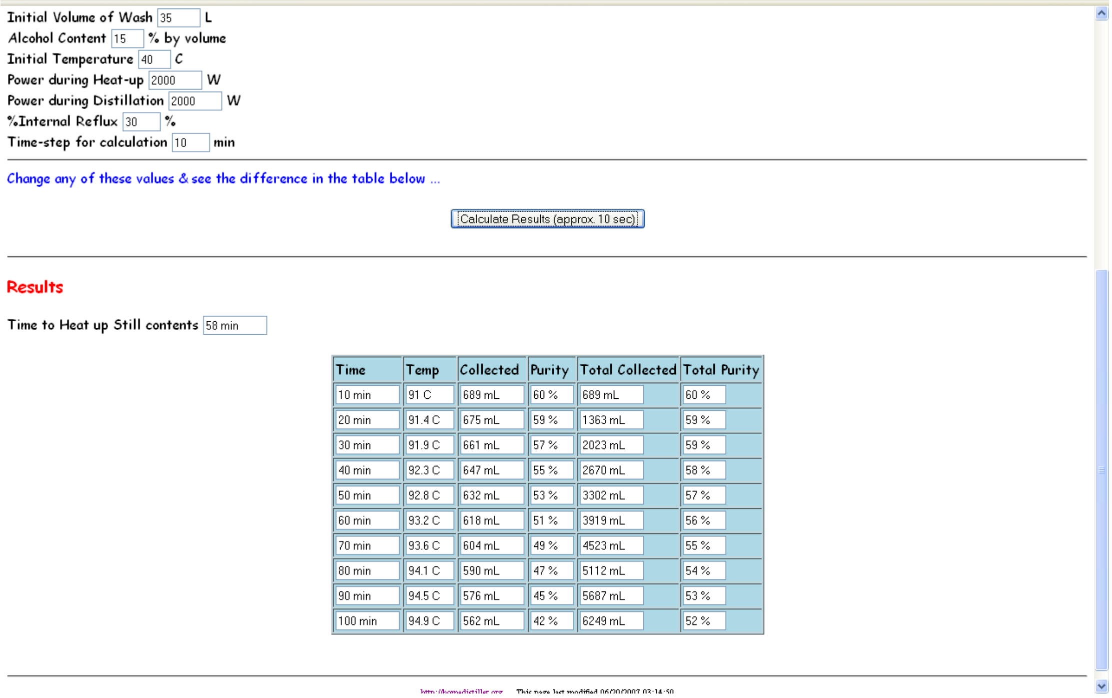

Initial Volume of Wash 35 L
Alcohol Content 15 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 10 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 58 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
10 min	91 C	689 mL	60 %	689 mL	60 %
20 min	91.4 C	675 mL	59 %	1363 mL	59 %
30 min	91.9 C	661 mL	57 %	2023 mL	59 %
40 min	92.3 C	647 mL	55 %	2670 mL	58 %
50 min	92.8 C	632 mL	53 %	3302 mL	57 %
60 min	93.2 C	618 mL	51 %	3919 mL	56 %
70 min	93.6 C	604 mL	49 %	4523 mL	55 %
80 min	94.1 C	590 mL	47 %	5112 mL	54 %
90 min	94.5 C	576 mL	45 %	5687 mL	53 %
100 min	94.9 C	562 mL	42 %	6249 mL	52 %

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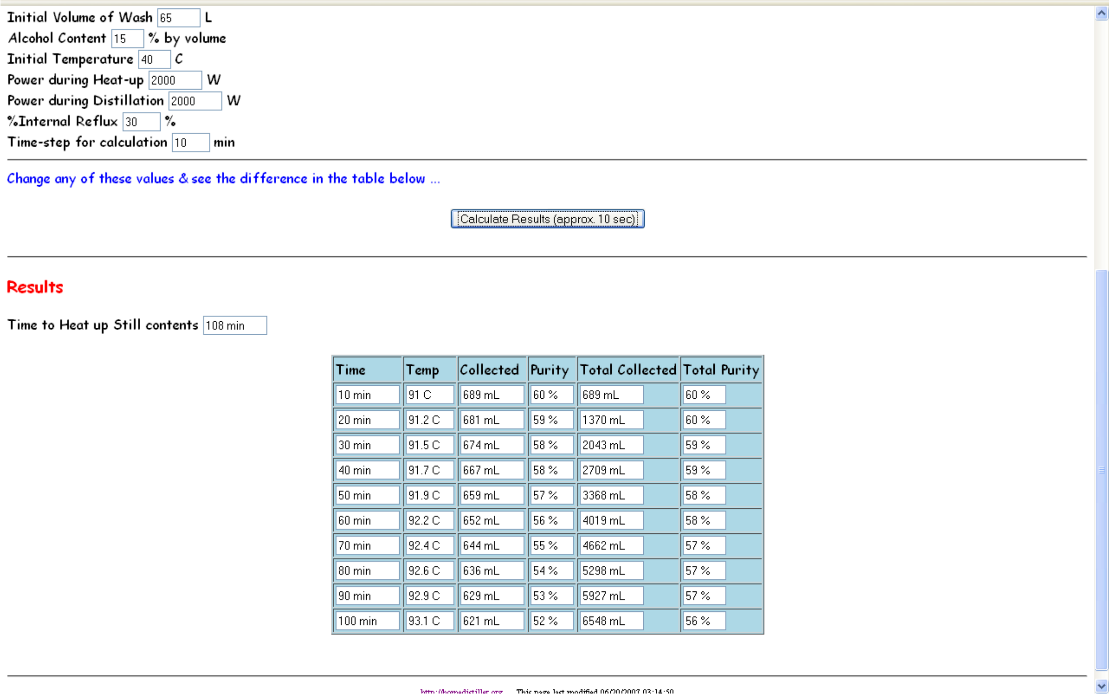

Initial Volume of Wash 65 L
Alcohol Content 15 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 10 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 108 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
10 min	91 C	689 mL	60 %	689 mL	60 %
20 min	91.2 C	681 mL	59 %	1370 mL	60 %
30 min	91.5 C	674 mL	58 %	2043 mL	59 %
40 min	91.7 C	667 mL	58 %	2709 mL	59 %
50 min	91.9 C	659 mL	57 %	3368 mL	58 %
60 min	92.2 C	652 mL	56 %	4019 mL	58 %
70 min	92.4 C	644 mL	55 %	4662 mL	57 %
80 min	92.6 C	636 mL	54 %	5298 mL	57 %
90 min	92.9 C	629 mL	53 %	5927 mL	57 %
100 min	93.1 C	621 mL	52 %	6548 mL	56 %

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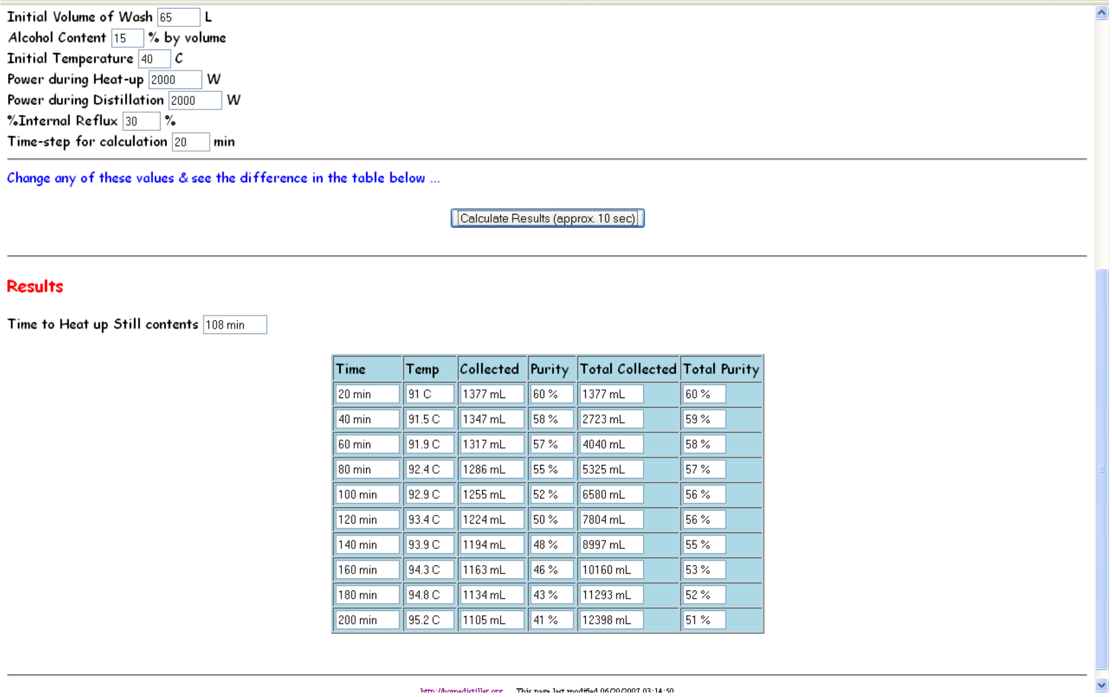

Initial Volume of Wash 65 L
Alcohol Content 15 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 108 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	91 C	1377 mL	60 %	1377 mL	60 %
40 min	91.5 C	1347 mL	58 %	2723 mL	59 %
60 min	91.9 C	1317 mL	57 %	4040 mL	58 %
80 min	92.4 C	1286 mL	55 %	5325 mL	57 %
100 min	92.9 C	1255 mL	52 %	6580 mL	56 %
120 min	93.4 C	1224 mL	50 %	7804 mL	56 %
140 min	93.9 C	1194 mL	48 %	8997 mL	55 %
160 min	94.3 C	1163 mL	46 %	10160 mL	53 %
180 min	94.8 C	1134 mL	43 %	11293 mL	52 %
200 min	95.2 C	1105 mL	41 %	12398 mL	51 %

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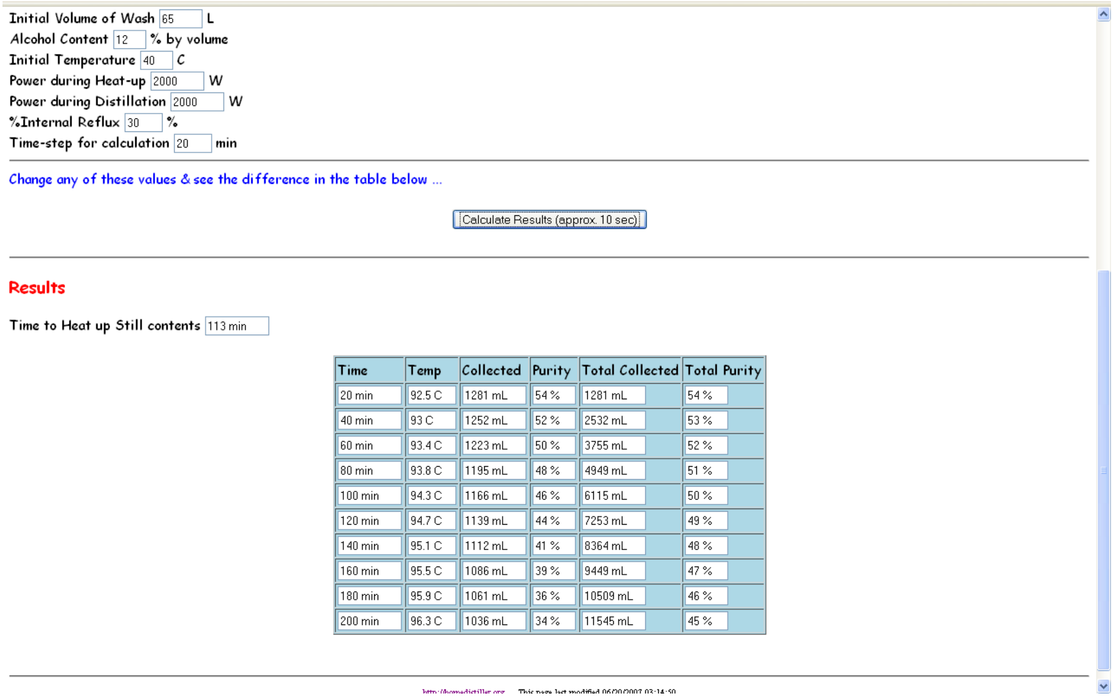


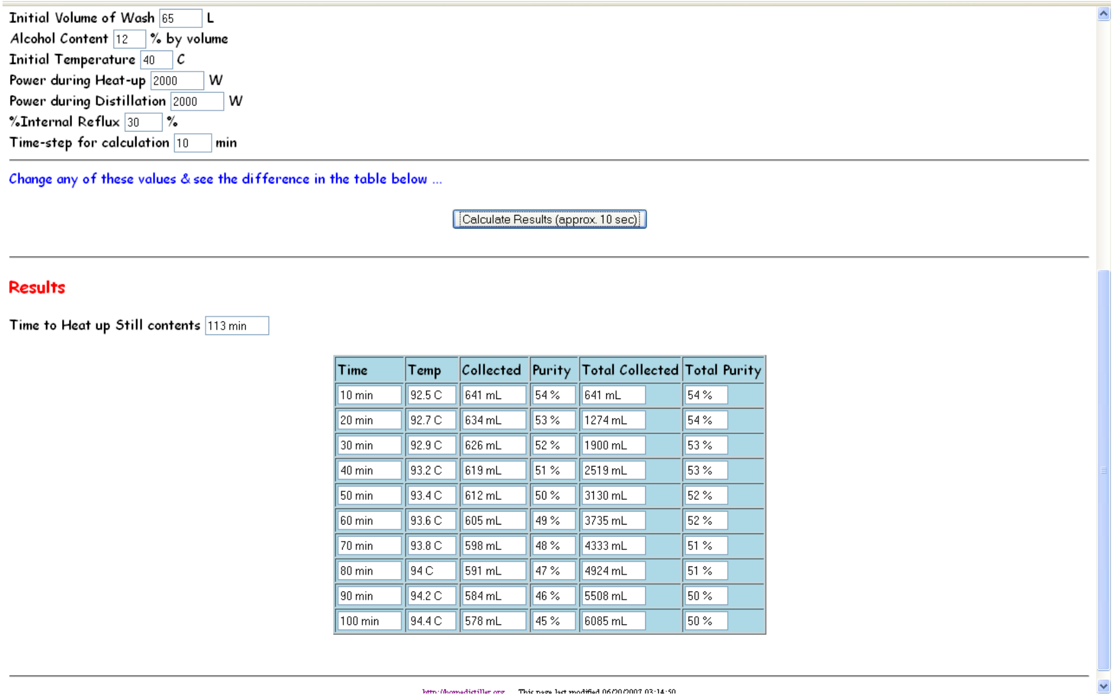
Initial Volume of Wash 65 L
Alcohol Content 12 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 113 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	92.5 C	1281 mL	54 %	1281 mL	54 %
40 min	93 C	1252 mL	52 %	2532 mL	53 %
60 min	93.4 C	1223 mL	50 %	3755 mL	52 %
80 min	93.8 C	1195 mL	48 %	4949 mL	51 %
100 min	94.3 C	1166 mL	46 %	6115 mL	50 %
120 min	94.7 C	1139 mL	44 %	7253 mL	49 %
140 min	95.1 C	1112 mL	41 %	8364 mL	48 %
160 min	95.5 C	1086 mL	39 %	9449 mL	47 %
180 min	95.9 C	1061 mL	36 %	10509 mL	46 %
200 min	96.3 C	1036 mL	34 %	11545 mL	45 %



Initial Volume of Wash 65 L
Alcohol Content 12 % by volume
Initial Temperature 40 C
Power during Heat-up 2000 W
Power during Distillation 2000 W
%Internal Reflux 30 %
Time-step for calculation 10 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 113 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
10 min	92.5 C	641 mL	54 %	641 mL	54 %
20 min	92.7 C	634 mL	53 %	1274 mL	54 %
30 min	92.9 C	626 mL	52 %	1900 mL	53 %
40 min	93.2 C	619 mL	51 %	2519 mL	53 %
50 min	93.4 C	612 mL	50 %	3130 mL	52 %
60 min	93.6 C	605 mL	49 %	3735 mL	52 %
70 min	93.8 C	598 mL	48 %	4333 mL	51 %
80 min	94 C	591 mL	47 %	4924 mL	51 %
90 min	94.2 C	584 mL	46 %	5508 mL	50 %
100 min	94.4 C	578 mL	45 %	6085 mL	50 %

Designing Your Own Still

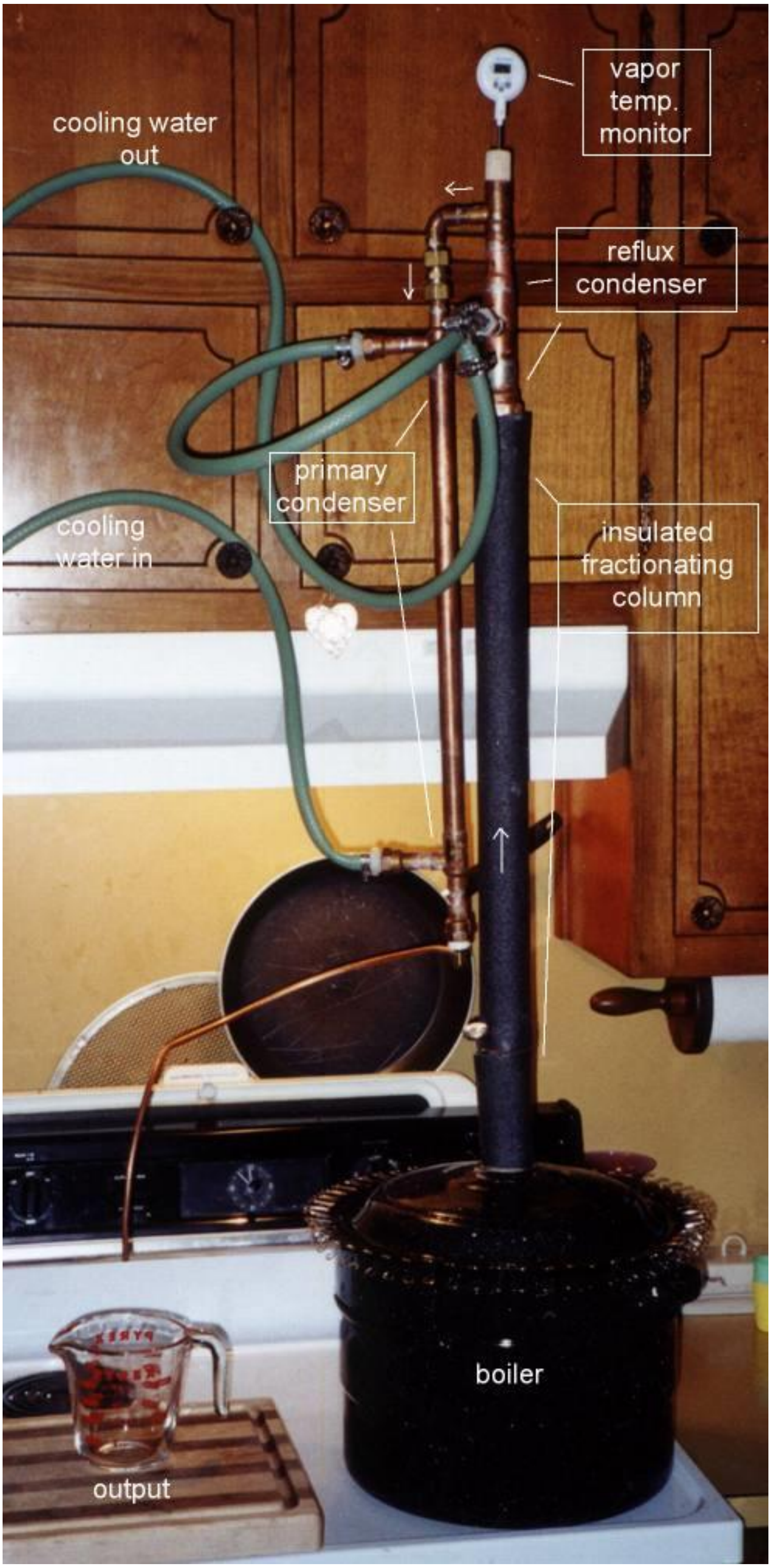
So how do you put all this together to make your own still ? Say you're looking at wanting to make 90%+ purity, off a 20L wash.

Pot

To hold 20L you want at least another 1/4 spare for foam, etc. So go for something in the 25-30L range. I'd suggest something where you can easily lock the lid down, but also be able to get into it fully to clean it out. Suggestions include paint tins as seen in walt or AV25L or a preserving pan with a clipped lid like Teds at http://mwci.s5.com/.

walt 

AVL 25 L 



vapor temp. monitor
cooling water out
reflux condenser
primary condenser
cooling water in
insulated fractionating column
boiler
output

These all have pretty thin lids, so to support the column, you may need a small flange to help hold it all up, or a stiffening plate/oversized washer to help strengthen the lid.

Heating Element

Probably in the 1000-1500 W size. Whats cost-effective for you ? A 1500W element will heat up the contents to begin in around 65 minutes, but a 1000W will take 98 minutes. If time is crucial, you could add a second element to act as a boost during the initial heat up.

Column Sizing

The diameter is based on the amount of heat you're using, whereas its length determines what purity you'll get. Its a hobby still, so I've assumed that the packing will be stainless steel or copper scourers - they only take about 1/2 the height that marbles do to get the same purity. You will also need to insulate the whole length of column too - plumbing suppliers sell slip-on piping insulation for around NZ$8/m

Diameter : 1 inch is too narrow for a 1380W element, but 1.5 inch is OK with a 1800W element. Roughly, let's say to use 1.5 inch for 1000W - 1500W and 1.75 - 2 inch for 1500W - 2000W. If in doubt, go up in size by say 0.25 inch. Too narrow will lead to all manner of problems & difficult operation, but too wide will only give a minimal reduction in purity. 2" is a well used, very reliable diameter that works under most circumstances.

Height : This is the purity. Use the wee interactive applet at the start of this page to see how the number of stages or HETP's improves the purity. Its easy to get the first gains up to 90%, but then more difficult to squeeze out the last improvements towards 95%+ Lets assume (we'll come back to this) that each HETP for scrubbing pads is around 15cm... then for a 15% wash, No packing, purity = 62% , 15cm packing = 82%, 30cm = 88%, 45cm = 90%, 60cm = 92%, 75cm = 92.8%, 90cm = 93.4%, 105cm = 93.9%. These won't be exact, and depend on a number of different factors, but it shouldn't be too far off. So, if height is a problem, and you're happy with low 90's, then 60cm should do ya. If you want to make a perfect vodka, go for 120 to 150cm. Normally I'd recommend at least 100cm, but the choice is yours, as it depends on the type of product you want to make.

These numbers assume that we've reached equlibrium nicely for each 15cm of packing. To do so, we need to provide heaps of surface area for the liquid and vapour to mingle over (done - using scrubbers), and that we're refluxing a large proportion of the vapour back down as liquid, rather than keeping it. But this means that our take-off will be rather slow. Eg we may be able to start out with a reflux ratio of say 3-4 (ie return 30-40mL for every 10 mL we keep) when the pot is very rich in alcohol, but later on, when its getting down in alcohol, we may need to increase this up to 5-10 to keep the high purity.

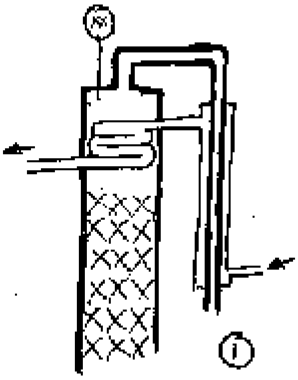
A reflux ratio of 4, with a 1500W element means that we're collecting at around 20 mL/min. Thus a 20L 15% wash will take a minimum of 2.5 hours to collect (20 mL/min), up to 5 hours at a reflux ratio of 8 (10 mL/min). The actual time will be somewhere between these, depending on what ratio you end up needing in order to deliver the purity you're after.

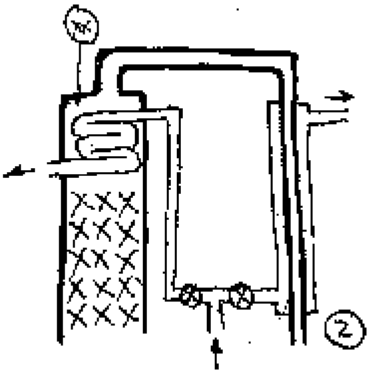
If the distilling time is taking too long, we can make the column taller, and then run at a slightly smaller reflux ratio, to get the same purity.

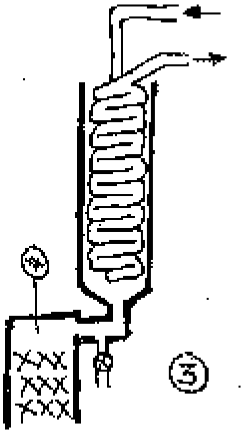
The collection rate is directly proportional to the element size, so if a 1500W element with reflux ratio of 4 takes 3 hours to distill, then 1000W will take 4.5 hours, or a 2000W 2.25 hours.

Making the Reflux

Theres a couple of different options for how to provide the refluxing liquid. The choices come down to how much control you want over it.



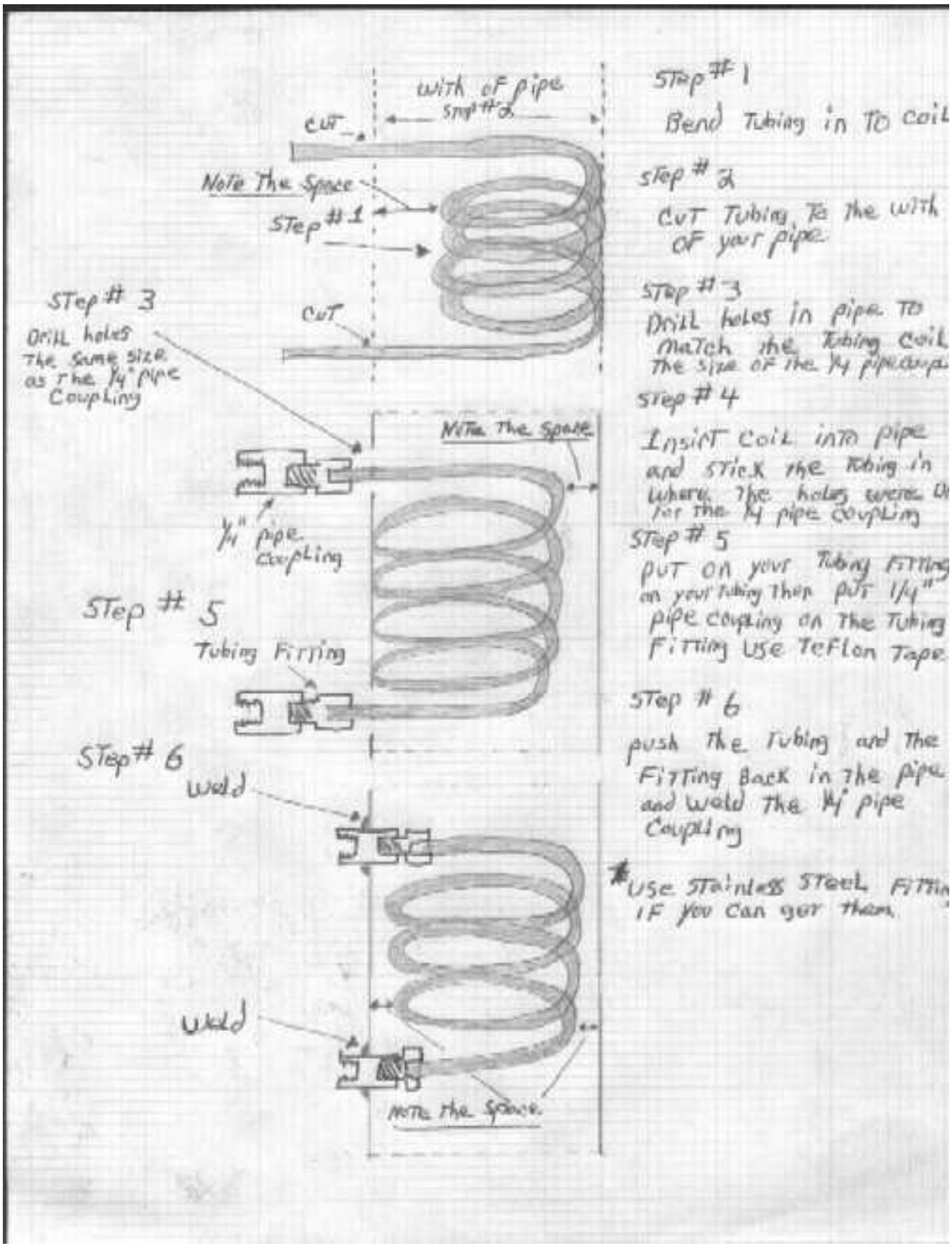




The first, simplest and cheapest, is just to have a cooling coil in the head of the column, which is fed cooling water direct from the condensor. Provided you have sufficient coil surface area available (eg > 1-2 m), you should be able to increase and control the reflux ratio to give you the high purity. If you only have a couple of coils inside the column (like I've drawn), then you wan't be able to make enough reflux, and you're in for mediocre results.

Second - plumb the cooling coil with its own water supply - say a T joint off the main line, with a couple of valves to be able to regulate the water to the coil seperately from the main condensor. This would allow you to say turn off the coil if you want to do a stripping run, without affecting the performance of the main condensor.

For excellent instruction on fitting a coil, see Homers diagram



Step # 1
Bend Tubing in To coil

step # 2
cut Tubing To the with
of your pipe

Step # 3
Drill holes in pipe To
match the Tubing coil
The size of the 1/4 pipecoup

step # 4
Insirt coil into pipe
and stick the Tubing in
where The holes were
for the 1/4 pipe coupling

Step # 5
put on your Tubing Fitting
on your Tubing Then put 1/4"
pipe coupling on The Tubing
Fitting use Teflon Tape

Step # 6
push the Tubing and The
Fitting Back in The pipe
and weld The 1/4" pipe
Coupling

*Use Stainless Steel Fittin
if you can get them

or a couple of Phils photos.

It is set up in "ambient reflux" mode in the first picture. The column is 1.7m.
It can be turned into a vapour management still by putting my vodka bottle on top, and a gate valve in the horizontal outlet.
The keg was very roughly angle grinded. it has a series of M6 studs welded onto the top, a flange fits over these and is held on with nuts.
I cut the bottom off the smirnoff bottle by wrapping some masking tape around it near the bottom. Then I used a normal steel file to score a line around the bottom using the masking tape as a guide. You have to go slow at first since the file tends to slip. Once you have filed a small bit you dont have to be so careful as the file slips into the groove easily. Then i heated the bottle by sitting it directly on my cooker hot ring for a few minutes and then quenching it in cold water. Those vodka bottles are very tough and it took a few quenchs before the base fell off. I have used a glass cutter too, but find the file easier. On the forums somebody mentioned using a vibrating metal engraver. nearly everybody will have a file though. I have cut wine bottles without scoring the bottle at all, just heating and quenching, about 1 in 4 bottles cracks correctly. The broken bottle should be sanded/filed down to prevent cuts. it is great to be able to see the reflux in action. That photo is of it actually running but i think the camera shutter speed was to slow to capture what was going on. the column is s/s at the 2 ends and has a copper centre piece about 1.4m which the s/s tubes slot into to make a perfect fit. It has 20 s/s scrubbers. It is insulated with a large cardboard carpet roll which is stuffed tight with glass fibre attic insulation inbetween the gap of the cardboard and the column.
What you cant see in the photo is the plumbline i have on the column, i put cardboard under the sides of the keg until the column is perfectly vertical.

Dom's Still

I have constructed my own offset head still.

The unit breaks down for easy storage, cleaning and transport. I have plans for a bigger boiler as this one is less than 19L.





Tim J's Still

Ken & Mikes Project

We get 2.7L from a 23 L, 10.7% mash. It is 91%

Mike : We polished with activated charcoal and used caramelized sugar for colour and oak toasted oak chips are in the diluted (52%) product for the vanillans.

I insulated the boiler to make it more efficient (around the pot and a round piece on top of the pot,as per picture).I also insulated the colomn with 2 pieces of insulation that are fit for a 1" pice of copper pipe.(one piece per side...look at the picture).By the way...I use 7 brass scrubbers from Zehrs market in my column and they impart no extra flavours!!! When rolled out between the hands...the scrubbers are about 5" long and 2" in diameter. Put them into the column slowly and carefully!!!

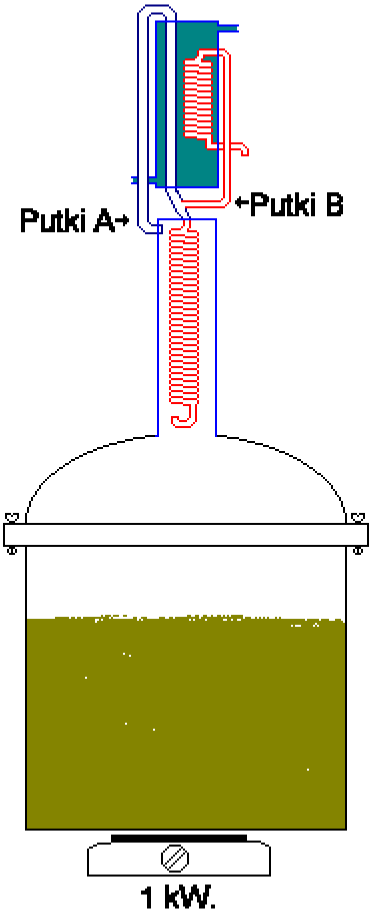
(also see Mikes recipe for Capt Morgans Spiced Rum)

Ken : **Pot Temperature**: Measured on the lid for a better idea of the steam temp as this is the portion that is most critical. By keeping the temperature between 198-206 degrees F (92-96C), we are able to tell when the wert is getting too hot and giving us that 'Brackish' smell that can be calmed with carbon filtering but never quite goes away. Now, Mike and I have slightly different opinions on the tails aspect but we do agree that the burning of the wert is what was making the first few batches of rum a little on the unpalatable side. We bit the bullet and drank it anyway but with the new numbers, we have made a very flavourful rum product. Final flavouring with cloves and cinnamon will be the defining bit. When the lid temp reaches 208F (98C), shut down the still. I know, there is more to come but I found a +4 degree variation between the lid and the boiler body. As soon as the boiler body hits 212 (100), the wert started to burn and that... smell... came through into the product.

Variac: Because we are using 2/1500 watt heating elements from a water tank for heat up, we get to temperature on 23L in about 45 minutes. At that point, we switch to one heater only (all that is needed to maintain the temp now) on variac control at 105-107 vac. Kinda like using a stove rheostat at 9 instead of 10. This slows the heating of the pot to get a longer run and as the alcohol is boiled off, the temperature climbs. We don't do a full boil all the way through, just a slight rolling.

We also found that we only needed 2 scrubbies (teased until they cried) in the column you see in our picture. We had added some more but it took quite a bit of heat to get a flow. We clean distilled water with nothing in the column and decided that less is more. To help the reflux happen quicker without losing too much in percentage, (about 5%) we didn't have to run quite as warm and ended up with a smoother result. We will add 1/2 of a scrubby for the next boil but we are on the right track for us. Keep in mind that these scrubbies have been pulled almost to the length of the column and allowed to coil back on themselves. This, it would seem, gives us the same area as the rashiq rings.

http://ponu.haisee.com/



Reima tells me ..."there is a neat still at http://ponu.haisee.com/ only it is in my old lingo so I have translated it hoping the owner does not mind. It should tickle the minds of those who like to play with thumpers, cause it seems to have one built in."

Lower colon is 300-400mm high. Top one is 250mm. Red tube of 8mm and blue of 10mm copper.

This does a double distilling in one go, like a built in thumper, and is self tuning. Only critical tuning needed is cooling water flow. Steam goes through "A" and condenses on its way back to lower colon coil made of 8mm by about 1m length copper tube. In this coil, being in the path of about 90C vapours a new boiling of distillate occurs. At the bottom of this coil there must be a 50mm liquid lock (a bend up). The lighter ethanol in this coil boils and travels up to the T piece and to the condenser, the heavier stuff runs back to the boiler through the liquid lock.
Both colons are of 60mm outside diameter SS-tube
Lower colon is 350-400mm and top one is 250mm length.
Coils of 8mm copper tube. Tube A 10mm and B 8 mm tube.
This works on a 20 litre boiler heated with a 1 kW heater.
Condenser coil length is not critical 0.5m length is enough. Highest pressure in this system is then 50mm water height.

When tube A is starting to warm up it is time to let in some cooling water, only little. It should not run out as thick as a match stick, if too much cooling there will not come out anything. Try to keep the top colons lower part hand warm when its upper part is hot. And remember the slower it comes out the stronger it is.

Scott's POS Firewater Hook Column & Flamethrower Condenser email: goyeast@yahoo.com

This is my column and condenser, assembled minus the tubing. It achieves total reflux by default, and the distillate is drawn off via the gate valve. I've since added a needle valve below the gate valve in order to achieve finer control. With a 750 watt element, I've drawn 400 ml per hour of 95%+ alcohol, which isn't very fast, but I just purchased a 1500 watt element that will probably increase this significantly. The column is 45 in. x 1.5 in. and is packed with s.s. pot scrubbers. The condender assembly is 44 in. long, with the jacketed portion being 26 in. x .75 in. around a .5 in. pipe (a lot longer than necessary, I've found).

I've only had two issues with this design.
1) The condenser screws onto the column, thus in order to draw off alcohol, I need to wrap the column's male fitting with PTFE tape to insure that the take-off valve is pointing toward the ground.
2) When assembled, the column and condenser need to be stablized. I use a homemade wooden frame which has worked well.

Pilch's Stills

The Ultra Pure Still at www.puredistilling.com

From Australias largest manufacturer of stills:

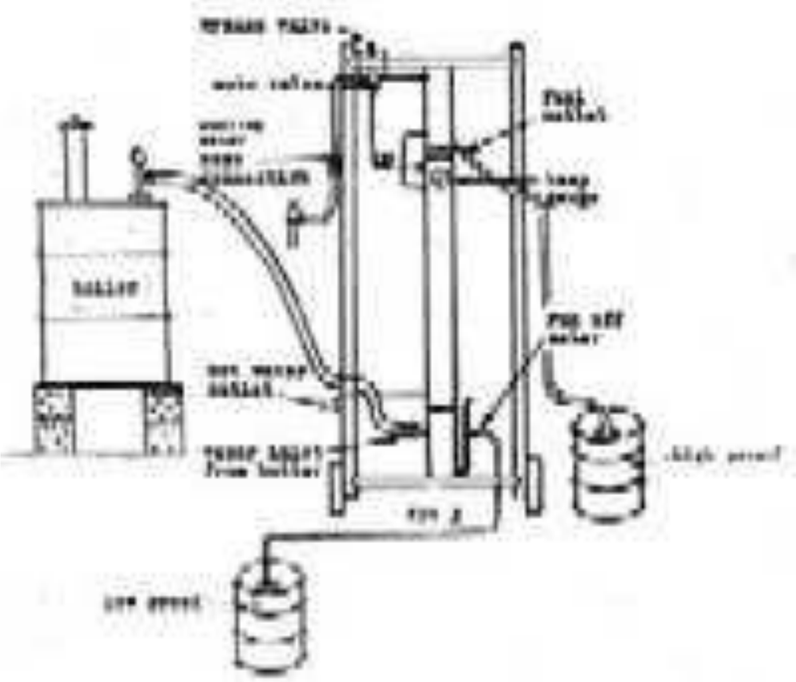
Purity: 95%
Speed: 1.2L / Hour
Capacity: 5L (can be fitted to any boiler)

100% Money Back Guarantee

Using just a 25cm column, this still produces 2 bottles of spirits from its 5L boiler in just 30 minutes, including heatup time!

It uses a 2200W element, and amphora structured copper mesh for smooth, authentic flavour. Comes with a digital thermometer for accurate cuts.

A true reflux still for an excellent price - just $467 delivered anywhere in the world - guaranteed.



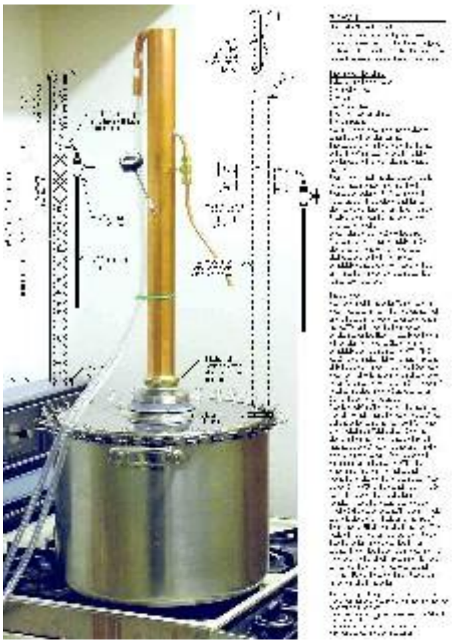
This is a fuel alcohol still, designed to be a higher volume still, allowing you to run 50 to 100 gallons of mash at a time and make enought ETOH to fill your gas tank.

If the main column is too narrow to have a coiling coil inside it, you can always use a cold collar around the outside of it. Another, but less effective method is to coil around the outside of the column.

There are excellent instructions for making the external condensor in the "StillMaker" pdf, or at Http://www.Moonshine-Still.com. Basically just use a couple of T fittings, or if you're a dab hand at welding, just build it up yourself. Another (easier) option is the "Euro" still condensor, where the cooling water is simply fed in a tube up through the outlet pipe. See a photo of it.

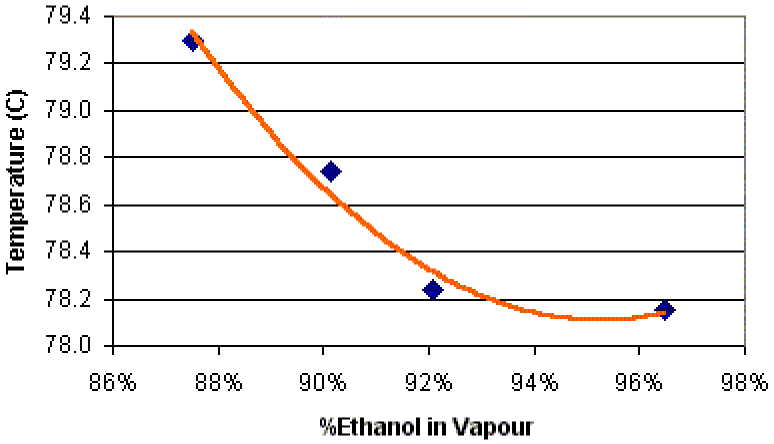
Third (my preferred option) is to do the Nixon style of condensor, as seen in the photos, where all the vapour is condensed (with an oversized coil - thus minimal water required), and then you proportion off the amount of liquid you keep vs return. This gives you maximum control over the reflux ratio, being able to dial it up from "total reflux", essential for getting a column into equilbrium before taking off the heads, through to "no reflux" if you want to do a stripping run, or only a low reflux run say for a flavourful rum or the like. The disadvantage of this design is that it adds to the height - say another 30 cm. But I reckon well worth it.

An excellent variation on that is Alex's (Bokakob) mini-still:



Controls

I prefer to only control the reflux ratio. If the column is wide enough, then you don't need to worry about metering the heat input via the element. Either up the water flowrate, or close down the take-off valve, in response to the vapour temperature measured at the top of the column. Use this graph below to compare temperature to purity. Cheap (NZ$28 at www.dse.co.nz) digital thermometers are excellent for reading this temperature.



Summary

So, in summary, to make a very cheap, short still, how about a 1500W element, with a 1.5 inch by 60-70cm column, scrubber packing, and simple external condensor (Euro style) & internal cooling coil of say 4-5 turns, directly plumbed between the two.

To make a more high performance still with more options on how to run it & what products you can make from it, first make it taller, and then consider using the Nixon condensor.

Calculation of a Pot Still Distillation Run

Heres a rough stab I've had at this....

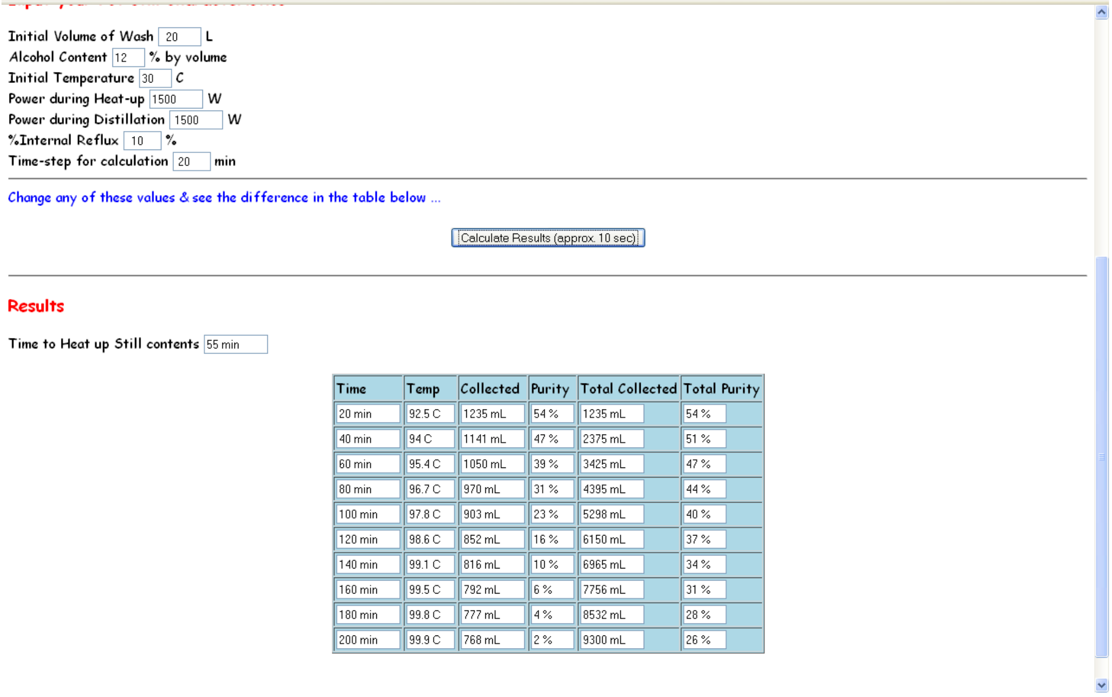
One assumption is that all the heat input is used to vaporise the vapour, eg no heat losses, but this should be a minor error. (I'll just claim that all pot stills are extremely well insulated ...

If you don't know what your power input is (say you are using gas heating instead), adjust the value used until the "time to heat up" is close to what you expect.

This can also be used for double & triple distillations, eg

- 20L of 15% will give around 6L of 45% (use say a 25% cut-off)
- feed this back in & see that you'll get around 4L of 68%, then
- distilling this gives about 3.4L of 80%

It's not quite such an accurate calculation at the higher %alcohols, because the timesteps are too large. An indication that that calculation has got where it's going is when the sample purity first goes -ve.



Initial Volume of Wash 20 L
Alcohol Content 12 % by volume
Initial Temperature 30 C
Power during Heat-up 1500 W
Power during Distillation 1500 W
%Internal Reflux 10 %
Time-step for calculation 20 min

Change any of these values & see the difference in the table below ...

Results

Time to Heat up Still contents 55 min

Time	Temp	Collected	Purity	Total Collected	Total Purity
20 min	92.5 C	1235 mL	54 %	1235 mL	54 %
40 min	94 C	1141 mL	47 %	2375 mL	51 %
60 min	95.4 C	1050 mL	39 %	3425 mL	47 %
80 min	96.7 C	970 mL	31 %	4395 mL	44 %
100 min	97.8 C	903 mL	23 %	5298 mL	40 %
120 min	98.6 C	852 mL	16 %	6150 mL	37 %
140 min	99.1 C	816 mL	10 %	6965 mL	34 %
160 min	99.5 C	792 mL	6 %	7756 mL	31 %
180 min	99.8 C	777 mL	4 %	8532 mL	28 %
200 min	99.9 C	768 mL	2 %	9300 mL	26 %

Calculations for a Reflux Still

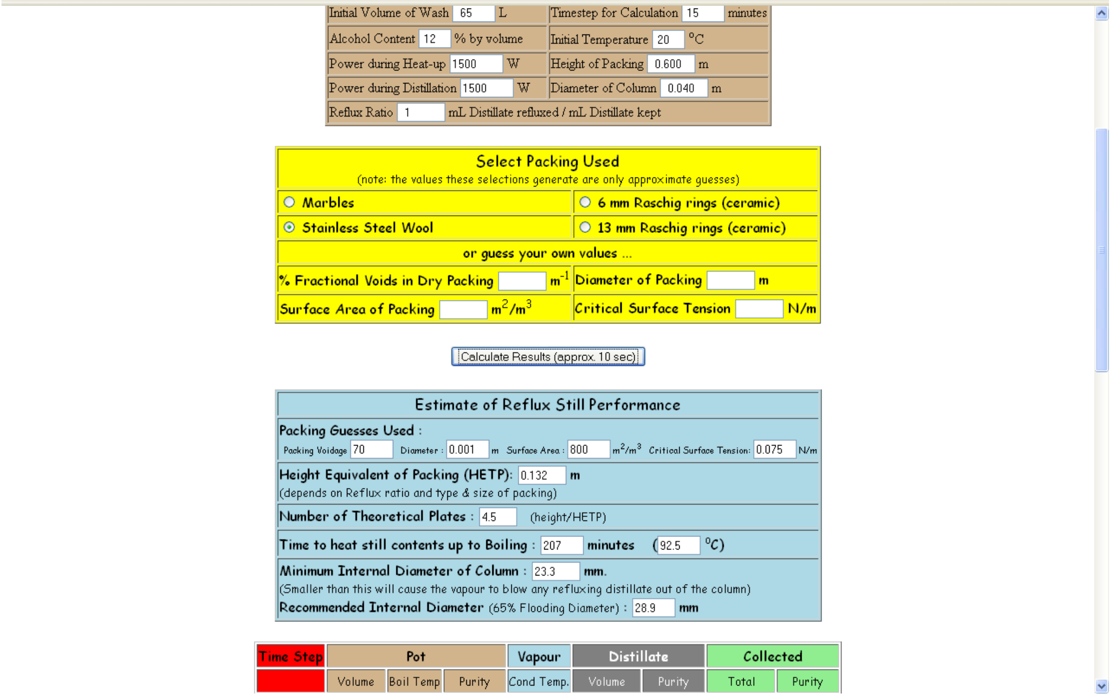
Heres the start of this. Still HEAPs to go ... I've so far totally ignored the cooling water & heat loss calculations (will include them later (much))

The calculations for sizing column diameter (at 65% of flooding) are based on Sherwoods equation (Perry 18-47), whereas the performance of the packing, and the resulting number of theoretical plates is based on Onda's method (Coulson 11-113).

If you don't know the power input to your still (eg you use gas), adjust the "power" values used until the "time to heat up" match with what you expect from experience.

This page is still very much work in progress. It may well all be totally wrong, and may very much change from one day to the next. Thats my perogative. I make absolutely no claims about its accuracy at this stage, but I'm trying to do my best.

Known errors at present : innaccurate for small number of plates, as result is rounded to closest plate, eg 1.45 plates rounded to Plate 1,but 1.55 plates rounded to Plate 2
There is still a small discrepancy vs Excel version of this - suspect rounding errors are at fault



Initial Volume of Wash 65 L	Timestep for Calculation 15 minutes
Alcohol Content 12 % by volume	Initial Temperature 20 °C
Power during Heat-up 1500 W	Height of Packing 0.600 m
Power during Distillation 1500 W	Diameter of Column 0.040 m
Reflux Ratio 1 mL Distillate refluxed / mL Distillate kept	

Select Packing Used
(note: the values these selections generate are only approximate guesses)

○ Marbles	○ 6 mm Raschig rings (ceramic)
● Stainless Steel Wool	○ 13 mm Raschig rings (ceramic)

or guess your own values ...

% Fractional Voids in Dry Packing ☐ m^{-1}	Diameter of Packing ☐ m
Surface Area of Packing ☐ m^2/m^3	Critical Surface Tension ☐ N/m

Estimate of Reflux Still Performance

Packing Guesses Used :
Packing Voidage 70 Diameter : 0.001 m Surface Area : 800 m^2/m^3 Critical Surface Tension: 0.075 N/m

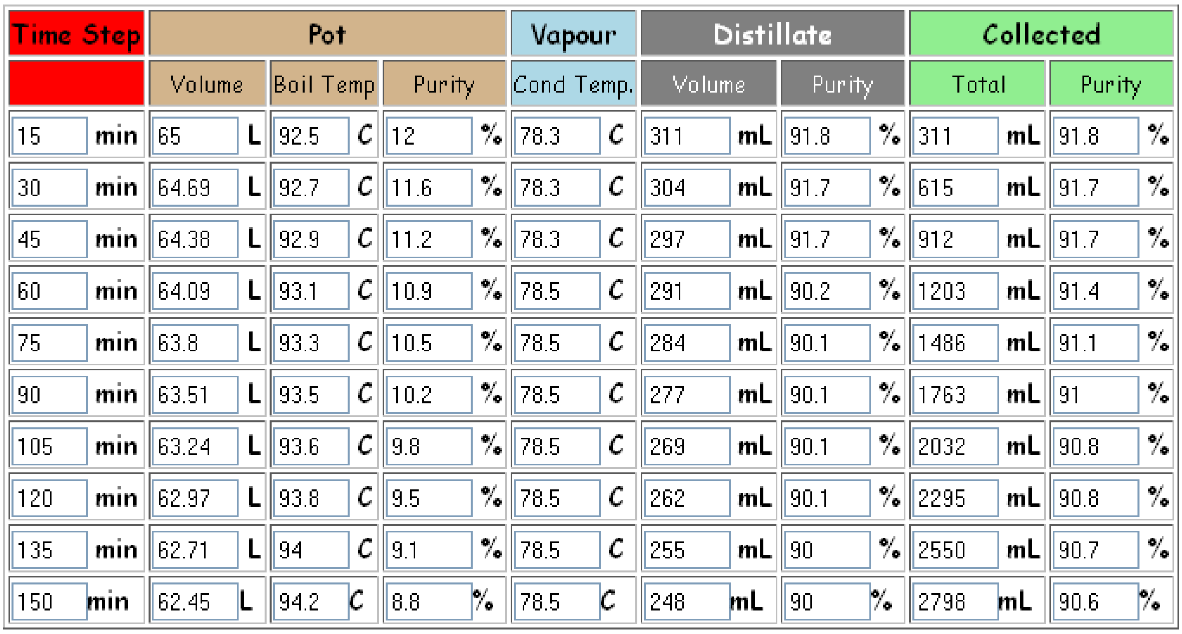
Height Equivalent of Packing (HETP): 0.132 m
(depends on Reflux ratio and type & size of packing)

Number of Theoretical Plates : 4.5 (height/HETP)

Time to heat still contents up to Boiling : 207 minutes (92.5 °C)

Minimum Internal Diameter of Column : 23.3 mm.
(Smaller than this will cause the vapour to blow any refluxing distillate out of the column)
Recommended Internal Diameter (65% Flooding Diameter) : 28.9 mm

Time Step	Pot			Vapour	Distillate		Collected	
	Volume	Boil Temp	Purity	Cond Temp.	Volume	Purity	Total	Purity



Time Step	Pot			Vapour	Distillate		Collected	
	Volume	Boil Temp	Purity	Cond Temp.	Volume	Purity	Total	Purity
15 min	65 L	92.5 C	12 %	78.3 C	311 mL	91.8 %	311 mL	91.8 %
30 min	64.69 L	92.7 C	11.6 %	78.3 C	304 mL	91.7 %	615 mL	91.7 %
45 min	64.38 L	92.9 C	11.2 %	78.3 C	297 mL	91.7 %	912 mL	91.7 %
60 min	64.09 L	93.1 C	10.9 %	78.5 C	291 mL	90.2 %	1203 mL	91.4 %
75 min	63.8 L	93.3 C	10.5 %	78.5 C	284 mL	90.1 %	1486 mL	91.1 %
90 min	63.51 L	93.5 C	10.2 %	78.5 C	277 mL	90.1 %	1763 mL	91 %
105 min	63.24 L	93.6 C	9.8 %	78.5 C	269 mL	90.1 %	2032 mL	90.8 %
120 min	62.97 L	93.8 C	9.5 %	78.5 C	262 mL	90.1 %	2295 mL	90.8 %
135 min	62.71 L	94 C	9.1 %	78.5 C	255 mL	90 %	2550 mL	90.7 %
150 min	62.45 L	94.2 C	8.8 %	78.5 C	248 mL	90 %	2798 mL	90.6 %

So the Purity of the distillate is determined mostly by the height of the column, and the type of packing (via the HETP), whereas the rate of product removal is dominated by the Reflux ratio. For purity say 80-90 %, the amount of reflux doesn't become too important, the column height is what delivers for you. However, to really push the limit towards 95% however, this is when you need to increase the reflux ratio, and wait a while longer to obtain the product.

To use this calculator to help you with your still design or operation, spend some time once to rigourously understand its operation. Treat this one run as an experiment, and spend the time on it. Measure & write down the temperatures every 5 or 10 minutes, and graph them as you go. Collect the distillate into 200 mL or so containers, and note how long it took to fill them (eg the flowrate). Once they're each cool, measure their %. Measure the cooling water flowrate & temperature, and work out how much it needs to be increased near the end of the run to keep it cool.

This will allow you to get an accurate idea of the heat input to the still, so that you can then optimise its diameter (you may need to widen it if too small, or decrease it (by stuffing it with some stainless steel rods or suchlike) if too large) if too far from that desired.

By understanding the flowrate of distillate you are collecting, you can determine the reflux ratio that you are getting from your cooling coils etc. Once you know this, you can work out the HETP for your packing, and thus the number of "theoretical plates" your still has. This will determine the maximum purity that you can achieve - if close to it, you're doing well, if miles away from it then something aint working right. If the maximum is less than what you want, then you'll need to make the column taller or change the packing (or both !).

The cooling water temperature will tell you if you're sub-cooling the reflux distillate. If this is happening, then you're wasting the top portion of your column as all its doing is trying to heat it back up to equilibrium tempeature again, before it can start stripping the vapour of its water content. If the cooling water flowrate is really large (eg more than about 2/3L per minute) then your cooling isn't as efficient as it could be - see if it needs more surface area to work over.

Once you understand how your temperatures & distillate flowrate changes at the end of a run, you can predict more accurately when you're starting to receive the tails. Compare the total distillate collected, and its purity, against what is theoretically possible. There's no point is trying to wring too much out of the still, or else you'll just be into collecting those tails and ruining your whole batch. (This is where the table of "amount collected over time" might be usefull to you - as a guide to when to stop)

These calcs aren't thecomplete picture, but should be usefull as a guide along with reflux design in terms of understanding and getting the best from your still.

Calculation of Condenser Size

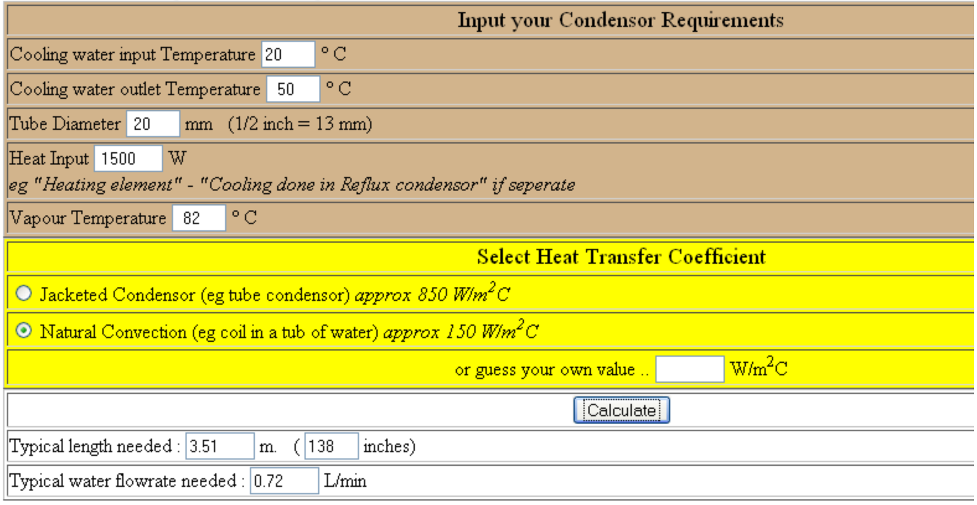
Theres quite a few variables involved, so its hard to cover every situation. You have to consider how hot the vapour is, what its composition is (eg water takes 3x as much cooling to condense than ethanol), how cold the cooling water is & how hot its going to get, and how well the cooling water is flowing around the tube, then even stuff like if the tubes are vertical or horizontal.

There are very detailed equations about that let you work this out precisely . But you can also use a few simplifying guesses to sorta give an idea of what size it could be, for far less effort. The results may not be quite as accurate, but they'll give you an approximate idea of what size is involved (so to be safe/certain you might even just double them !)

The hardest bit is the"heat transfer coefficient". This descibes whats going on inside & outside the cooling coil or tube, as well as the heat transfer properties of the tube (eg plastic vs copper). Rather than doing all the calculations, we can use a "typical" value. For "organics" being condensed using water in a shell heat exchanger, this value can be typically 700-1000 W/m2C. Lets use 850. This is for industrial condensors, where the cooling water will be flowing past the tube at a fairly good velocity. For the situation where the cooling coil is just sitting in a big tub of water (and nothing is stirring the water), this value will be more like 100-200 W/m2C (lets use 150 W/m2C).

Just remember that the size of the pot is irrelevent. Its the heating element we need to match.

If you have a "reflux" condensor somewhere in your still as well, this will be taking out some of the heat too. Subtract away the amount of heat used there, from the total. So then your distillate condensor might not be as big in that situation.



Input your Condensor Requirements

Cooling water input Temperature 20 ° C

Cooling water outlet Temperature 50 ° C

Tube Diameter 20 mm (1/2 inch = 13 mm)

Heat Input 1500 W
eg "Heating element" - "Cooling done in Reflux condensor" if seperate

Vapour Temperature 82 ° C

Select Heat Transfer Coefficient

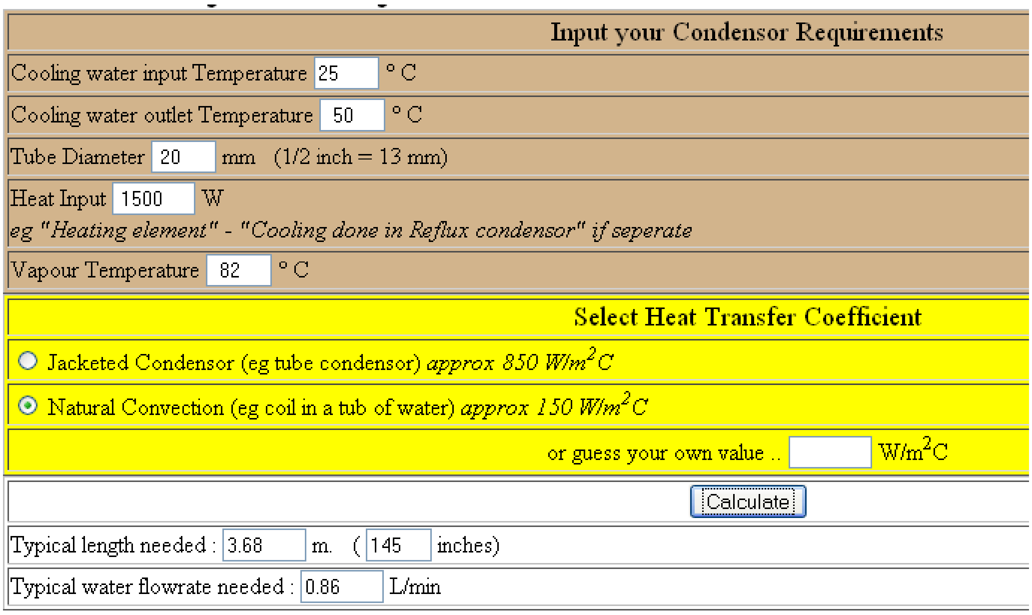
○ Jacketed Condensor (eg tube condensor) *approx 850 W/m^{2}C*

● Natural Convection (eg coil in a tub of water) *approx 150 W/m^{2}C*

or guess your own value .. W/m^{2}C

Typical length needed : 3.51 m. (138 inches)

Typical water flowrate needed : 0.72 L/min



Input your Condensor Requirements

Cooling water input Temperature 25 ° C

Cooling water outlet Temperature 50 ° C

Tube Diameter 20 mm (1/2 inch = 13 mm)

Heat Input 1500 W
eg "Heating element" - "Cooling done in Reflux condensor" if seperate

Vapour Temperature 82 ° C

Select Heat Transfer Coefficient

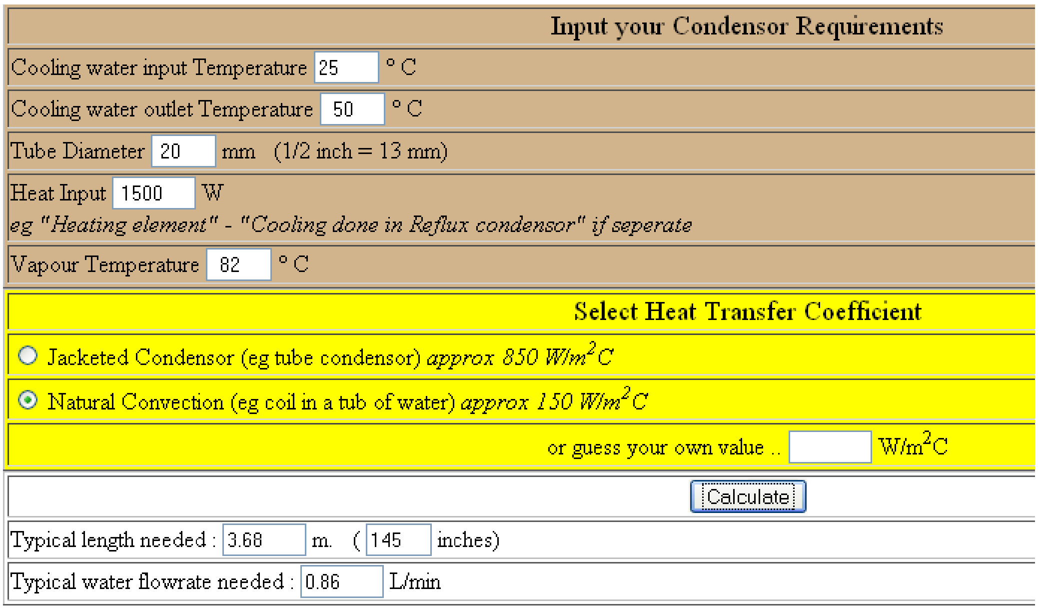
○ Jacketed Condensor (eg tube condensor) *approx 850 W/m^{2}C*

● Natural Convection (eg coil in a tub of water) *approx 150 W/m^{2}C*

or guess your own value .. ☐ W/m^{2}C

Typical length needed : 3.68 m. (145 inches)

Typical water flowrate needed : 0.86 L/min



Input your Condensor Requirements

Cooling water input Temperature 25 ° C

Cooling water outlet Temperature 50 ° C

Tube Diameter 20 mm (1/2 inch = 13 mm)

Heat Input 1500 W
eg "Heating element" - "Cooling done in Reflux condensor" if seperate

Vapour Temperature 82 ° C

Select Heat Transfer Coefficient

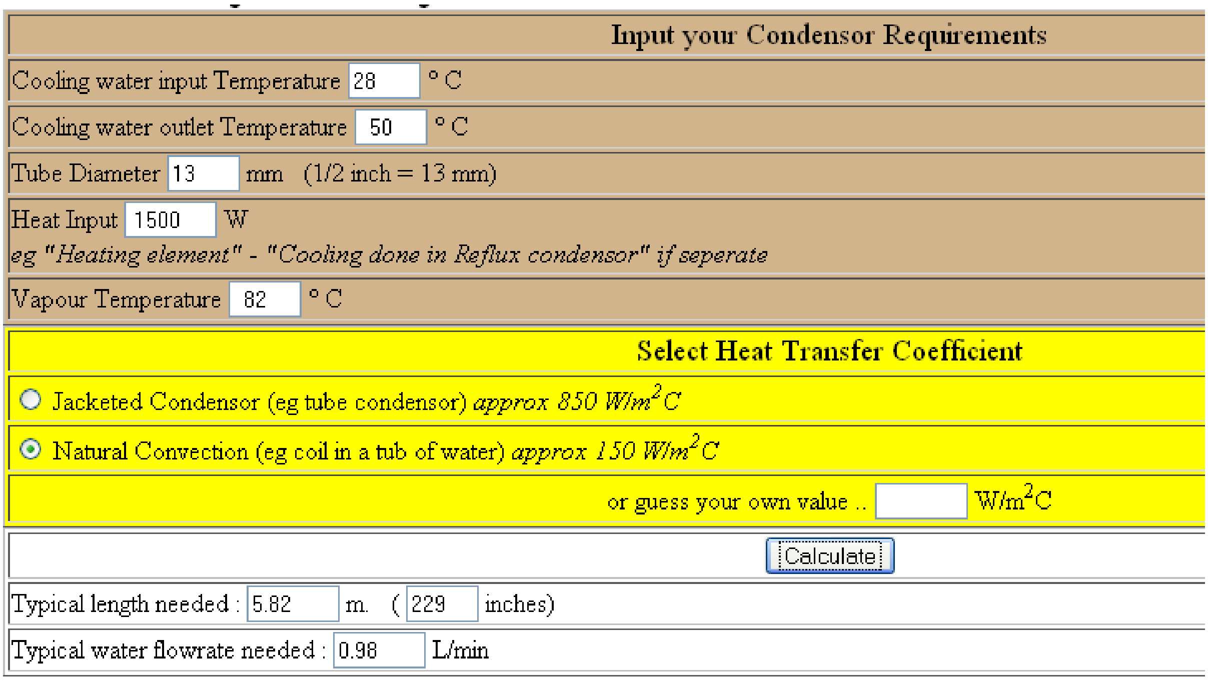
○ Jacketed Condensor (eg tube condensor) *approx 850 W/m^{2}C*

● Natural Convection (eg coil in a tub of water) *approx 150 W/m^{2}C*

or guess your own value .. ☐ W/m^{2}C

Typical length needed : 3.68 m. (145 inches)

Typical water flowrate needed : 0.86 L/min



Input your Condensor Requirements

Cooling water input Temperature 28 ° C

Cooling water outlet Temperature 50 ° C

Tube Diameter 13 mm (1/2 inch = 13 mm)

Heat Input 1500 W
eg "Heating element" - "Cooling done in Reflux condensor" if seperate

Vapour Temperature 82 ° C

Select Heat Transfer Coefficient

○ Jacketed Condensor (eg tube condensor) *approx 850 W/m^{2}C*

● Natural Convection (eg coil in a tub of water) *approx 150 W/m^{2}C*

or guess your own value .. ☐ W/m^{2}C

Typical length needed : 5.82 m. (229 inches)

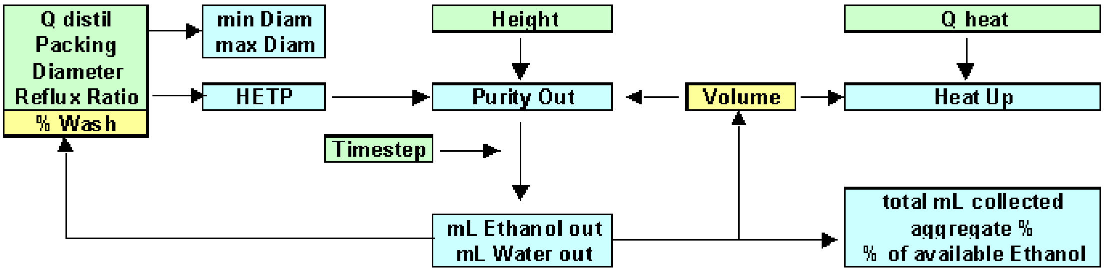
Typical water flowrate needed : 0.98 L/min

Note that you don't need such a long condenser if you keep the outlet temperature of the water cold. But then the flowrate of water needed increases. Yours to choose.

If you're going for the "coil in a tub" approx, the "cooling water outlet temperature" refers to how how the tub would typically get to at the end of the run. The maths isn't strictly true, but should do as a bit of a guess. You can multiply the flowrate by how long you'd be running the still for in order to work out how much water the tub would need to hold.

As always, they're only as accurate as the guesses used, and the guesses I've shown above in the examples might not match your situation in practice. But doing this should give you a basic starting point from which to experiment. If in doubt, double the size you estimate, and you should be OK (though your pocket a little bit lighter).

Equations used during Reflux Distillation Calculations



Knowing the about the wash & column, we can calculate things like recommended min & max column diameters, the purity we expect off the top column, and how long it will take to heat up to temperature. Then, we can look at the column performance over time - how much we expect to collect from it, and how this changes (as does the column performance) over the course of the run.

I've collated all the required Physical constants, etc for water & ethanol on a data page

Physical Properties

Value	**Units**	**Ethanol**	**Water**	**Reference**
Liquid density	g/mL	0.789	1.000	Perry 3.2
Vapour density @ 90C	g/mL	0.0015	0.001	PV=nRT
Molecular weight	g/mol	46.0634	18.0152	Perry 3.2
Liquid Heat Capacity	J/gK	2.845	4.184	Perry 3-183
Heat of Vapourisation	J/g	855	2260	Perry 3-178
Vapour Pressure @ 90C	torr	1187	525	Perry 13-4
Liquid Viscosity	kg/ms	0.00037	0.00032	Perry 3-252
Vapour Viscosity	kg/ms	108×10^{-7}	125×10^{-7}	Perry 3-311
Surface Tension @ 20C	mN/m	22.39	72.75	Kay & Laby
Vapour Diffusivity ethanol/water	m^2/s	?		?
Vapour Diffusivity ethanol/air	m^2/s	102×10^{-7}		Perry 3-319
Liquid Diffusivity ethanol/water	m^2/s	128×10^{-11}		Perry 3-319

Perry = Perry's Chemical Engineers' Handbook, 6th Ed, 1987, Robert H. Perry & Don Green
Kaye & Laby = Tables of Physical & Chemical Constants, Kaye & Laby, 16th Ed, 1995

Min & Max Diameter

Calculate the flooding diameter, based on figure 18-38 in Perry

$\frac{U_t^2 a_p \rho_g \mu^{0.2}}{g \varepsilon^3 \rho_l}$ (call this "y") vs $\frac{L'}{G'}\sqrt{\frac{\rho_g}{\rho_l}}$ (call this "x")

Plotting the flooding line, I found : $y = =1.4427 x^2 -1.0271 x + 0.2312$ where

U_t = superficial gas velocity (m/s)
a_p = total area of packing (m^2/m^3 bed)
ε = fractional voids in dry packing
g = gravitational constant = 9.8067 m/s^2
G' = gas mass rate ($kg/s.m^2$)
L' = liquid mass rate ($kg/s.m^2$)
ρ_g and ρ_l = gas and liquid densities (kg/m^3)
μ_l = liquid viscosity, m Pa.s (cP)

Through the top section we have

V = vapour flowrate (kg/s)
D = distillate (kept) flowrate (kg/s), and
L = liquid flowrate (kg/s)

Based on the composition of the wash, and the power input ($Q_{distill}$), you can estimate the amount of vapour you are generating (V in kg/s)

$$Q_{distill} = (V * \%ethanol * H_{vap\ ethanol}) + (V * \%water * H_{vap\ water})$$

Then G' = V / column area (πD^2)

The amount of liquid (L) being refluxed will depend on the Reflux ratio; since D=V-L, and the Reflux ratio is L/D, then

$$L = \frac{V}{1 + \text{Reflux Ratio}}$$

So then L' = L / column area

(hmmm.. this is where I do something a little bit dodgy... we are estimating the amount of vapour being generated off the wash. This will

be true for the bottom of the column, but may not be quite the same as the vapour flowrate at the very top - some of the water will have been removed from it, and it will have picked up some more alcohol vapour on the way ... So what I do is a wee mass balance based on the expected purity at the top. This can get you into a catch 22 - because you don't know this until you can work out the HETP for the packing, but you need this value to calculate the HETP.. so guess a final %, run through the calcs, see what the top % actually is, and adjust from there & recalculate if necessary).

So... calculate out x = $\frac{L'}{G'}\sqrt{\frac{\rho_g}{\rho_l}}$, solve for y, then work out U_t

Since U_t = G' / area of column, and knowing area = πD^2 you can solve for D_{Flood}

This is the flooding diameter - eg smaller than this will cause the vapour flowrate to be too fast to allow the liquid to drain down past it. It is the absolute minimum diameter.

So the column needs to be a little wider. Standard recommendations are to use approx 65% the flooding velocity, so scale up the diameter we should use by

$$D_{65\%} = D_{Flood}\sqrt{\frac{100}{65}}$$

Likewise, if the column is too wide, there won't be enough interaction between the liquid and the vapour. I can't find any recommendations for this, but I'm guessing about 25% would be about it, so :

$$D_{25\%} = D_{Flood}\sqrt{\frac{100}{25}}$$

Now the flowrates of Liquid & Gas will be different at different heights of the column... so once you've been through the whole exercise, redo this calculation a couple of times, at a couple of different heights (flowrates). You find out that the differences aren't really worth worrying about.

HETP (Height Equivalent to a Theoretical Plate)

eg how much height of packing is needed to get the same performance as a theoretically perfect (equilibrium) plate. I've done the estimate using Onda's method (from Coulson, Richardson & Sinnott "Chemical Engineering").

Calculate the effective area (a_w) using :

$$\frac{a_w}{a} = 1 - \exp\left[-1.45\left(\frac{\sigma_c}{\sigma_L}\right)^{0.75}\left(\frac{L_w^*}{a\mu_L}\right)^{0.1}\left(\frac{L_w^{*2}a}{\rho_L^2 g}\right)^{-0.05}\left(\frac{L_w^{*2}}{\rho_L\sigma_L a}\right)^{0.2}\right]$$

where:

a_w = effective interfacial area of packing per unit volume (m^2/m^3)
a = actual area of packing per unit volume (m^2/m^3)
σ_c = critical surface tension for the particular packing material (see table below)
σ_L = liquid surface tension mN/m
L^*_w = mass flowrate per unit cross-sectional area, kg/m^2s = L'

Critical surface tension	
Material	**σ_c [mN/m]**
Ceramic	61
Metal (steel)	75
Plastic (polyethylene)	33
Carbon	56

Then calculate the liquid and gas mass transfer coefficients (k_L and k_G) using :

$$k_L\left(\frac{\rho_L}{\mu_L g}\right)^{1/3} = 0.0051\left(\frac{L_w^*}{a_w\mu_L}\right)^{2/3}\left(\frac{\mu_L}{\rho_L D_L}\right)^{-1/2}(ad_p)^{0.4}$$

$$\frac{k_G}{a}\frac{RT}{D_V} = K_5\left(\frac{V_w^*}{a\mu_V}\right)^{0.7}\left(\frac{\mu_V}{\rho_V D_V}\right)^{1/3}(ad_p)^{-2}$$

where:

K_5 = 5.23 for packing sizes >15mm and 2.0 for sizes <15mm
V^*_w = gas mass flowrate per cross-sectional area [kg/m^2s] = G'
d_p = packing size [m]
k_L = gas film mass transfer coefficient,[$kmol/m^2s$ atm or $kmol/m^2s$ bar]
k_G = liquid film mass transfer coefficient [$kmol/m^2s$ or $kmol/m^3$ = m/s

depending on whether use R=0.08206 atm.m^3/kmol K or R=0.08314 bar m^3/mol K]

From these you can then calculate the film transfer heights:

$$H_G = \frac{G_M}{k_G a_w P} \qquad H_L = \frac{L_M}{k_L a_w C_t}$$

where:

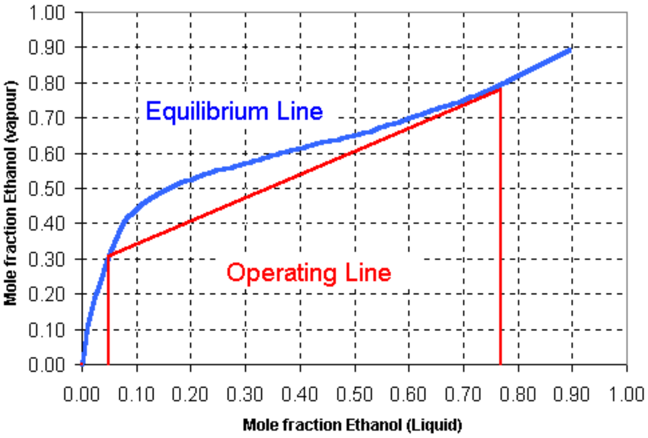
P = column operating presure, [atm or bar]
C_t = total concentration, kmol/m^3 = ρ_L / molecular weight solvent
G_m = molar gas flowrate per unit cross-sectional area, kmol/m^{2}s
L_m = molar liquid flowrate per unit cross-sectional area, kmol/m^{2}s

From these you can then estimate the height of the overall gas-phase transfer unit:

$$H_{OG} = H_G + \frac{G_M}{L_M} H_L$$

where:

m = slope of the equilibrium line (I reckon its about 0.49)
Gm/Lm = slope of the operating line



Now... for a section of the packed column in which the operating and equilibrium lines can be considered straight (hey- that's almost us !), theoretical stages can be converted to numbers of transfer units by :

$$N_{OG} = N_t \frac{\ln\left(m \frac{G_m}{L_m}\right)}{m \frac{G_m}{L_m} - 1}$$

and then

$$Z_p = (HETP)(N_t) = (H_{OG})(N_{OG})$$

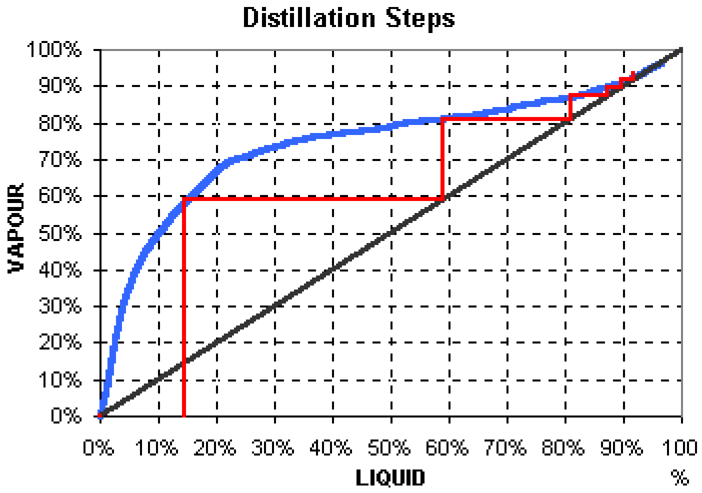
where:

Z_p = packed bed height
N_t = number of theoretical stages

Mass Balance

Once you have worked your way through this, the rest is pretty much straight forward ..

Estimate the purity at the top of the column by stepping off the correct number of theoretical stages on the Equilibrium diagram



I'm still working on a suitable correlation to use to describe the equilibrium line, but at present I use (x & y as %alcohol by volume (as a fraction, eg 0.15 not 15%)) (and don't believe beyond 95% ish) :

$$y = -31.065\, x^6 + 116.08\, x^5 - 169.95\, x^4 + 123.99\, x^3 - 47.195\, x^2 + 9.1398\, x$$

So... pick a suitable time-step, then calculate the volume removed (flowrate * time). You know the purity of it, so you can then update the total removed, the aggregate purity, and the purity and volume of the wash left in the pot.

For each time-step you can then go back to the start and redo it all again (HETP etc) if you really want to....but its not really worth the effort, as these don't change much.

Just keep a good track of the various units you're using, cos there's a bit of switching between moles, kgs, and grams along the way (let alone dabbling in Imperial units...).

Physical Properties

Ok .... heres my collection of Ethanol-Water physical properties, and some of the correlations that I have derived from them. If you can contribute any usefull data, please e-mail me : Tony.Ackland@comalco.riotinto.com.au

Here's what I've got so far ...(with absolutely bloody no guarantees about its accuracy or correctness !!!)

Basic Data for Ethanol-Water Binary Mix

Physical Properties

Value	Units	Ethanol	Water	Reference
Liquid density	g/mL	0.789	1.000	Perry 3.2
Vapour density @ 90C	g/mL	0.0015	0.001	PV=nRT
Molecular weight	g/mol	46.0634	18.0152	Perry 3.2
Liquid Heat Capacity	J/gK	2.845	4.184	Perry 3-183
Heat of Vapourisation	J/g	855	2260	Perry 3-178
Vapour Pressure @ 90C	torr	1187	525	Perry 13-4
Liquid Viscosity	kg/ms	0.00037	0.00032	Perry 3-252
Vapour Viscosity	kg/ms	108×10^{-7}	125×10^{-7}	Perry 3-311
Surface Tension @ 20C	mN/m	22.39	72.75	Kay & Laby
Vapour Diffusivity ethanol/water	m^2/s	?		?
Vapour Diffusivity ethanol/air	m^2/s	102×10^{-7}		Perry 3-319
Liquid Diffusivity ethanol/water	m^2/s	128×10^{-11}		Perry 3-319

Perry = Perry's Chemical Engineers' Handbook, 6th Ed, 1987, Robert H. Perry & Don Green
Kaye & Laby = Tables of Physical & Chemical Constants, Kaye & Laby, 16th Ed, 1995

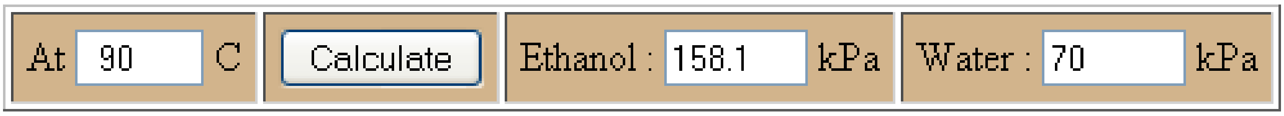
Vapour Pressure

log (P_sat) = A - B/(T+C) : P_sat [torr], T [C]

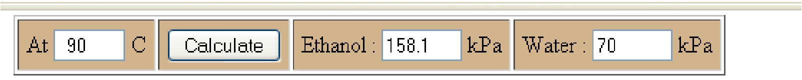
torr x 133.22 = Pa

Perry 13-4

Species	A	B	C
Ethanol	8.1122	1592.864	226.184
Water	8.07131	1730.63	233.426


At 90 C

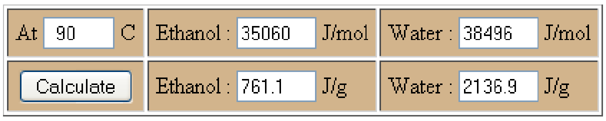
Ethanol : 158.1 kPa
Water : 70 kPa


At 90 C
Ethanol : 158.1 kPa
Water : 70 kPa

Heat of Vapourisation

Hv = Ho * ((1-T/Tc)/(1-To/Tc)) ^ (A +B(1-T/Tc))

Value	Ethanol	Water
Ho	38743.84	40799.86
Tc	513.9	647.3
A	0.32	0.19
B	-0.14	0.21


At 90 C
Ethanol : 35060 J/mol
Water : 38496 J/mol

Ethanol : 761.1 J/g
Water : 2136.9 J/g

Surface Tension

st [mN/m] = 24.05 - 0.0832 x T [^{o}C] in range 10-70 ^{o}C


At 90 °C

Ethanol surface tension is 16.6 mN/m

Equilibrium Data

The molar data is from Perry 13-12, I've done the conversions to mass fraction and volume fraction, using the density and molecular weight data above.

Temperature	Mole Fraction		Mass Fraction (g/g)		Volume Fraction (mL/mL)	
(C)	Liquid (x)	Vapour (y)	Liquid (x)	Vapour (y)	Liquid (x)	Vapour (y)
95.5	0.019	0.170	0.0472	0.3437	0.0591	0.3990
89	0.072	0.389	0.1657	0.6196	0.2012	0.6736
86.7	0.097	0.438	0.2147	0.6654	0.2573	0.7160
85.3	0.124	0.470	0.2654	0.6943	0.3141	0.7422
84.1	0.166	0.509	0.3374	0.7260	0.3923	0.7705
82.7	0.234	0.545	0.4381	0.7535	0.4971	0.7948
82.3	0.261	0.558	0.4743	0.7635	0.5334	0.8036
81.5	0.327	0.583	0.5544	0.7811	0.6119	0.8189
80.7	0.397	0.612	0.6269	0.8014	0.6804	0.8365
79.8	0.508	0.656	0.7252	0.8301	0.7698	0.8609
79.7	0.520	0.660	0.7346	0.8322	0.7782	0.8628
79.3	0.573	0.684	0.7745	0.8470	0.8132	0.8753
78.74	0.676	0.739	0.8423	0.8784	0.8713	0.9015
78.24	0.747	0.782	0.8831	0.9014	0.9055	0.9206
78.15	0.894	0.894	0.9558	0.9558	0.9648	0.9648

Correlations

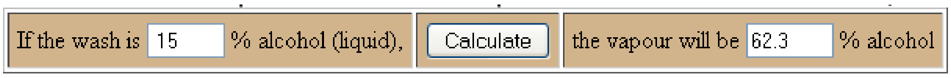
Vapour-Liquid Equilibrium

%vap = -94.7613*x ^ 8 + 450.932 * x ^ 7 - 901.175 * x ^ 6 + 985.803 * x ^ 5 - 644.997 * x ^ 4 + 259.985 * x ^ 3 - 64.5050 * x ^ 2 + 9.71706 * x

where %vap = % of ethanol in vapour if condensed (mL per mL), and x = % of ethanol in liquid (mL per mL).

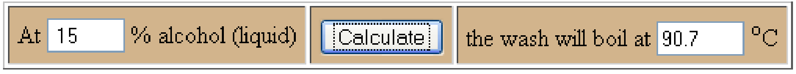
Temperature

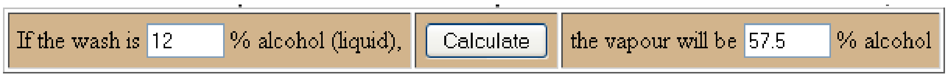
T (in C) = 60.526 * %liq ^ 4 - 163.16 * %liq ^ 3 + 163.96 * %liq ^ 2 - 83.438 * %liq + 100


If the wash is 15 % alcohol (liquid), Calculate the vapour will be 62.3 % alcohol

Temperature

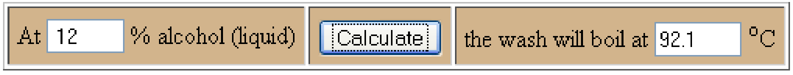
T (in C) = 60.526 * %liq ^ 4 - 163.16 * %liq ^ 3 + 163.96 * %liq ^ 2 - 83.438 * %liq + 100

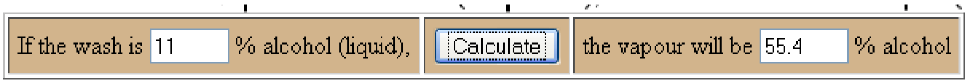

At 15 % alcohol (liquid) Calculate the wash will boil at 90.7 °C


If the wash is 12 % alcohol (liquid), Calculate the vapour will be 57.5 % alcohol

Temperature

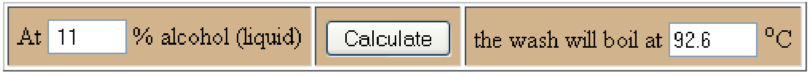
T (in C) = 60.526 * %liq ^ 4 - 163.16 * %liq ^ 3 + 163.96 * %liq ^ 2 - 83.438 * %liq + 100

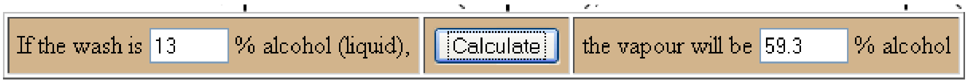

At 12 % alcohol (liquid) Calculate the wash will boil at 92.1 °C


If the wash is 11 % alcohol (liquid), Calculate the vapour will be 55.4 % alcohol

Temperature

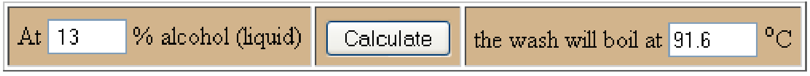
T (in C) = 60.526 * %liq ^ 4 - 163.16 * %liq ^ 3 + 163.96 * %liq ^ 2 - 83.438 * %liq + 100

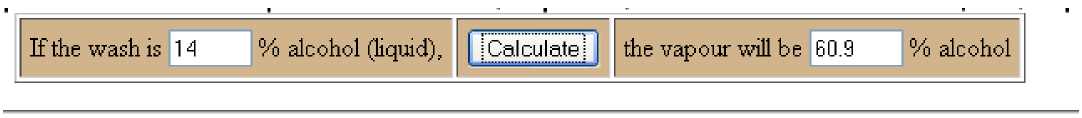

At 11 % alcohol (liquid) Calculate the wash will boil at 92.6 °C


If the wash is 13 % alcohol (liquid), Calculate the vapour will be 59.3 % alcohol

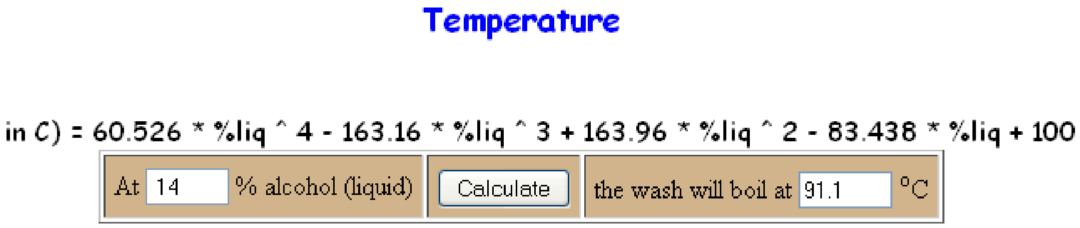
Temperature

T (in C) = 60.526 * %liq ^ 4 - 163.16 * %liq ^ 3 + 163.96 * %liq ^ 2 - 83.438 * %liq + 100


At 13 % alcohol (liquid) Calculate the wash will boil at 91.6 °C



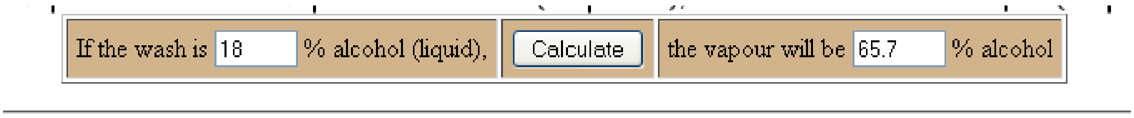
If the wash is 14 % alcohol (liquid), the vapour will be 60.9 % alcohol



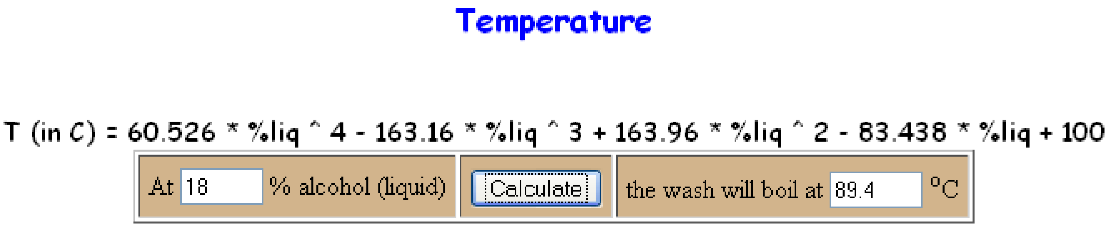
Temperature

in C) = 60.526 * %liq ^ 4 - 163.16 * %liq ^ 3 + 163.96 * %liq ^ 2 - 83.438 * %liq + 100

At 14 % alcohol (liquid) the wash will boil at 91.1 °C



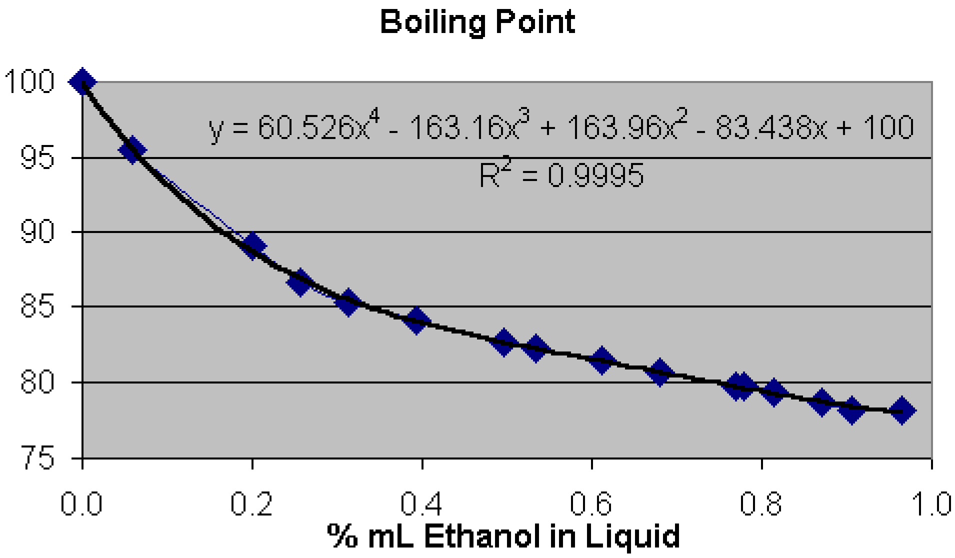
If the wash is 18 % alcohol (liquid), the vapour will be 65.7 % alcohol



Temperature

T (in C) = 60.526 * %liq ^ 4 - 163.16 * %liq ^ 3 + 163.96 * %liq ^ 2 - 83.438 * %liq + 100

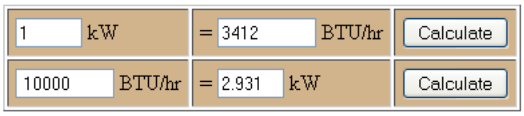
At 18 % alcohol (liquid) the wash will boil at 89.4 °C



Unit Conversion Tables

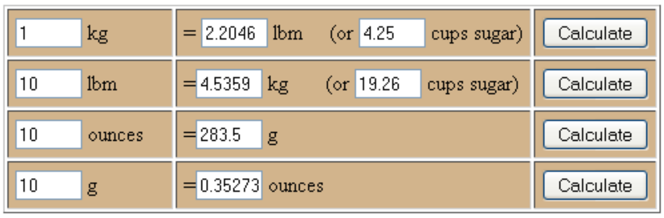
Just for you old-school types, or those Americans out there who haven't yet grasped the virtues of using SI (metric) units (the maths is a lot easier !), heres a conversion calculator for you.

Energy



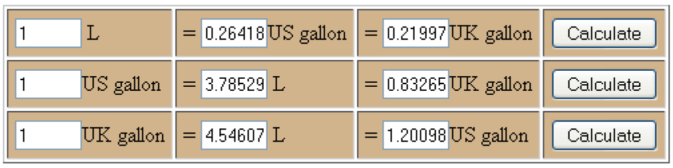
1 kW	= 3412 BTU/hr	Calculate
10000 BTU/hr	= 2.931 kW	Calculate

Mass

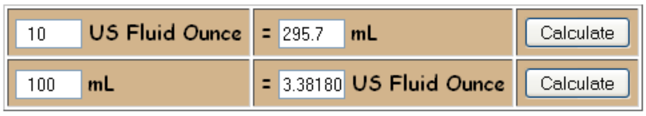


1 kg	= 2.2046 lbm (or 4.25 cups sugar)	Calculate
10 lbm	= 4.5359 kg (or 19.26 cups sugar)	Calculate
10 ounces	= 283.5 g	Calculate
10 g	= 0.35273 ounces	Calculate

Volume

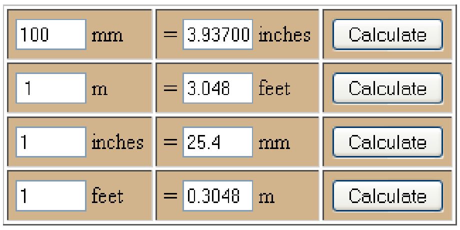


1 L	= 0.26418 US gallon	= 0.21997 UK gallon	Calculate
1 US gallon	= 3.78529 L	= 0.83265 UK gallon	Calculate
1 UK gallon	= 4.54607 L	= 1.20098 US gallon	Calculate



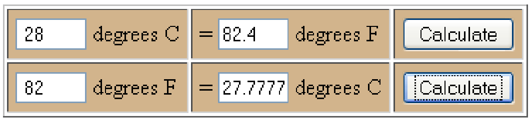
10 **US Fluid Ounce**	**=** 295.7 **mL**	Calculate
100 **mL**	**=** 3.38180 **US Fluid Ounce**	Calculate

Length



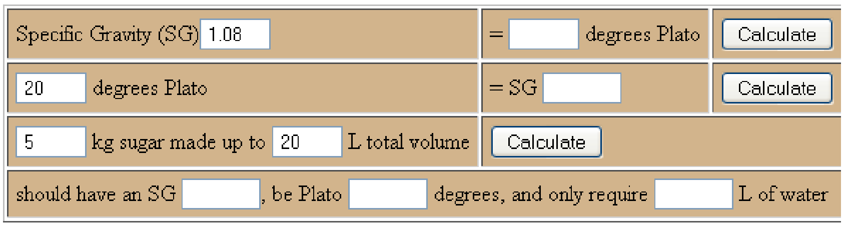
100 mm	= 3.93700 inches
1 m	= 3.048 feet
1 inches	= 25.4 mm
1 feet	= 0.3048 m

Temperature



28 degrees C	= 82.4 degrees F
82 degrees F	= 27.7777 degrees C

Sugar Concentration



Specific Gravity (SG) 1.08	= degrees Plato
20 degrees Plato	= SG

5 kg sugar made up to 20 L total volume

should have an SG , be Plato degrees, and only require L of water

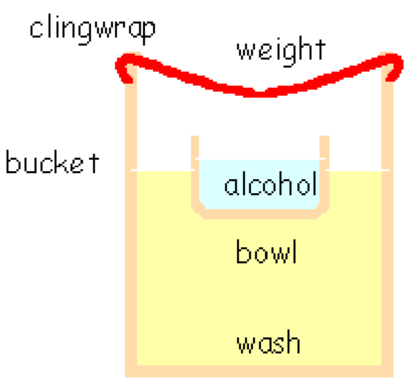
"degrees Plato" = weight % of sugar per total weight of the solution.
eg 20P = 200g sugar, in 1kg of solution

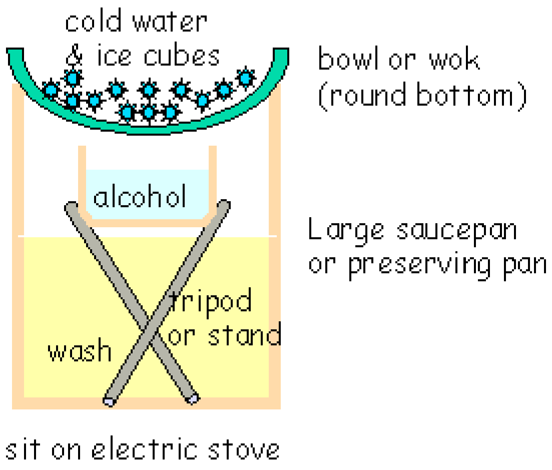
Stills that Aren't Stills

It is possible to collect alcohol from a wash, without using a full-blown still. They use common kitchen items, and takes seconds to construct / dismantle (hmmm... say the Yanks). My only concern is that there is no way to remove & discard the methanol/fusels etc - so you're in for one hell of a hangover if starting with fruits high in pectin. These methods don't produce a great product (require a second redistillation through the equipment again, or use carbon to clean it up), and are low in % alcohol, but they are an alternative technique, and are better than nothing.

Slow Evaporation

Bucket Still


Bucket Still


Ice-Water Still

The Bucket Still is the simplest. Float a bowl in the wash, cover the lot with a layer of plastic or clingwrap. Sit something heavy on the clingwrap so that any condensate that forms on the wrap will run down to the middle, and drip into the bowl. Leave the bucket etc somewhere warm. This process will take a long time to collect very much at all, and will be of quite low strength, but is probably better than nothing. Easily adapted for use in your cell.

Ice-Water Still

This concept can be beefed up a little, by heating the wash and cooling the vapour more efficiently (the Ice-Water Still). In "Brewing Real Schnaps Without a Still" (sorry, dead link: http://olliver.family.gen.nz/schnapps.htm) Vik describes a simple method using just a bowl & a saucepan, to make schnapps. To prevent the collected alcohol from re-evaporating, it would be wise to support (ie on a tripod ?) the collection dish above the wash, so that it remains cool(er)... Vik tells me that the bowl floating in the mash doesn't get as hot as I'd thought because both the alcohol evaporating from it, and the cool liquid dripping into it keep it at a temperature lower than the mash, and that the continuous circulation of alcohol might even improve the flavour. He can get results >50% alcohol by volume with a single pass, though this does need a stiff brew to start with. Just remember that your final product is highly flamable, so take care when making it on the stove-top.

Jack describes how to use it for whisky or schnapps ..

> *After looking over the "double distillation for whiskey" method on your site, I did some playing around with a large (20 litre) version of the ice water "wok for a condensor" design. Because the collected distillate is sitting on a tripod made of copper tubing (nothing special- just three pieces of thin tubing cut to fit into a tripod and support a bowl above the mash) the distillate is collected very hot- making hydrometer readings impossible (yes, you could probably adjust for temperature, but the stuff is still steaming- it would break the proof hydrometer). To get around this problem, I figured out a method of distilling spirit by measuring the amount collected. Here is how it works:*
>
> *1.start with a mash of a 10%abv, 20 liters total volume, run it through your potstill until you collect the first third. Volume collected= 6,666.6ml (yes, I am this precise in my collection measurements) The temperature you run this first run at is pretty unimportant. On the second run, use the lowest power setting that you have.*
>
> *2. load the 6,666.6ml of "low wines" into your potstill and run it on it's lowest possible power setting. Collect the first 100ml of spirit as "heads" (don't drink them! use them to start the bar-b-q). Now, collect the next 1,641.6ml of spirit that comes out of the still. With a starting mash of 10%, following these directions, this spirit should come out at 80%abv (at least with my ice-water/wok still it does- suprising since this is the least efficient still design I've ever worked with- make sure to use the LOWEST power setting on your stove). This is your finished whiskey- cut and age it as you wish.*
>
> *3.Collect the next 580.6ml of spirit that comes out of the potstill as*

"tails". These are to be added to the mash of your next batch- this separation point ensures no heavy alcohols get into the finished spirit, but no alcohol is wasted.

That's it- out of a 10%abv mash on the first run collect 1/3, on the second, collect the heads, then the next 1/4, then collect the tails (enough to total 1/3 collected out of the second run). This method gives me 4 bottles of great malt whiskey at 40%abv when I'm finished, along with a little more than a half liter of tails for the next batch (you can also save the tails, and when enough has been collected, run out the first 1/4 of the total as a finished whiskey- it should be very good- I haven't collected enough tails to try it yet). This system works just as well for brandy and schnapps. and is usefull when you don't have a nice storebought still- hell, it doesn't even require a thermometer! Using this system, the ice water/wok still can be made with a 20liter aluminum stockpot and a glass bowl to work as the condensor, and it will work just as well as any normal potstill.

The bowl I use for the lid/condensor is glass and it lets me see into the collection bowl to check if it's full- if it is- siphon out the water, remove the bowl, get a face full of steam, then use an oven mitt to grab the lip of the bowl and pour the contents into a pyrex graduated cylinder- make a note of the volume, then pour into an old 5 liter wine jug (1 of 2) that are labeled "low wines". I can only tell when the collecting bowl is full- because of the water I'm looking through (in the bowl) any "full line" marks I put on the collection bowl would not be visible.

I have run across a picture of an old still that had the same tall pot with a tripod supporting a collection bowl (made of copper), but coming out of one side of the collecting bowl (and through the wall of the still "body") is a tube that allows one to collect the distillate without opening up the still. I would like to try this- no time. Making a funnel out of copper sheet, and attaching a length of tubing to the funnel's narrow end, then feeding the tube through a hole in the still body (maybe stopping any leakage with lots of teflon tape) so the tube extends out one or two feet and drops the distillate into a cup would be nice, elegant way of avoiding a constantly steam-burned hand and face.

p.s. when looking for a bowl to work as the condensor, make sure it has a

> *narrow base, or the distillate will fall off of it and miss the collection bowl.*

Solar Still

These are both based on the solar still, sometimes used in desert regions. Patrick explains:

> *When I was a boy growing up in Arizona, USA, I learned how to make a desert survival solar still. I often thought that it might work to distil whiskey. I have never tried it with whiskey but it works to purify water. You dig a hole in the ground as big as your plastic sheet or nylon poncho will cover. You then put chopped cactus plants into the hole. If there is damp earth in the hole then no cactus needed. Put a container like a can or bowl in the bottom of the hole right in the middle. You then place your plastic or nylon poncho over the hole and place rocks around the edge of the covering until it is secure and forms a bond over the hole. You then carefully put a stone in the middle of the plastic sheet, causing the sheet to have a low spot right over the container. This solar still will produce drinking water out of the desert soil. If you were to dump mash into the hole before covering it with the plastic sheet this should produce alcohol. I'm not sure but this may be how they made mescal (tequila) in the old days. I don't know if this would work in cooler climes under 100 deg F.*

Freezing

Another technique is to freeze the wash, and separate the ice (water) from the alcohol. Freezing appears to fall somewhere in-between the legal issues for many areas (eg can you really stop your Applejack from freezing if its left outside ?). Sort it out with your own authorities (or just keep your freezer contents personal).

One thing to be aware of is the the more alcohol that is in the wash, the cooler it will need to be before it freezes ... Disolving (or mixing) something into a liquid will make the freezing point go lower than when it is pure (see the full theory at http://www.chem.vt.edu/chem-dept/dillard/1074Lecture27.pdf)

$dT = K_f\ m$ where $K_f(\text{water}) = 1.86$

Adding ethanol to water will therefore depress the freezing point by 1.86 C per molar conc present. Doing the translation between molar and regular % by volume gives ...

5% abv	1.6 mol%	3 C lower
10% abv	3.3 mol%	6 C lower
20% abv	7.2 mol%	13 C lower
30% abv	11.7 mol%	22 C lower
40% abv	17.1 mol%	32 C lower
50% abv	23.6 mol%	44 C lower

This explains why beer (at 5% abv) will freeze for ya in the freezer, wine will need it to be a bit colder, but frozen schnapps or vodka won't normally be possible.

Scott adds more details ...

> *from http://users.stargate.net/~mshapiro/cfoot.html .. Another method, known as fractional crystalization, is done by inverting the process and freezing the beverage instead of boiling it. This works for very similar reasons to that of normal heat distillation, namely, the differential in freezing points of the two liquids involved. Water freezes at a temperature of 0 C, while ethyl alcohol does not freeze until reaching -114 C.*
>
> *This allows the water to be frozen out of the liquid, leaving behind the ethyl alcohol, as well as the other alcohols and esters. This produces a drink of a rather different character from heat distillation, as it contains everything except water, while heat distilled beverages leave everything behind except alcohol. Note also that simply lowering the temperature to 0 C will not produce an increase in alcoholic strength. The temperature required for this process is in the range of -15 C and below, but must vary, much as the diurnal cycle naturally does.*
>
> *This allows crystals of ice to form as the temperature drops. As the temperature rises slightly the alcohol will drain out of the crystals so that when the temperature again goes down and more crystals of ice re-*

> *form they are purer crystals of water, containing less alcohol. As this process repeats itself the solution will gradually work its way toward the alcohol concentrations listed in the following table which is adapted from a chart on page 102 of the book, Wines & Beers of Old New England:*

Temperature (F/C)	% Alc.
10 / -12.2	8
5 / -15.0	11
0 / -17.8	14
10 / -12.2	8
-5 / -20.6	17
-10 / -23.3	20
-15 / -26.1	24
-20 / -28.9	27
-25 / -31.7	30
-30 / -34.4	33

There is an excellent account of the history of using freezing at Whisky on the Edge by Alex Kraaijeveld.

I've just tried making some myself, with no success. Poured 1.5L of beer into a plastic container, and put it in the freezer. When frozen, I broke it open. The trouble was though that it appears that it all froze too fast - any alcohol there is trapped within the ice matrix - there was no clean "core" of alcohol. I think that if this is to work, you will have to freeze it VERY slowly, so that the alcohol has time to diffuse its way ahead of the freezing ice front.

Raj tells me though that to get a good clean separation ...

> *The trick with freezing is to partially thaw and refreeze a few times to promote larger pieces of ice--the frozen cylinder with a heart of alcohol is the consequence of diurnal cycling in a barrel over weeks.*

Jack tells me though ..

> *Don't bother trying to get a frozen heart of alcohol- it's not really needed. Just fill a gallon (4liter) milk jug half full of your beer/wine, let it freeze solid in the freezer, then get a one quart (1liter) wide mouth jar, and stand the milk jug upside down in it. It will take about four hours or so, but eventually as the ice slowly melts (don't apply any heat), the jar will fill up, and you will have just about doubled the alcohol (by cutting the volume in half). using a 10% wine this method will turn a half gallon into a 17% quarter gallon. I have not tried sticking this 17% wine back in the freezer to see if I can get any more ice out of it, but it's worth a try. It also seems to be the easy way to get "distiller's yeast" performance without fooling about with yeast starters and the like.*

There's an excellent book by James Hay called "Homespun Spirits", explaining how to "spin" the alcohol out. Basically what is done is ...

Standard wash is prepared as for distillation - resulting in a liquor of 12-20% alcohol. This is then poured into 1.25 - 2L PET soft-drink bottles. Fill the bottles with little headspace. Shake the bottle to aerate them, so that plenty of air bubbles will form during freezing. Freeze solid (may take several days). Cut V shaped slits into the side of the bottles. so that the points face away from direction of rotation. Approx five rows of four slits, each with sides & base approx 10mm long. Make a couple of air holes above the solid surface. Modify a bottle cap so that it fits into a power-drill - eg thread a long bolt through it, with a couple of washers, and a nut to hold it all in place. Tighten the drill chuck around the length of bolt that extends. With the bottle attached to the drill, spin the bottle inside a tall container (rubbish bin). Use a variable speed drill, so that you can control the speed. The slits create an aerodynamic drag, forming a vacuum. This causes the air bubbles to expand, breaking up the ice, and releasing the non-frozen alcohol. Keep at full revs until no more alcohol is seen running down the side of the bucket, or ice starts coming out the slits. Slow the speed down slowly. Store the spirit for a couple of weeks to let it clear, then polish as for distilled spirit.

However, Ups474 writes :

> *More correctly known as "fractional crystillization", the practice of freezing an alcoholic mash then removing the (concentrated)alcohol was*

> *used in ancient times before distilling was known. The problems with trying to purify alcohol this way was that not only did the ethanol come out of the block of ice, but so did all the nasty higher and lower alcohols that cause painfull hangovers, and there is no way to separate them from the ethanol by freezing.*
>
> *The other reason you may have already seen: if you have ever put a bottle of vodka in the freezer (a traditional method of serving), you will notice that no matter how long it is in there, it never does anything but turn slightly thick, like syrup- no water freezes out once the alcohol gets up to 40%. Unless you have easy access to a source of liquid nitrogen, etc. so you can "super cool" the mash, then bring it's temp back up in a controlled enviroment so as to melt off various alcohols at various times, it's not worth bothering. Even then, it ain't worth it-the energy needed to keep the mash that cold would exceed the energy requirements needed to distill it.*
>
> *Home winemakers use this technique to make fortified wines without using distilled spirits- Put the mash in a plastic jug, leaving enough room for expansion, then put this in the freezer until it's a solid block of ice, then invert the container over a collection jar and gather everything that melts out until you have collected half of what is in the jug. With a 10% mash, this will come out to about 17% ABV.*

AppleJack

Here's what I've found on making Applejack. Its from a 1957 book "Home-made wines" by Mary Aylett, you may find similar in other wine-making books at your local library.

- **Apple-jack.**

  > Make a good strong cider, as described in the recipe given, then put it in a sealed cask. Place the cask in some place where it can freeze through very slowly. In Canada this is doen by digging a large hole in the ground and covering the cask about three inches deep. When the thaw comes, the cask is at once dug up, and the contents will be found to have separated into apple water and to pure spirit. The spirit will be in the centre of the cask. The ice

must be broken with great care, and the liquid spirit in the centre carefully run off. This is the apple-jack. It should nver be drunk undiluted.

- **Cider.**

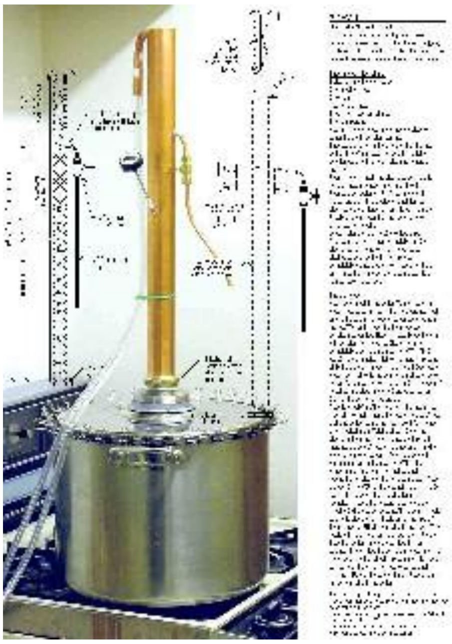
  Any apples will make good cider, but cider apples are best. If sweet apples are used a mixture of bitter apples or crabs is to be advised. Put the apples into a wooden tub, and smash them roughly with a wooden balk until they are a crude pulp. Cover the tub and leave for twenty four hours. Then put the pulp through a press or crush it in a strong hessian bag. As the juice runs, put it in a cask, and see that it is quite full. Keep the cask in a warm place and allow it to ferment spontaneously which as a rule it does very quickly. At a normal autumn temperature, the apples will ferment within 48 hours. Top up the cask with apple juice until the first violence of the ferment has subsided, then put the cask in a cool place to finish. Do not bung down hard until all sounds of fermenta tion has ceased. It will be ready to drink in three months, but will be better if left for six. It will improve if well racked. For sweet cider add sugar at the rate of a pound to a gallon, or more to taste. *(Through the book, Mary is a firm believer in natural fermentation. I'd play on the side of caution, and direct the fermentation by adding a suitable yeast.)*

Air Stripping

Yet another technique is to strip the alcohol from the wash using air bubbles. A smaller bucket of wash is put inside a larger bucket, with an airstone (like that used in a fish aquarium) bubbling small bubbles up through the wash. The vapour will strip some alcohol out from the wash, and it will condense on the walls of the outer container. I suspect that a fair amount gets lost too - as some air will always be exiting the setup. Maybe you'd arrange it so that the air intake to the pump was inside the buckets, so that you were just recycling the same air.

Designs & Plans

Check out the **Photos of Stills** section to at least see what they should be constructed like.
There are some excellent designs by Alex (Bokakob) in Bokakob designs.



Both Pot & Reflux stills are relatively simple and both produce liquor. The difference is just that for a reflux still you have a packed column before the condensor, and you get some of the vapour to condense and drip back through the packing. You do this if you want to make clean/pure/tasteless alcohol of around 75%-96% purity for adding flavours to, or making gin/vodkas etc.

If however you just want to make straight forward whiskey / schnapps etc with some flavour, you can use either a pot or a reflux still.

An interesting note is that some copper in the vapour path is benefical. See the Materials page for more details why. Some people who have built all-stainless steel stills have found there to still be some smell +/or odour in their neutral spirits, which goes away when they put some copper in (usually replacing the scrubber packing with copper scrubbers).

Reflux Still Designs

For neutral spirits you want a reflux condenser, so that the falling precondensate washes the rising vapour, reducing the water and impurity content, giving a cleaner, safer, and higher purity product. The more contact you can achieve between the liquid & vapour, the cleaner and purer the product will be. To do this, increase the reflux ratio (the ratio of liquid falling to vapour rising) and the surface area that it is occuring over. A reflux can be made by packing the upper section of the column with inert packers (eg marbles (OK), rachig rings (better), or best - stainless steel pot cleaners (the ones that look like little springs, NOT the fine weave ones, or God forbid, those already soaped ready for use)), and cooling them by wrapping the cooling water hose around the outside, or passing a couple of cooling lines through the top of the column. Even better is to have either a separate condensor above them, or best - totally condense all the vapour above the packing, divert some to keep, and return the rest to the top of the packing.

Plans for Reflux Stills

- One of the simplest and most effective designs is that from John Stones "Making Gin & Vodka" book - the "offset head" design. Theres heaps of photos of this, including detailed dimensions etc from Matt, on the Offset Head Photos page. I have one of these myself, and its bloody fantastic. It should be your first choice.

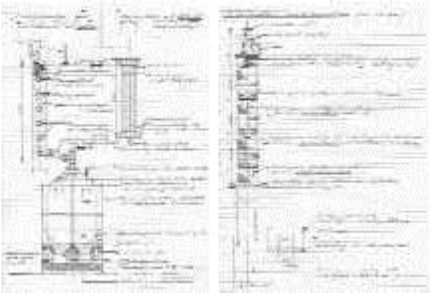
- Many different designs & their construction are covered in Mike Nixon and Mike McCaw's "**The Compleat Distiller**" (Dec01), available from http://www.amphora-society.com.

- Another resource on how to make a Reflux still is Bob Lennon's Build a World Class Distillation Apparatus site (and its FREE !). Informative & very good. Heaps of details, illustrations, & explanations. Check out the Photos page for the modifications Rob van Leuven has made to his Stillmaker - its now puting out 95% purity too. **Update !** Site recently (Aug01) updated to include a new valved reflux design, using a beer keg for the pot. Download his site and the still plans, for **FREE**, either as a Word document, PDF, or Zipped HTML file (each < 2MB).

  Tony :I also have copies of these files : orginal design (681 kB) & Valved reflux design (2.06 Mb). In my opinion the designs can be improved - if building the original design, move the through-tubes to the top of the column - heaps of discussion why on the Reflux Design page, and if making the valved reflux design (which is superior to the original by a long shot !), make the overhead condensor narrower - to fit into a 2" not 3" section, and fill that center gap with some scrubbers - less chance of vapour sneaking up through the center that way.

- Jan also has put together some really good construction instructions at his Distilling page.

- Peter in Holland has a diagram of his reflux still design, and the trays he uses in another still (see the photos page). Click for larger pictures :



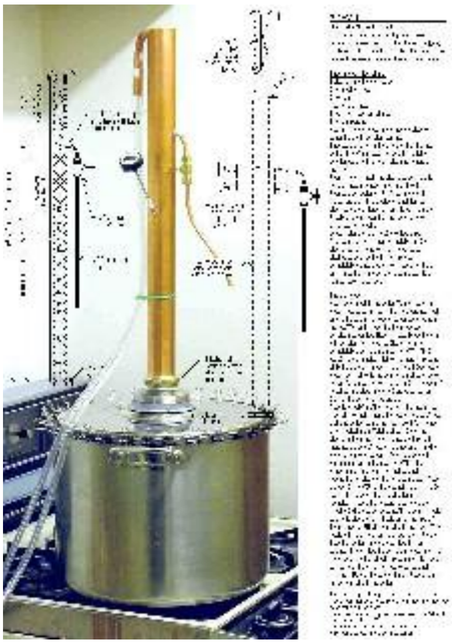
- Ian Smiley's book "Making pure corn whiskey" has very detailed instructions for building the Offset head design: http://www.home-distilling.com

- Riku has published how to make Liquid Management (LM), Vapour Management (VM) and Cooling Management (CM) at Harry's Alcohol Library -see the "low cost stills" link.

- StillCookers page at http://us.geocities.com/stillcooker/index.html

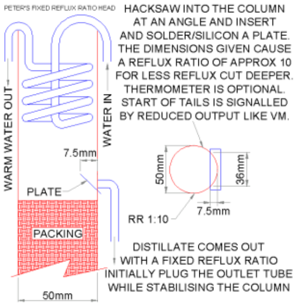
- Elricko's pages
    - Recirculating cooling
    - Converting a keg to electric heating

- UPDATE Alex (BOKAKOB) has provided some excellent drawings of different designs for reflux columns in Bokakob designs. These are incredibly simple, but very effective. There is a lot more discussion on them in the Distillers group at YahooGroups.com
- One example is Alex's (Bokakob) mini-still:



For a very simple reflux head design, Peter offers:

> *This design uses a collection method similar to Alex's (Bokakob's) ellpitical head. It is not as pretty outside but is easier to build. The operation is similar to a Vapour Management Head as seen in the great book "The Compleat Distiller" by Mike Nixon & Mike McCaw.*
>
> *You cut the column at an angle and insert a thin plate plate which only was 1/11 the area of the column area and no needle valve, this would ensure a constant RR of 10 (seal the outlet during stabilisation). This a simple design which is easy to build. A thermometer is optional as I feel I could run this column without one, using taste to determine when heads are finished. The onset of tails is noted by a reduction in output towards the end of the run, just like a Vapour Management still head.*
>
> *There are a few optional extras. A thermometer is very useful but is extra cost and building, it is not essential and if you run a standard size & % wash you will get to know when to make cuts. An extra larger plate could be installed to do stripping runs, which could be plugged for slow runs.*



There is plenty of information too on stills for making fuel alcohol. The Journey to Forever site has the following plans ..

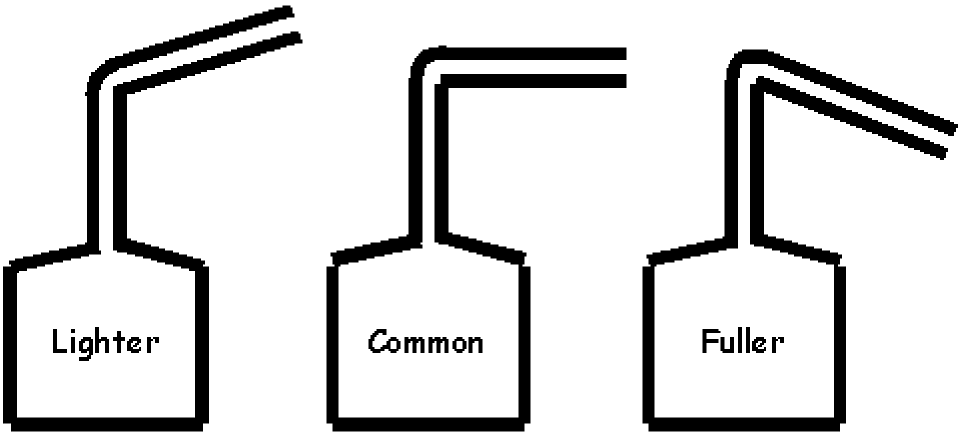
- Six-Inch Column Still Plans
- Three-Inch Column Still Plans
- Two Low-cost Backyard Stills
- The Butterfield Still
  See also the manuals ...
- Mother Earth Alcohol Fuel manual http://journeytoforever.org/biofuel_library/ethanol_motherearth/meToC.html
- The Manual for the Home and Farm Production of Alcohol Fuel by S.W. Mathewson: http://journeytoforever.org/biofuel_library/ethanol_manual/manual_ToC.html

- see also Distillation of Alcohol and Denaturing by FB Wright, 1907 - available as a free download.

If you're looking for a supplier of small needle valves to use in these stills, try either hardware shops, or supliers of gas fittings for BBQ's or camping equip.

Pot Still Designs

There don't seem to be many instructions around for how to build pot stills. I guess this could be because there are just so many ways, and it really depends on what you have available to you. One factor to consider is the angle of the lyne arm. Even with a pot still you get a little bit of vapour condensing on the head & arm, and running back down into the pot as a bit of reflux. Depending on how much internal reflux is going on, the flavour will vary. An upward sloping arm will cause much to run back into the pot, thus cleaning & lightening the vapour more, whereas a downward sloping arm will send all the vapour towards the jar, and you'll collect a heavier flavour. See my Photos of Distilleries and Photos of Stills sold commercially pages to see what variations in this are around in commercial distilleries, and Portugese Copper Alambics and Alquitars. Some also have a bulge in the head. This constriction then expansion causes some of the vapour to drop out, and again increases the reflux, and lightens the spirit.



Jack writes ...

For a potstill, I've found that the lyne arm (as it comes off the still body) should go up at a 45degree angle for 2 feet, then it should drop into the condensor. The diameter of the tubing depends on the heat - for most stovetop models (typically built out of a pressure cooker) 1/4 to 1/2inch tubing is used for the lyne arm and the condensor. The narrower the tubing is, the lower the heat setting you need to use. The condensor running off of your potstill can be whatever diameter you have (provided it's no smaller than 1/4"). Also, remember that you don't have to have a coiled-tube condensor- you can use a jacketed model just as easily. With stovetop potstills there is a lot of room to adjust the materials dimensions, because the heat source is so easily adjusted.

Wal elaborates ...

The shape and height has an effect on flavor.

1. *Traditional Alambic. This is descended from stills used by alchemists. It consists of a domed cylindrical boiler with a bulbous still head. It sits in a brick furnace. From the still header chamber, the lyne arm usually slopes downwards or is U-shaped ('Swan's Neck'). The condenser is a coil in a tank of water. Raki stills, moonshine stills and the 'Alambic Charentais' for making cognac are examples.*
2. *Varied Boiler shapes.*
    - *Conical, classic whisky pot still ('Springbank' whisky)*
    - *Onion shape, slightly fatter than the classic shape ('Glenlivet' whisky)*

    - *Pear shape ('Vintage Islay' whisky)*

3. *Varied Neck (Column) shapes and heights.*
    - *Conical column from boiler. The smallest whisky stills are at 'Edradour'and the tallest at 'Jura', 'Bruichladdin', 'Glenfardas'. The stills at 'Glenmorangie' whisky distillery are ex gin stills and are the tallest at 5.3m*
    - *Boil ball and conical column ('Strathmill' whisky)*
    - *Boil ball and cylindrical neck ('Lomond Still')*
    - *Additional reflux feature in column. Column length and the Milton Ball header chamber create reflux, but some necks are cooled with running water to increase reflux ('Fettercairn' whisky). The traditional Australian brandy pot still has a 'Brandy Ball' water jacket at the top of the column. All are open columns. The 'Lomond Still' has 3 adjustable plates and is used as a wash still at 'Scapa' whisky distillery.*
    - *Carterhead Still. The column contains a basket holding the gin botanicals ('Bombay Sapphire' gin')*
4. *Varied Lyne Arms.*
    - *Horizontal*
    - *30 degree downward slope*
    - *30 degree upward slope ('Deanston' whisky)*
    - *U-shaped or 'Swan's Neck'.'Alambic Charentais' for cognac, 'Plymouth' gin', 'Talisker' whisky, 'Lagavulin' whisky.*

Ian Wisniewski's article "Still Very Important" in "Whisky Magazine" describes in more detail how the shape of the still can affect the flavour... Big thanks to **Whisky Magazine** for permission to reprint the following

Knowing that stills of a certain size and shape yield spirit with a particular flavour profile is all very well, but applying this knowledge the other way around is far more challenging. In fact, designing stills in order to produce a spirit with specific characteristics is merely a starting point, as this is only one factor in a complex (and not always fully understood) equation, which also includes the spirit cut, heating method, rate of distillation and type of condenser.

Even the relationship between the wash and spirit stills is difficult to quantify beyond stating that new make spirit is shaped by wash stills and refined by spirit stills. But if the low wines aren't right, the spirit stills can't correct them (and if fermentation is mismanaged, distillation can't fix that either).

(snip)

As the degree of reflux (condensation) is a key factor in establishing the profile of the spirit, the length of the neck is an important consideration. The taller the *still, the greater the degree of reflux. This is because heavier, denser, oilier flavour compounds have a higher boiling point than lighter flavour compounds and as they rise up the still the temperature becomes relatively cooler, which means they condense and return to the boil pot (base).*

(snip)

As a shorter neck means less temperature variation, there is consequently less reflux. This promotes the progress of heavier flavour compounds into the condenser, yielding fuller-bodied spirit, with a creamier, earthier, oilier texture.

But size doesn't always matter, as reflux can also be enhanced by customising stills with various matching accessories, including a boil bowl, pinched waist or flat top, while cooling the neck of the still is another option.

A traditional (cynical) explanation for a flat topped still has been the low ceiling it had to squeeze under. However, the technical influence of a flat top, as at Cragganmore, results in a slightly higher degree of reflux because the progress of vapours is not as gradual or progressive as it is with a swan neck.

A pinched waist (as though a corset had been tightened around the still), can be seen in The Glenlivet's wash and spirit stills. By reducing the surface area available to the vapours (by about two-thirds at The Glenlivet), a pinched waist initially accelerates the progress of vapours into the neck. The subsequent, sudden widening of the neck, and relatively cooler temperature, consequently increases reflux.

A boil bowl (bulbous section between the boil pot and neck) can vary from being mildly to acutely convex (the more convex, the more reflux). When vapours carrying heavier flavour compounds expand into this larger, relatively cooler area, they condense and return to the boil pot.

Dalmore Distillery effectively doubles up by having a cooling jacket (also known as a water jacket) between the boil bowl and neck of the spirit still through which cold water circulates (using the same water source as for the condenser). This practise dates from 1839, with the oldest jacket still in active service dating from 1874.

At Fettercairn a different approach yields a similar result. From a circular pipe located at the top of the spirit still, cold water runs along the neck and collects in a trough fitted around the still (from which it also drains). This has the effect of "giving the vapours inside a little fright" according to Distillery Manager Willie Tait. His more technical explanation is that cooling a fairly short neck gives it the effect of being much taller.

While purifiers are rarely seen, this is a feature of Glen Grant's wash and spirit stills. As vapours leave the still and enter a copper pipe in a tank cooled by water, lighter elements within the vapour continue onto the condenser while heavier elements return to the still via another pipe. Without this proceedure Glen Grant's new make spirit would be oilier and heavier, says Chivas Brothers'

Brand Ambassador Jim Cryle. Similarly, in the opinion of Site Manager John Reid, a purifier in the spirit still increases the buttery, creamy notes of Edradour's new make spirit.

But just as important as design features that make a still unique, is the manner in which the still is employed. Pungent, fruity esters are more evident in spirit collected between 68 and 72% abv, while a spirit cut extending to around 58% abv includes heavier, oilier, fatty acids. Consequently, altering or separating the spirit cut into batches collected at different strengths would enable varying styles of whisky to be produced from the same still.

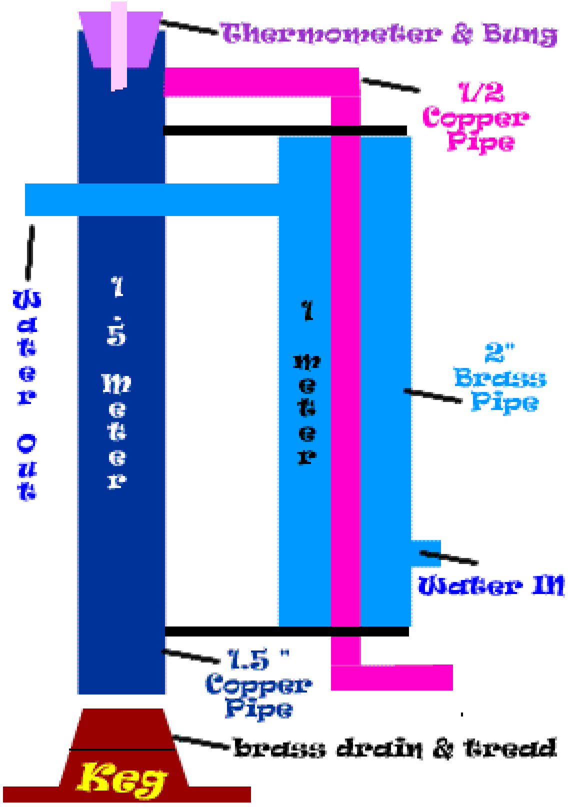
(snip)

How [heating] is utilised also affects the degree of reflux. Heating the still more rapidly increases the rate of distillation, driving off vapours more readily. As this reduces the degree of reflux, it promotes a higher proportion of heavier flavour compounds. Driving vapours more rapidly also entails the risk of carrying over some undistilled liquid, showing as a sour note in new make spirit. Correspondingly, a lower temperature means a slower rate of distillation, more reflux and a lighter (some say finer) spirit. At the leisurely end of the scale this means collecting around nine litres of spirit per minute, compared to around 20 litres per minute in the fast lane. Additional reflux can also be prompted en route to the condenser, using a lye pipe (or lyne arm) extending at an incline, which drives heavier flavour compounds back into the still.

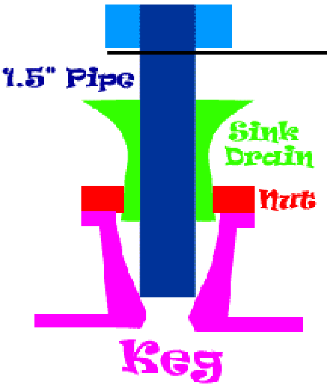
By providing a greater surface area than a typical worm, a modern 'shell and tube' condenser increases the degree of contact between the spirit and copper, helping to strip out meaty, sulphurous compounds. However, worms (a coiled copper pipe of decreasing diameter, set in a worm tub with cold water) do not neccessarily result in a higher level of sulphurous, meaty flavours and the challenge lies in controlling the level of these characteristics to achieve a complex whisky.

(snip)

So, knowing these principles, is it possible to quantify the importance of the stills within the production cycle? Well not easily, that's for sure. Beyond the usual 60% of the malt's eventual flavour being attributed to maturation, I'll leave dissecting the balance to an expert. "Less than 10% is accounted for by the barrel's previous incumbent, then maybe 5% is influenced by the barley variety, and 5% by the strain of yeast," says David Robertson, The Macallan's Master Distiller. Then the crucial bit. "10% could be the wash still and 10% the spirit still, with the influence of the spirit still being divided into 5% each for the size and shape of the still and 5% for the spirit cut." Sounds good to me.



Kez's Keg Still



Column length and diameter ***: 1500 x 42 mL***
Packing ***- copper scourers***
Heat input ***- gas burner***
Pot size ***- keg 50L***
Distillate purity ***- 90%***
Condensor ***- half inch tube inside 2 "***
Cnstruction tips ***- go to your local rubbish tip shop for good bits and the keg***
Approx cost ***- AU$80, the keg was $20 and the welding for free***

Matt's Offset-Head Still

I made the still from the Nixon-Stone design outlined in the great book:

Making pure corn whiskey
A professional guide for amateur and micro distillers
By Ian Smiley
http://www.home-distilling.com/

I highly recommend this book - it has great descriptions, information and almost all information I needed to build the still

I made a few modifications to the design - the main one being the size of the copper pipe used to build the column/condenser. The book's design is for 1 1/4" pipe, I used 2" copper pipe, which almost doubles the volume of the column. Also, I am converting a 316 stainless steel drum for the boiler, rather than using a hot water service as suggested. A few other modifications have been made, outlined

Boiler.

The boiler is a 60L 316 Stainless drum, which Jan put me on to (thanks Jan!!!!), and I've put 2 x 1380 watt elements in it.

The elements were very easy to put in. I made the holes using a 32mm 'chassis punch' which creates the hole by two 'jaws' pulling together through the metal wall.

The elements are 'replacement' elements for the Still Spirits still. If you order them for this purpose, you will also need to ensure that you also order the aluminium nuts and power leads.

Inside the boiler, you can see the hole above where the socket for column attachment is welded, and the 70mm stainless steel rod across the hole to keep the scrubbers in.

The rod is 4mm wide s/s, and spot welded either side of the inside of the lid over the hole.

Nixon-Stone Head.

Again this is made from 2" copper pipe. Above and below the T, there is a 50mm section of tube. On the bottom section, a 2" Female BSP tube bush is soldered, and this screws on to the top of the column. The top section has a 2" copper tube cap, with a 40mm 3/8" copper pipe, attached to a series of compression fittings and adapters, eventually to hold the 3mm stainless steel probe of the digital thermometer, via the 3mm brass compression fitting. Horizontally out of the T, there is a 40mm section of 2" pipe, going to the elbow, then a 370mm vertical section for the condenser to go in. At the bottom of the elbow, another 40mm of 3/8" copper pipe is soldered through the horizontal pipe/elbow join (for strength). The top of this piece is flush with the inside of the pipe/elbow join, and it is here the product goes down through the needle valve, and eventually to the waiting mouths!
Inside the 50mm section of pipe below the T, with the BSP fitting that screws onto the column, I have also made another modification - a angled copper plate to direct the reflux flow down the center of the column - On the photo you can also see the 'lip' I bent in the middle of it.

Note: In the broken down photos of the head and head and column, the horizontal section going from the T to the elbow in the head is quite a lot longer than 40mm. This photo was taken before I shortened it, to decrease the tipping effect of having a full condenser a long way from the column.

Condenser

The condenser coil is made from 3/16" copper pipe, which was wound to form the coils. I modified the condenser design so it is longer than the design in the book, and also has a smaller internal coil at the top within the main condenser coil, so any vapours reaching the top of the condenser in theory get condensed rather than escaping. This removes the need for a scrubber poked down the middle of the coil, as is often suggested with the standard coil design. The intake pipe goes down 120mm inside the main coil, then coils around itself back to the top to form this internal coil. This then wraps around itself again, forming the main coil which extends all the way down the condenser (360mm), and the returns through the middle of it all.
The hoses running to and from the condeser coil are 133mm clear PVC tube, and connect to the condenser with a brass nipple-3/16" compression fitting. The inlet attaches to the kitchen tap with a hose fitting.

Rob van Leuven's Offset-Head Column

Dicks Still

This is how I fixed the problem of securing the tower to the top of my urn. The white disc is a painted disc of MDF clamped down onto the s/s urn top using 4 x 6mm threaded brass rods. These are fixed to the inset brass strip that secures the curved wooden slats forming the urn insulation. To seal the urn top I use a length of thin silicon rubber tubing, slit down its length and threaded round the disc's edge. The white cord fastened by the needle valve is just a bit of additional 'belt & braces'.

Urn is a converted 40 liter SS tea urn. The urn is double skinned and is insulated between the two walls of SS. There were no elements in the tank when I obtained it. The two elements are 2400watt and 1500watt for fast boil up.

Power supply is three 240volt individually switched outlets. One outlet is a triac controlled. I boil up on full power and then switch off the 2400w and switch the 1500w to the triac plug and distill under triac control.

The tower is 1200mm x 50mm diam measured from the base of tower to center of 50mm tee. The condenser housing is 40mm diam. The cooling coil is 600mm long x 8mm diam (about meters of tube to construct the coil).

I think I have about 12ss scrubbers from the base to the top of the reflux return pipe (12mm diam)

Insulation is 150mm black compressible plumbers foam.
The insulation is held in place by a cotton sleeve fastened with Velcro.

Tom "the StillPastor"s Still email : THART@FIRSTPRESABQ.ORG

The pot is a 15.5 gallon beer keg with two 1" threaded inlets welded near the bottom. This kettle is heated with two water heater elements- each a 1500 W 110 volt element. This may change, I will have to see as time goes by. Suggestions are welcomed.

The column is 3" in diameter and stands 1.25 meters tall with an internal cooling loop at about 1 meters The column is removable and has a perferated plate at the bottom. The column is also constructed in two parts, being divided just below the internal coil near the top. The lower meter of the column is insulated with boiler pipe insulation, and the column packed with S/S scrubbies up to the internal coil.

The still actually has two heads. The first is the one I

originally constructed, which is a simple pass through, jacketed condenser made of copper. This condenser is actually design so that water flows both around and through the consensing tube. It works great. The second is a new fractionating head also made of copper roughly based on a Nixon/Stone design. The actual design for this head is here. I included both heads on this still because I could and I enjoy having options, besides what else would I do with the old one?

The various valves you see in the pictures are all ball valves to control the flow of the chilling water, vapor and distillate. I am able to run the still in a variety of configurations with this set-up and as I said earlier I enjoy having options to play with.

The top of the column is open to accept the probe for my digital thermometer.

In addition to my new electric kettle, I also have my original 10 gallon pot that is double walled and heated with hot water or steam depending on how I wish to run it. More options.

Ned Steamgoon's Still

The stillhead is based on Tom Hart's design from the Yahoo Distillers group *(see above)* - it is 0.5 metres from the reflux needle valve to the water outlet tube at the top. The vapour tube from the column and the main tube of the condenser are 40mm, the outer jacket is 50mm. The inner core is 25mm and its outlet tube is 12.5mm. Water enters the outer jacket at the top for counterflow - the outlets of the inner and outer are each controlled by their own ball valve. With the ball valves half open it does not get warm any further than about 150mm up from the vapour inlet so it probably needs be only half as high.

The main column is 1200mm x 50mm packed with 13 jumbo SS scrubbers. The urn is rated at 2400 watts. It produces over 1.5 litres per hour at 93%.




Big Kahunah's Still : email : big_kahunah@hotmail.com

Some of the photos here show the design modified in a number of ways ...

JourneyMans Vapour Management Still Head

As per Nixon & McCaws "The Compleat Distiller" at http://www.amphora-society.com

Attached is a picture of my new Vapor-Management still head. It sits on top of a copper-scrubber-packed column and a standard coiled-copper reflux condenser goes on top. (2" tubing for column and reflux condenser.)

The safety bypass is on the back of the head / not in this picture - EXTREMELY IMPORTANT. Here's the design criteria:

1. position thermocouple as close to distillate valve as possible The probe active area is at the tip. It's positioned about 1/8" away, and centered on, the valve input.
2. Use a cork gasket and flange assembly to insulate the head from any cooling effects of the reflux condenser.
3. Get the distillate valve input out of the constricted/high-speed area between the head and reflux condenser to eliminate any venturi effects through the Leibig.
4. Angle the distillate valve downward to eliminate pooling of any distillate that may condense there. (There shouldn't be any because:)
5. Attach the distillate valve directly to the head to keep the valve as hot as possible.

Mike explains a bit more about how the Vapour Management head works ...

> *If you feed vapour to the middle point of a horizontal tube, then it will split into two streams. If the cross-sectional area of one arm of the tube is A and the other is B, then the vapour will divide in that ratio, A/B.*
>
> *You can control that cross-sectional area by means of gate valves, and this is useful for some applications.*
>
> *If you feed vapour into the middle point of a vertical tube, density now becomes a factor and this can be used to control the behaviour of a distilling column depending on the composition of the vapour inside. First thing to note is that vapour rises in a distillation column not because if convection, as some think, but because it is pushed by vapour generated in the boiler. All vapour in a distillation column therefore rises at the same rate no matter what its density, and at a rate determined by the power pumped into the boiler.*
>
> *When vapour meets the middle point of the vertical tube, some will be driven further*

up the column and some will enter the tube. In practise, this middle feed point is sealed off by a gate valve in a side arm during stabilisation of the column, and the vertical tube comprises the path up to the top condenser and the path down to the product condenser. It is a 'kinked' vertical tube fed with vapor at its middle point. When the gate valve is opened, vapour enters the side arm and, if it is less dense than air, will try to rise. If it is denser than air then it falls. It cannot rise in the side arm as that arm only goes down, but can fall as it points down to the product condenser and collecting vessel. The gate valve controls amount that can enter the side arm. The relative densities of steam at 100C, air at room temperature, and ethanol vapor at 78C are 0.6/1.0/1.6 If the vapour in the column is ethanol, then it will fall down through the product arm, and if it is steam then it will continue up to the top condenser.

The changeover point, when the vapor in the column is the same density as air, if when the vapour comprises 45.5% ethanol and 54.5% steam. The volume of vapour falling down through the side arm therefore tails off and finally stops as the vapour mix in the column approaches and then reaches this point.

As this represents the onset of tails, the side arm being at the top of the column, a vapour management still automatically stops delivering product before it is contaminated with a significant amount of tails. It is also the reason why you cannot test the operation of such a still using steam alone. Subsequent collection of tails can be done by turning off the top condenser, blocking that path with a rag in the top vent, and fully opening the gate valve. A rag is recommended for blocking the top vent as a gate valve would present the possibility that both gate valves could be closed together, sealing the whole still.

Mike Pemberton's Vapour Management Still email : bifrost@xtra.co.nz

(no picture yet)

A brief description of my rig: (as per Nixon & McCaws "The Compleat Distiller" at http://www.amphora-society.com)

- **Boiler** : 5 gallon under bench hot water supply. Thermostat removed. 1000 watt element. Heat control applied.
- **Column** : 1000 mm Aluminium tube filled with Stainless steel scrubbers. Internal diameter 44mm.
- **Top Condenser** : 200 mm tall containing 10 5/16 thin walled aluminium tube. Firebox/shotgun construction.
- **V.P.Head** : Single ¾ gate valve connected via 18mm internal diameter aluminium tube.

- **Final Liebig condenser** : 330 mm long. Experience shows that this length is marginal. Longer would be better.
- **Insulation** : Plumbers Foam insulation on the column and along the take-off pipe to and including the gate valve.
- **Heat control** : After the column had started to reflux; the power input was reduced to approximately 500 watts and equilibrium confirmed.

To date two runs have been completed. The first at my old rate of collection 7 mls min. Purity of 95% plus (I will have to get a longer sight tube so that I can get the actual reading!) hung in to the bitter end. This is characterized by a marked decrease in output, not quality.

The second run started out at the greedy rate of 17 mls min. The only difference is that towards the end of the run as the output decreases so does the concentration. Near the end the rate drops off to 6mls min and down to 92%

The only disadvantage with this new technique would be the time/difficulty in collecting the alcohol/congener mix (if indeed any useful alcohol is left in the wash). I would suggest that anybody adopting the Vapour management style retain their old method of collection when they re design their head. In order to switch from Vapour management collection to their old style at the end of the run.

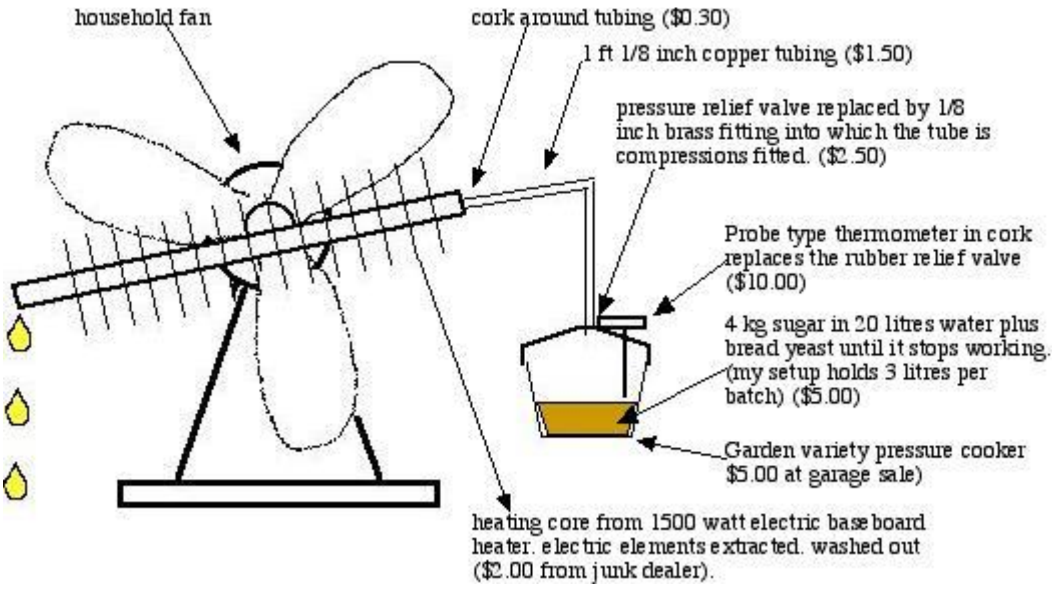
In conclusion, the method is superb for those who desire top quality product directly from the still without having to muck about with carbon treatment in order to get a potable product

Plans for Pot Stills

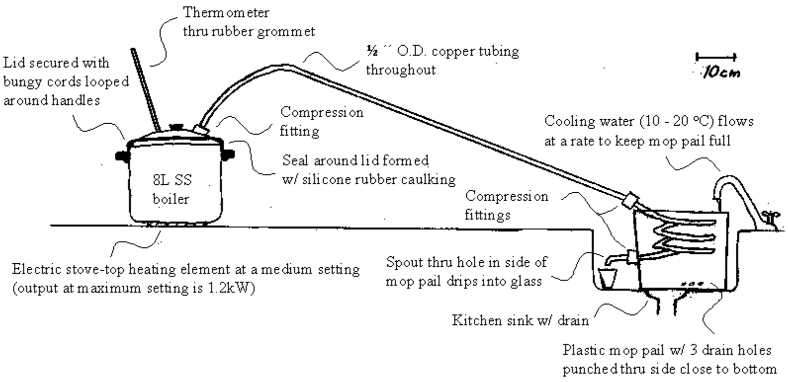
- Dangerous Laboratories Tea Kettle still

Regarding using pressure cookers, Jack cautions ...
I've used them- I hate them. The pressure release valves ALWAYS leak (fire hazard, and damned wasteful), thay always come coated in some impossible-to-remove grease, the places to mount the thermometer is always guaranteed to give false readings (either high or low, never the same twice). They are expensive, heavy, the aluminum model pits to easy, and the steel is to expensive (with the same problems except pitting of the metal). Don't bother. Get a small keg or 5 gallon drum that's stainless and food grade- I've seen them for from $20 to $40US. Or get a milk can (US$100) expensive, but attractive.

Below is a diagram of Harold B's pot still. Very cheap and easy to make. Harold suggests that you should adjust the heat so that the lower end of the condensor can be touched. The reason for this is that you can see water vapour if things are too hot, but you can't see the alcohol vapour.

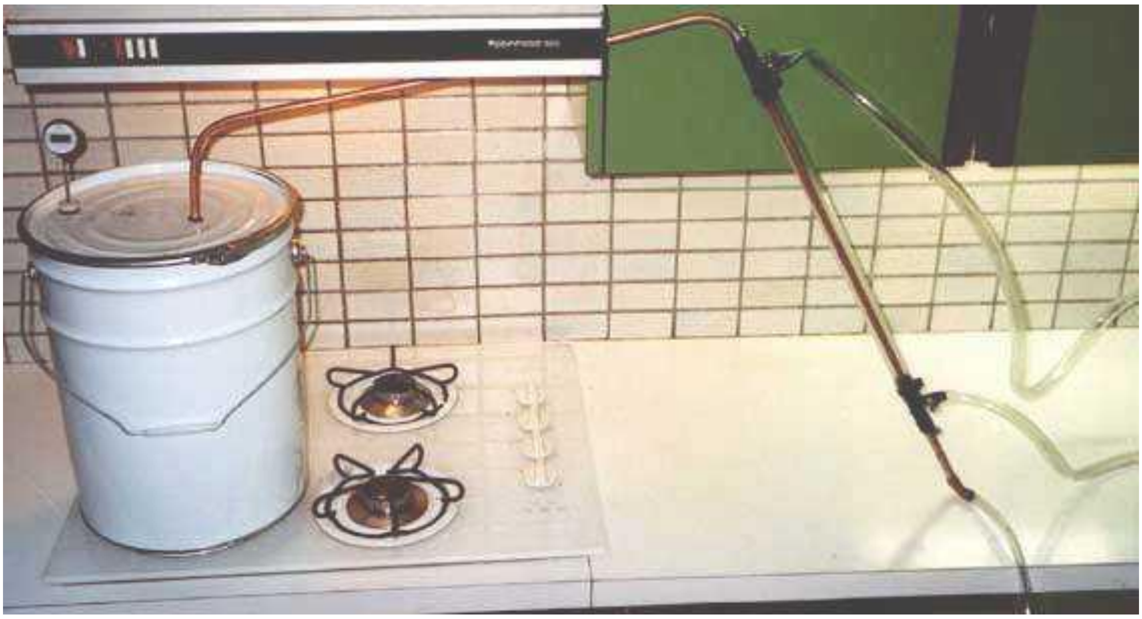


Another great simple design is Geoffs..



Walter describes his pot stills ... "Volodia's Samohonka 1&2"

Inspired by folk stills in Jamaica and East Africa made from 44gal drums, (see "Alcohol in East Africa. 1850-1999" - www.dur.ac.uk/History/web/distillhist.htm) I made an urban version using:

- 

- *Pot : 5gal (20 L) open top paint container.(These can be ordered in new from some proprietary paint chain outlets/paint trade oulets, or get some free from painting contractors and clean them with paint stripper/turpentine (I have done this before I found a source for $AUS15 ($US7.50) "Ameron" coatings makes a heavy gauge container for their industrial coatings. The parent company is in the U.S. The paint company "Solver" in Australia can get unused containers through their chain of shops. Container* manufactures sell them quite cheaply but only in lots of 50 (I enquired). Cleaning free empties is not too difficult. and helps to recycle them. I know a local owner of a paint store who recycles them into kid's rubbish bins with appropriate designs on them - why not something more useful!

- Outlet arm - 1.5m of 10mm (3/8in) soft copper tube, bent to form a "lyne arm",up 200 vertically & then 600 long inclined upwards (to get some reflux) and then down 700 vertically. The 10mm soft copper tube is easily bent without flattening - use salt inside the tube to help prevent this, standard grommet for plastic beer fermenters, or improvise using cut sections of synthetic wine corks glued to both sides(they close in well).
- A 500 long Leibig condenser over the 700 copper tube section out of plastic T sections (2 x 19mm/13mm (3/4in,1/2in) barbed PVC Tees) & 500 length of 19mm (3/4 in) plastic tube, clamps, silicone or epoxy resin, plastic glue.

- Rubber grommets (as for plastic fermenters)
- Plastic tubing - standard 13mm (3/4in) plastic tubing with plastic tap to hose connector, 10mm tubing for distillate (this fits on the 10mm (3/8in) copper tube), and for the water outlet from bucket to sink.
- Gas flame diffuser mat or bain marie (water bath) to get even heating.
- Thermometer -digital or mercury to measure pot vapor temp. Stop distilling at 91C (196F).

- *Thumper/Doubler - 10 L (21/2gal) paint container, with rubber grommets for copper tubing.*

- *Worm condenser variant - 20L (5gal) plastic bucket or cut down container, coiled copper tubing, grommets.*

No welding - just glue, silicone, clamps. All this is sitable for most kitchen stoves and sinks. Obviously this is an introductory still for the beginner.Paint tins are not heavily coated. Kept dry it should last years - rust remover will extend this.

I forgot to mention Safety aspects important as we don't want kitchens going up in flames! I switch the exhaust fan on to take away any stray fumes, even though the ring clamp is air-tight. I made the lyne arm quite long for partial reflux and to take it away from the stove. The distillate *outlet tube goes down to the floor, well away from the stove. An electric stove might be safer, although apparently slower.*

MooNShiNeR describes his 75 gallon pot-still, doubler and shotgun condenser below. See Moonshine Still Photos for a couple of photos of it.

I use a medium sized (75 gal) pot still with a doubler/thumper (5 gal) and a shotgun condenser for my purposes. I also utilize a 20 gallon outfit with a 1 gallon doubler and a worm condenser mainly for running smaller batches and epecially for running backings or low wines to "up" the proof quickly.

I use copper sheets soldered with silver solder to build most of my components. Shotgun condenser made from of an old, antique copper fire extiguisher. Cut both the ends off and sand everything inside and out. Clean it to the "eat off of it" stage. Cold water enters the shotgun condenser from the bottom and exits the top to force the hot water out and this always keeps the bottom part of the condenser way-cool.A shotgun condenser is basically a condenser with a water jacket too cool the steam and it has dozens of 3/8" copper line that the steam goes through. It's kinda hard to explain. Where the steam goes through looks like the business end of a gatlin gun. Bore two holes in the jacket about 3" from each end and solder a brass hose copper garden hose connector in it, top and bottom. On the one you use for the bottom, you will put a spigot used to regulate the amount of cool water coming into the condenser. On the top one you'll attach a garden hose and lay it out where the hot water can drain off the top of the condenser. Two copper sheet circles are cut and clamped together and numerous holes drilled through them. The circles are placed inside the copper jacket and spot soldered.(silver) in place with a few pieces of the 3/8" line in to keep things lined up good. The lines are cut about 4" shorter than the jacket. Start putting the lines in and soldering them in place and solder the circles in good, top and bottom.

On the first run, you'll be able to tell if you have any leaks or not. you can fix them if it does.

Make a tight fitting cap for the top to be sealed/pasted on with corn meal and water. The bottom does not require a tight fit at all. It is just there to collect the alcohol as it comes through and then out to the *jug/bucket. With a shotgun condenser, you can fire the still as hard as you want to and you'll have no problem with it not keeping up. That's why people who do volume like them so much.*

A. Nonimus suggests ..

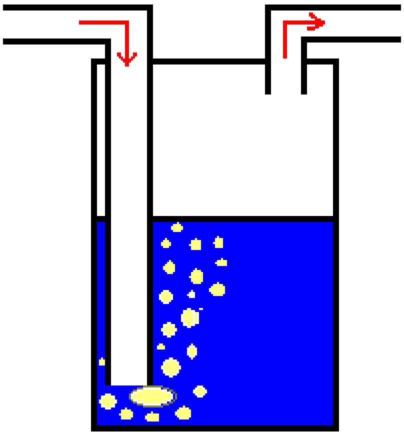
First off - most homemade potstills in the U.S. are made out of 20 litre pressure cookers (they have all the fittings you need including pressure release safety valves)- If this is in fact what is planned, you MUST remember to NOT PERMANANTLY MODIFY THE PRESSURE COOKER IN ANY WAY -(remember, 3/8" copper tubing makes a nice coil, and fits the outlets on most stills!) if the law gets news about you running your own still- they can (with a warrant- not hard to get anymore, I'm afraid) raid your place, if they find a pressure cooker with a bunch of copper tubing attached to it, and holes drilled in it that are homemade- they will have the evidence needed to take you to jail for running a still. IF the pressure cooker is always returned to it's original state (normal fittings and weights) after you distill with it, and if you put your condensor next to some beer making supplies (or, rather mash making supplies- same thing)- when (if) the cops show up, they find a normal (unaltered) pressure cooker and something you will swear up and down is a wort chiller for the making of beer. If no moonshine is found- they have absolutely no case against you.

Second - The average 20litre pressure cooker can be set inside a large stockpot (the 30 quart or larger models, just measure the cooker, and go out shopping for a cheap canning pot big enough to hold it easily). By placing 2 pieces of wood, pipe, etc. accross the top of the canning pot, the handles on the pressure cooker will sit on these cross pieces- this will keep the bottom of the pressure cooker off of the bottom of the canner. Fill the large tub with water and then fill the pressure cooker/potstill with your mash and cook with a nice even heat (if using gas this reduces the fire hazard as well- now the alcohol isn't in direct contact with the metal touching the flame). This allows you to distill mash that has a lot of solids (the more gentle heat helps prevent sticking and burning), it also allows you to do something else while warming everything up- Just put the water on to boil, and put the canner in after the heat is where you want it- better temp control- and unlike the still- you don't have to watch the water heat up (unless you are bored out of your mind)- just make sure *the potstill body isn't touching the metal of the large stockpot (The "jacket")- there you go- a homemade steam heated still!*

Toms potstill .. *The boiler is a 2.5 gallon soda canister. I heat it by securing it in a pot of boiling water, and run it like a double boiler. It works great!*

Thumpers, Doublers & Slobber Boxes

Some moonshine stills have a "thumper" or "doubler" between them and the condensor. This is a jar of sorts, half-filled with liquid (water, mash or tails). See the Moonshine Photos for examples of them. There is also an anonymous file on how to construct a doubler : Doubler.pdf (220kB)



Thumper

This acts as a simple second distillation stage. Once its fully saturated with alcohol (hence better to start with something already containing alcohol), and up to temperature, the vapour leaving it will be doing the equivalent of a second distillation (usng the incoming vapour as the heat source) (see the wee applet in Reflux Design ... set it to 2 stages .... so the vapour leaving a 15% wash will be coming off at 65%, after going through a second stage (the thumper) it will be at 85%).

Rudenoise's pot still shows an excellent example of a thumper in action ...

I wanted to start out with a small still and this was the answer. In a matter of four hours I had a still made, using 3/8 copper tubing I made a condenser and encased it in a PVC jacket with water circulating through it. I use gromments to pass the copper coil ends through, and some brass nipples for a water entry and return, this is hooked up to a small tabletop fountain pump in a bucket of water that circulates the water through the jacket. It really works well. I used the stainless steel cooker. I first primed it (for no better term) on the stove with water prior to modifying it. While still warm (cooker) I washed it with soap and water and this took care of the grease they lubricate the lock with. In addition I added a "Thumper" or "Slobber Box", using a pickle jar and a couple rubber grommets (works great), and a hotplate.

How does this work ? I'll try and describe it ...the main pot heats up, and begins giving off ethanol vapours (say at 40% purity at 96 ° C off a 5% wash)... these get passed into the thumper and try to bubble up through the liquid there. But because the liquid is cold too, the vapour will all condense if given the chance (e.g. small bubbles & water deep enough). A bit later on, the thumper liquid is starting to heat up and increasing in ethanol content .... soon the thumper is at say 84 ° C, and the ethanol content is around 40% - gees - that sounds like a second pot still doesn't it ? So the ethanol starts coming coming out of solution, though this time it will be at around 75-80% - hence the second distillation occurring - all for free, no additional cost or heating involved. Of course all this depends on how effective the thumper is at knocking down the incoming vapour - e.g. bubble size, depth of immersion, % alcohol in the vapour & thumper liquid etc, but you get the basic idea.

Look at the energy involved ..

Heat of Vapourisation/Condensation
Water = 2260 J/g
Ethanol = 855 J/g

So an incoming stream of 40% ethanol will give up about 1698 J/g, whereas to vapourise a 75% rich vapour needs about 1206 J/g. Then given that the flowrate of the 75% product is going to be only just over half of that entering, you have HEAPs of energy left over, to first heat the liquid there during the inital phase, then to superheat the vapour once the thumper is up to temperature. So the stuff coming in can more than happily look after itself in terms of redistilling itself.

I have a spreadsheet Thumper.xls which does these calculations for different scenarios. Play with the spreadsheet, and test the various scenarios ....

- Thumper vol 1000mL and 0%
- Thumper vol 1000mL and 30%
- Thumper vol 3000mL and 30%

With a small thumper volume, the contents are fairly quickly heated up towards the liquid boiling point, but its % alcohol is quite low. For this situation, the vapour then tends to bubble up through the thumper, with no further enriching. What goes in is what comes out - no real increase in purity. The extreme case is one where the thumper acts to strip alcohol from the vapour, and produce a lesser strength vapour.

This situation changes a little if the small thumper is initially charged with a liquid of high % alcohol - eg the tails from the last run, say at 30-40%. In this case, the excess energy available is sufficient to cause the thumper to act like a second distillation stage - once its up to the boiling point of the % alcohol in there, the energy goes into vapourising the vapour there, producing an output quite a bit higher in % than the vapour entering from the pot still. Unfortunately, because of its small volume, this isnt sustained for too long, all the alcohol is driven off, and past a particular point in time, the thumper then simply lets the vapour bubble through & do nothing further, if not actually stripping the vapour & producing less than that off the potstill.

The best scenario for the thumper is where it is of quite a large size, and charged initially with a reasonable % alcohol. Even starting it with the same % wash as that in the pot still is an advantage. In this case, the excess energy from condensing the pot still vapour goes into releasing a vapour of quite a high % alchol, always higher than that exiting the pot still. In this scenario, the thumper is a benefit, as it allows quite an enriching of the vapour to occur, with no additional energy required. The only condition is that the thumper is charged with a liquid of a reasonable % to begin with - if simply filled with water it wont work.

To make the thumper effective you want

- lots of vapor liquid contact, ie heaps of small bubbles - eg use a screen or simply lots of pinholes in the bottom of the inlet tube.
- the liquid in the thumper to begin high in alcohol, so a small volume of wash or, maybe better, tails from the last run. Deb recommends .. *You put tails or mash into the thumper - not water - and the loss is not a factor compared to the resulting alcohol content :) I highly recommend a thumper!*
- larger is beeter than smaller. For sizing a thumper, Ted suggests ..

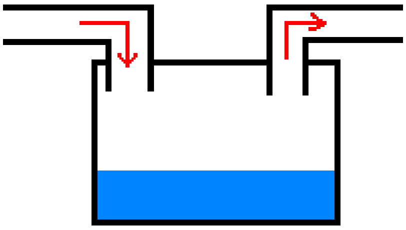
  *A good rule of thumb is make the thumper twice the size of the amont of distillate in a single run. ie: one run = 1 liter of spirits then make the thumper 2 liters .... as a minimum, have it at least 1/3 the volume, ie ((#gallons of wash * %alc of wash) / 3), or if using tails in the doubler, ((gallons of wash * %alc of wash + gallons of tails * % alc of tails) / 3). I myself prefer to use a larger size to allow for condensation that always seems to overflow the*

> *thumper. My grandfathers still was 250 gallons and had two 50 gallon thumpers as well as a 50 gallon slobber pot.*

Jim writes ...

> *Run your doubling keg in a water bath makes a good drink and it's pure. Do not add no liquid it makes it's own liquid*

Note that thumpers aren't the same as slobber boxes (although they look fairly similar. The inlet in a slobber box doesn't extend down into the liquid, so no bubbling & hence further distilling takes place. Rather, it just provides a place for any rubbish (ie foam, mash etc) pushed up the neck of a pot still to settle out before entering the condensor. They sometimes have a small drain cock on the bottom of them to help empty them while the still's running. The original purpose for a slobber box was for stills heated by a fire beneath them - if the heating got too vigorous, and the contents foamed or bubbled up into the lyne arm, that it would settle out in the slobber box rather than go and contaminate the main spirits being collected. They're not needed on well controlled stills.



Slobber Box

Double Walled Boilers

Joe writes:

> *Single walled bottom still designs are good only for sugar mash distillation and unsuitable for distilling thick mashes or preparing absinth. With direct heating, and especially with internal heating of keg, local overheating can (and will) occur for highly viscous mashes (grappa, plum, apricot, apple, quince, etc.). The decomposition (burning) of mash produces a terrible taste and smell, hard to remove. If you try to polish the distillate, fruit taste and smell will disappear first.*
>
> *It is a rather easy task to transform a keg to a safe, dual purpose,*

water bath type double bottom boiler. Generally a keg consists of the vessel itself, there is a lower and an upper skirt. Skirts are most cases welded to the vessel. If you close the lower skirt with a flat head (e.g. a 1/16"ss plate) and patch the went holes, you get a lower vessel for the water bath. For joining the head TIG, MIG or stick welding is best, but brazing is also possible. Patching the went holes you may use welding or brazing. Drill a ¼" hole on the side of lower vessel. Attach (braze) a ¼" pipe to the hole and have it run vertically to the top of the keg. Lace it through the upper skirt through a went hole and bend it to vertical position. Attach a proper safety valve (e.g. a weight type for pressure cooker) on the upper end of pipe. When selecting the type of safety valve you have to consider the danger of implosion during cooling. At 180 degree from the ¼" pipe (on the opposite side of lower vessel) drill a ¼" hole and braze over the hole a ¼"nut. Close it with a heat resistant gasket and a ¼" flat head screw. This will be the bleeder. Perform bubble test on joints.

Filling: Remove the weight of safety valve, screw off the bleeder. Fill up the lower vessel through the safety valve body and ¼" pipe using a plastic hose. When water starts to flow from bleeder, stop filling, reinstall safety valve weight, fasten bleeder screw. During distillation process water bath temperature will be in the lower vessel slightly above 100 Celsius due the minor overpressure, but this has no detrimental effect. Check water level in lower vessel each time before using, by shaking the keg. According my experience refill is rarely needed. Annually descale lower vessel with vinegar. In case of using the keg in cold climate avoid freezing the water.

I have been using this construction for years without problem, quality of distillate improved dramatically. Of course, if you distil thick mashes a greater opening (min. 6" diameter) is needed to fill and clean the keg.

Gin Heads

David writes ..

A Gin head is a large separate compartment that sits above the boiler on a gin still in which the botanicals (juniper berries, coriander etc.) from which gin gets its unique flavour are placed and through which the the alcohol vapour must pass before it enters the column. As such gin stills are pot stills rather than reflux. They are still specifically designed for making gin although they are and can be used for making other similar drinks. As such they have mostly been made by one British company for the last two centuries although I dare say there are now other companies that make similar stills elsewhere. Steam or vapour distillation is better at extracting essential oils and other more soluble components as compared to steeping which tends to extract tannins, phenols and the more harsh bitter components.

UPS adds ..

A gin head still is a pot still that has a basket like arrangement just at the start of the "lyne arm" (the part of the condensor coil that is coming out of the top of the boiler, but has not yet entered the cooling tank yet). In the basket goes the botanicals that turn what is essentially a vodka into a gin. This is the method that Bombay uses among others, and is thought to give a more delicate style of gin. Nothing really fancy, just a basket sitting on top of the boiler before the condensor- if you lookat some commercial distilleries pics, you often see a swollen bulb at the top of the still where the condensor line runs out from - if a basket arrangement was put there it would be a gin head still - appearantly, many scotch distilleries use a gin head still - they just don't put any botanicals in it. This is a holdover from the days in England when gin was the most common (cheap) drink to be found- when gin's image crashed the scotch distilleries bought the surplus stills.

Ted also adds ..

A gin head is a pot or column that steam travles through enroute to the condenser. A thumper works rather well. Just pack it with the herbs and run clean drinkable 60% ethanol in your still for gin. Pack it with peppermint to make schnappes. Pack it with... well you get the picture. Put just water or varying amounts of ethanol in the still for making oils from mint or whatever has an oil contenet.

Condensers

I have done a wee interactive calculator to help with sizing condensers. Andrew advises ...

One of the easiest ways to increase a heat trasfer coeficient is to increase the velocity of the fluids. Temperature of the cooling medium helps, but velocity is MUCH better. This is why blowing on a spoon full of soup with your breath (about 90degrees F) cools it off much quicker than holding it in front of your nose, even on a chilly morning. What I'm getting at is that close clearances are desireable, as you will get lots of heat tranfer into your cooling water.

A good design, utilising this is Tom's version, used in a Nixon-Stone settup - see here for his diagram.

If you're wanting to make a condensor coil, like the Nixon-Stone style ...

Paul offers ..

if you are going to bend copper, get a tube bender. This is a wound steel spring that allows you to bend tubing without kinks. Your hardware or plumbing supply can help.

and John ...

Spring-benders while they aid in crude tube bending can be replaced with a die and mandrel type of bender. This will yield uniform bends.These benders are available from "Imperial Eastman Co." For larger diameters anneal the bend area, cool,pack with sand and form over wooden die that has been fabricated to match bend radius. This procedure will elevate the finished product above the amateur level.

You just need to evaluate if the extra cost is worth the extra quality.

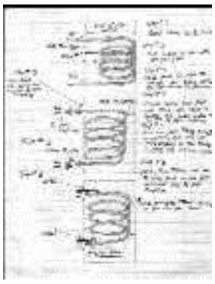
Jack suggests ..

A fancy mandrel type of arrangement is easier to get than you might think - most people in this area just wind the copper tubing around an old paint can. It works a lot better than doing it by hand or with a spring *tubing bender. Past about one half an inch in diameter it gets to be a little hard to do.*

Another approach is to air cool the distillate. "Vonmantik" writes ..

I had the fortune of befriending an old distiller from the smokey mountains who had a ten liter cooker with reflux tower. The unusual part was that he had designed a air cooled condenser. It was made of about 25ft of 3/8 copper tube coiled tight and centered in about 4ft of pvc pipe, on top was a small box fan (from a recycled computer) that drew air through the pipe. Intake was controlled by a homemade collar with allowed the operator to contol air flow. This an idea that can be expanded on it there is a problem plumbing water to the place you want to set up.

Homer has a diagram of how he has fitted the coils into his reflux column. Click for a larger diagram :



Walter describes the "gattling gun" condensor ...

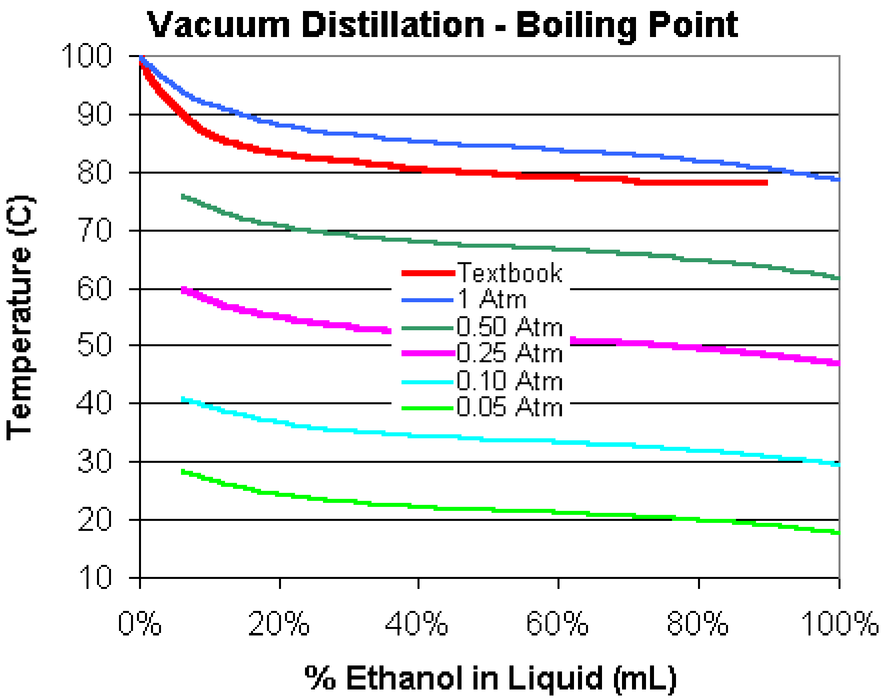
I noticed that the N-S stills have a coiled vapor condenser consisting of 3m of 5mm tubing through which water flows, and from comments seems inadequate. What about using a mini shot-gun condenser? On a typical 50mm diam. column this would mean say a 300mm length of 50mm tubing, with a plate on both ends with 12 holes drilled in a geometric pattern to take 12, 5mm open-ended tubes welded in place. It is still open to the sky for safety. On the side there is a water inlet at the bottom and an outlet at the top for the cooling water. In effect we have 3.6m of vapor in 5mm tubing surrounded by cooling water rather than the other way around. The unit can be welded on the top or attached by a standard 15mm threaded plumbing connector so that it could be replaced if necessary.

Brett has provided some excellent details on how to construct one, in a 2Mb pdf file: Making the Gattling Condenser

Vacuum Stills

Using a vacuum allows the use of lower temperatures, and can attain higher alcohol concentrations, eg at 42 mm Hg (cf 760 mm Hg = atmospheric pressure) the column only need be at 35 C (ie just use hot tap water to heat with). The azeotrope (the point where distillation ceases to work because the vapour and liquid purity are the same) moves towards 100 % as the pressure is lowered; below 0.1 atmospheres it disappears, allowing you to distill all the way to 100% alcohol (provided you beef the reflux ratio up to >20). They can also be more energy efficient, and allow for a greater capture of the available alcohol. The lower temperatures also mean that they're use a bit in the distillation of essential oils (which would be otherwise be broken down at higher temperatures).

The graph below shows the reduction in temperature. I'm not quite happy yet with my calculations for this (the Textbook & 1 Atm lines should be the same), so don't go and design from it, but you can see the basic principle at work ...



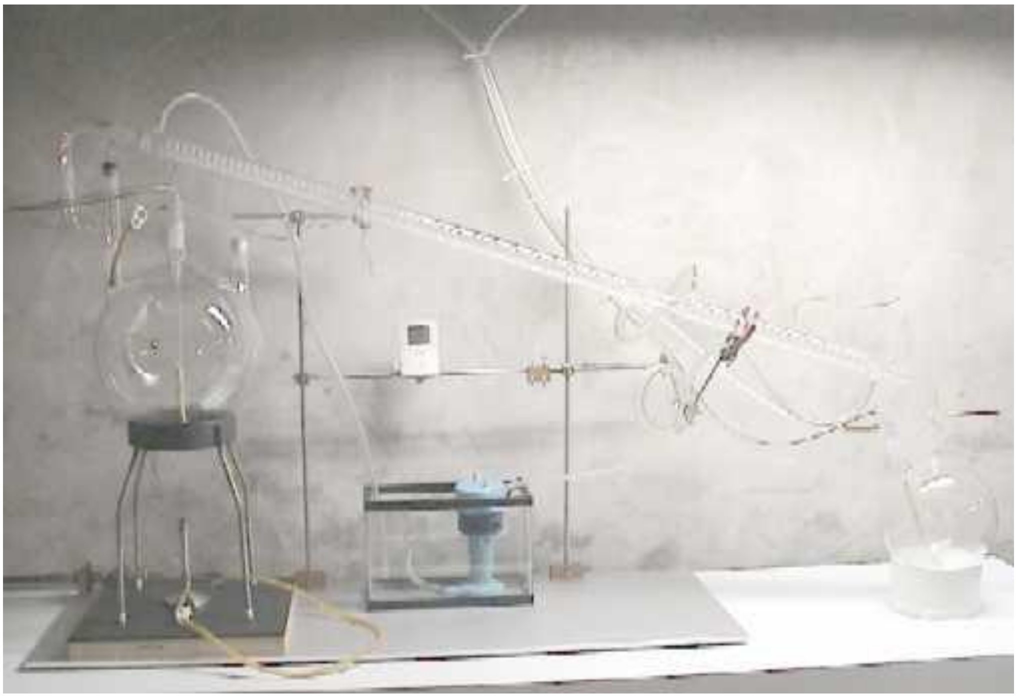
To create a vacuum, you can either use a mechanical pump, or a a venturi ejector (water jet pump). The venturi ejectors (vecktors) are commonly used by laboratories etc to assist with filtering material. They just use flowing water to create the vacuum, and cost around US$20.

Joel describes his vacuum still

Not only is it all lab glassware with ground glass connections....but the entire system runs under a 25"Hg vaccuum. The vaccuum makes the whole process much more eficient and keeps the boiling temps very "true". The vaccuum is also used to change batches without having to take anything apart.

The tank in the picture is the main coolant resivior. I built a cooling tank that sits outside and uses the cold winter ambient temperatures to chill the coolant. It consists of a 35 gallon garbage can with 125 feet of copper coils inside. The can is filled with automotive anti-freeze and the little pump in the pic pumps winshield washer fluid through the closed loop copper coil system and then through the condenser coils in the picture. On a really cold winter day....I can get a 100 deg. ambient drop between the inlet and outlet ports on the chiller.

After distilling the "product" 6 times and paying close attention to the temperatures (to make sure all the methanol has been separated from the "good stuff") I end up with distilate at 180 proof that WILL NOT give you a hang over.



Ólafur describes his vacuum still ...

My pot is around 60L. It is enclosed in a rather large plastic barrel and I heat the system with hot water. The water is around 80C so I don't need a lot of it and, besides, it doesn't cost a lot here in Iceland. The column is 2" X 60cm SS packed with ceramic rings. The water for the jector I let straight through so as not to create resistance on the out end. The cooling water I let in at the bottom end... The jector suck out of my collecting jar which is in turn connected to the condenser so any vapour rising up the column has to go through the condenser before it gets to the collector before it gets through to the source of the vacuum. The cold water in iceland is somewhere around 4-5 C so cooling is not a problem.

Note that in most cases, the vacuum is applied to the distillate collection container, after the condensor. This way there is little loss of vapour from the process, and there doesnt need to use much vacuum. Many of the comments below are concerning the setup where the vacuum is applied to the vapour line.

There are several problems with Vacuum stills though:

- you can lose some alcohol vapour out through the vacuum pump,
- you must have an accurate measure of the vacuum applied (not a big problem, one of the reasons the still is not easy to build),
- its hard to find leaks (thus requires care during construction),
- very low vacuums are difficult/expensive to attain (but generally not required - only a small vacuum is needed), and
- the low temperature can make it difficult to recondense to vapours (need realy cold cooling water & enough condensor surface area)

Often the vacuum can be made by using a "Venturi" or "Vektor" which uses the cooling water, and causing it to go through a small nozzel increases its velocity. This causes a corresponding decrease in pressure, and hence can "suck" vapour from the still. However, this can eject some vapour out of the system.

The heating can be a simple water jacket around the pot, using hot tap water.

What can also be confusing is when the mash begins to boil, the vapours will expand into the vacuum space, and your gauge may go back to zero. This doesn't mean you've lost your vacuum, but if you can have some of your still appliance in glass or plastic so you can see what is going on, this helps so you know you have some action and not a leak.

One of our visitors is in the process of working on an improved vacuum still design. We'll keep you posted once he's happy with the results (including maybe a photo, design, info, history & performance.)

1 Atm		= ☐ kPa	= ☐ mm Hg (mercury) (torr)	= ☐ mm H_2O (water)

David suggest how he would go about setting up a vacuum unit ...

I would go for a batch method where the still, condenser, and receiver were under vacuum; cooling would be circulated car antifreeze which was cooled with an ice/salt mixture. The condenser would be a multi tube high surface area low-ish volume of copper, the salt/brine would attack the copper hense the car antifreeze. This would give a nice big temp change. The pump would only have to maintain the vacuum so it could be a smallish *piston perhaps a good diaphram might do. The exhaust routed through a secondary condenser although I wouldn't expect much if the primary condenser was doing it's job, the reciever could sit in a bucket of ice/water to stop any secondary boiling.*

Another way of cooling would be to use a freezer, make a dummy door "if you want the freezer after" with a couple of holes in it, inside have a tank of antifreeze and circulate this through the condenser, it could run as low as -18 oC !. Any condenser after the vacuum pump would only have normal cooling as it would be at atmospheric pressure.

Tip if you're going to make a multi tube condenser these hints may save you some time. The endplates can be cut from sheet copper or a piece of tube opened out. Cut a circle out about 0.5 inch dia larger than the tube. Find a socket from a car socket set about 3mm dia less than the bore of the outer tube, trap the annealed copper disc between a thickish "6-7mm thick" metal plate" in a vice, and beat the edge of the copper over the socket. With dividers find the centre of the disc on the inside not out. If you use 32mm bore copper tube seven 10mm pipes will fit in nicely. Draw the 7 circles evenly spaced. Don't try and drill the holes! it's disasterous! Just drill a very small hole and use a metal cutting fret saw better still a jewellers saw if you have one. I use mine frequently it's a great tool. Make two plates. Silver solder or use the copper/phosphorus rods to solder the 7 tubes to the end plates,then slip the unit inside the outer tube, solder in place, make end plates to reduce the size down to a more convenient size "you gone metric yet" 3/4 or 22mm as we use here now.

Laurance adds ..

Don't use any old car antifreeze! Any trance leaks will contain poisonous ethylene glycol. Use propylene glycol (typically RV water line antifreeze or other antifreeze for use in potable water systems)- it will work just about as well and there's that much less chance of poisoning yourself (with antifreeze, at least).

Plates instead of Packing

Gaw has made a hobby-sized column with plates in it, rather than using packing. He elaborates ..

I built a bubble plate still using the encyclopedia and the pics from message #1560 posted by Peter of the Netherlands. Not being happy with the scrubbers or marbles and not being able to afford the threaded unions he had used, some $200 US each, I created a bolt together system using stainless plates from a salvage yard and 4 inch copper pipe. My still will now produce 3 1/2 US gallons per hour of 95% after a thirty minute warm up time, using two three KW elements in the main thirty gallon boiler and one 1500 watt element in the smaller six gallon water heater at the base of the still which I have converted to operate on separate temp controllers.

Other Design Sites

Other design sites include :

- Big Al's page

Other texts which you'll find out there in the Net include:

- The blueflame text.

  - Jesse Duke - master bootlegger
  - Homemade alcohol by The Guys Six Feet Under.

  Note that some of these older texts are a bit wrong / incorrect / offtrack. I list them here merely for their "historical" value, rather than expecting that you'll design anything based on them.

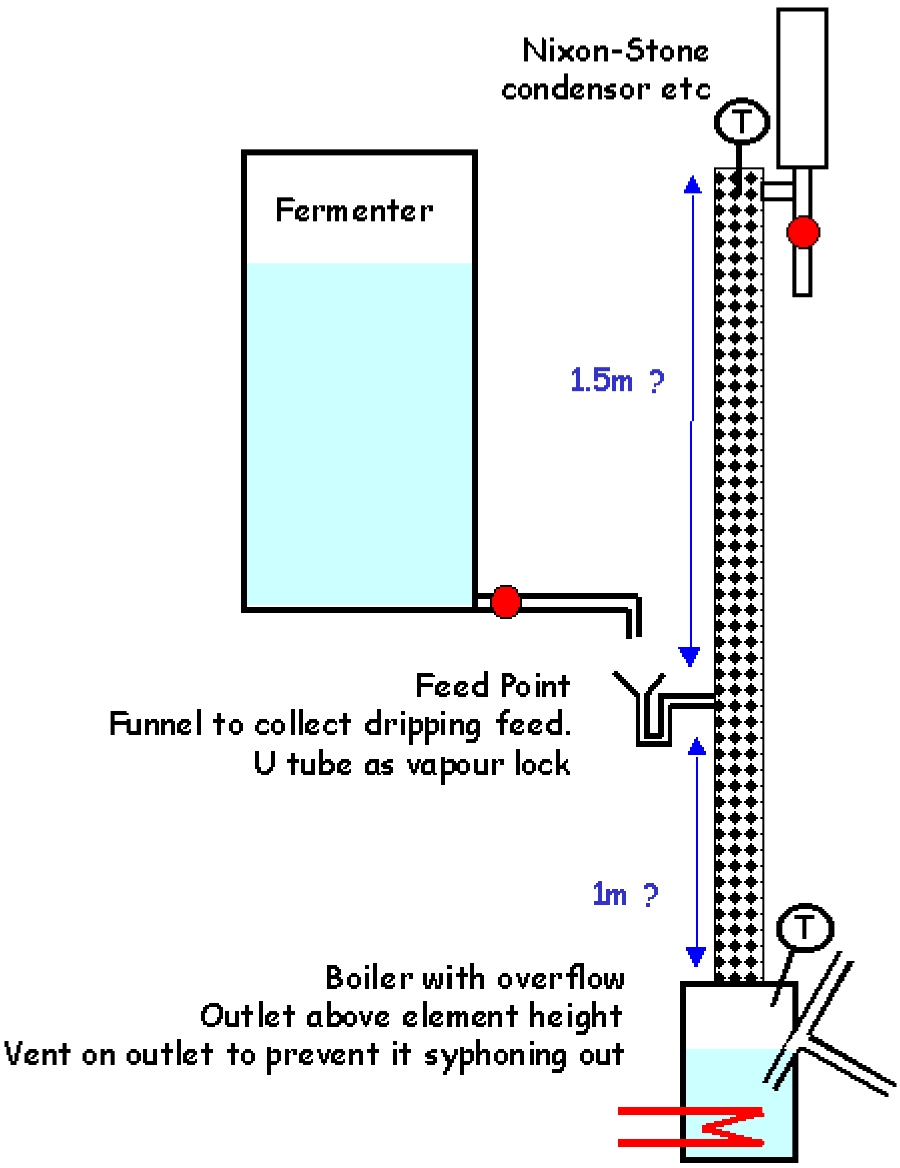
Continuous Still Design

I've finally got around to making a continuous still. Its very easy to convert your existing column - all you need is a small (1-2L) boiler - eg an old electric kettle.

This would be a great tool to use for stripping down large quantities of wash, to say 85-90% purity, for redistilling the regular way. Eg 200 L of wash at 12%, if stripped at 85% purity, would give 28 L. Redistilling this would then give you the confidence that any heads and tails have been completely removed.

Concept

The design is quite straight forward. Use your existing column as the rectifying portion. Introduce the wash above a stripping column. The purpose of the stripping portion is to ensure that there is no alcohol left in the liquid by the time its dropped down to the lower boiler. This means that there wont be a loss of alcohol out the overflow. The boiler can be quite small in volume. It has a simple overflow so that the excess water is removed from the system automatically without need of control.



and photo

Rectifying Section

The rectifying portion of the column is just your standard reflux column - a packed pipe, with an overhead condensor & reflux control. Use either a Nixon-Stone layout or whatever your choice is (modified "gattling gun" condenser ?). As usuall, the taller this portion the greater the final purity will be - eg if using stainless steel scouring pads for packing, then 330mm = 87%, 660mm = 92%, 990mm = 94% etc. At least 1m would be required, but I'd suggest using 1.5m - this will allow a lower reflux ratio for the same purity (eg much faster offtake available). Fully insulated etc. Use a thermometer in the head of the column to monitor the vapour temperature and hence purity - adjust the reflux ratio to inc/dec as required. For a 800mm column I was getting a very consistant 84 %. Its very easy to control - first set it to a very high reflux ratio, then slowly open up the collection valve until the temperature begins to climb a little. Back off a bit, and theres your collection rate. Approx 5-7 mL/min (fast dripping) for a 1500W heat source. If the reflux ratio is kept too high for too long, you'll eventually notice it coming out via the boiler - you'll see the temperature there decrease as the water begins to contain some alcohol. So dont push your column too much - learn what sort of % you can expect for its height, and dont ask for too much more.

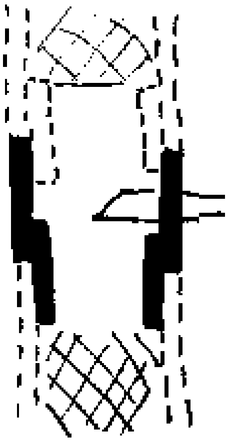
You could also simply convert your existing column, by tapping a feed point into it 40cm up from the bottom. It would then mean that the rectifying section was only around 80cm tall, but thats ok for just doing stripping runs.

Feed Point

The feed point only needs to be a short collared section that joins the rectifying & stripping columns, with a inlet that will introduce the wash to the centre of the column. Have the tube from the feed point loop downwards into a small vapour lock, to prevent and steam escaping out there. Open it up into a small funnel, so that its easy to drip the wash into it. You need to have the wash freely dripping, so that you can judge how fast it is flowing. If you were to plumb it direct from the fermentor to the column, you would have no idea how fast the liquid is flowing.

It would probably pay to have a simple paper filter in the feed line, to ensure that any yeast cells etc are removed from the feed, so that the column does clog up with gunge during the run.

In a commercial column, the feed would generally be preheated before it is introduced to the column. I found that that was not necessary - this set up works well without preheating the feed.



Stripping Section

Approx 3 HETP (eg 36cm of scrubber packing) should do the job to strip the feed to less than 0.5% alcohol. If not, or if you want to reduce the % even smaller, then simply make it taller. Fully insulate this portion, just like the rectifying section. 40 cm height works well - stripped all ? the alcohol out - the boiler was always at > 99.8C provided I kept the feedrate low enough (around 30-60 mL/min).

Boiler and Overflow

1-2L capacity should be suitable for the boiler. For a 38mm column, around 1500-1800 W should be suitable. A bit of this will depend on just how fast you run the feed into the column. The purpose of the boiler is to provide the steam that will strip the feed of alcohol. I used an old electric kettle from a garage sale : $1. Bent the spout flat and soldered it watertight. Made the lid have a fitting that would mate with the existing one on the bottom of my column, and stuck an overflow though the side of it. Thermometer in the top and its ready.

The overflow is necessary to discard the excess water - eg if stripping 24L of wash in 4 hours (typical hobby setup), this is a feedrate of 100 mL/min. If its 10% alcohol, then you've got 90mL/min of water overflow (and around 10 mL/min distillate collection). As to whether or not 1800W is suitable for 100 mL/min feed rate is open to argument, but given thats the energy input for the same setup but batchwise, then it should still hold for the continuous case.

Use a thermometer in the boiler headspace to watch the purity there. If the temperature starts dropping below say 99.8C , then slow the feedrate. If this cannot be sustained, then look at increasing the height of the stripping section.

The overflow requires its inlet to be below the liquid level, so that the steam doesn't exit it too, but positioned higher than the element, so that there is no chance of emptying the liquid level below the elements & burning them out. You will also require a vent to atmosphere off the overflow too, to prevent it from acting like a syphon. Mount the overflow through the side of the boiler, as the overflow level needs to be lower than the bottom of the column, so that the bottom of the column does not become fully blocked off by liquid. Because there is always a steady dribble of liquid coming out the overflow, you're always certain that the boiler is full, and not boiling dry.

Running it

The still is very easy to run. Set up your fermentor so that is sitting well above the feedpoint (eg on a ladder or a couple of boxes). Place a bucket beneath the overflow tube.

Fill the boiler with water, and turn on the power. Wait for this to start boiling, and all the column preheated. At that stage, start the condenser water flowing.

Start the feedrate slowly feeding in via the funnel. Keep the head at total reflux, until the temperature there has reduced down to 78-80 C, then slowly open it up. Slowly increase the feedrate to the column, until it causes the boiler to start dropping in temperature below 99.9C - at that point slow it down a touch. Open up the head, until its purity likewise starts to suffer - eg it rises above 80C, then just back off a touch too. Don't try and run the head too pure, or else you'll overload the column with alcohol and simply push it into the boiler from where it will be lost.

Once its balanced & running, it wont need further adjusting, unless the feedrate slows as the liquid level in the fermentor drops. This can be minimised by mounting the fermentor as high as is practical.

The thermometer in the boiler shows you how to adjust the feedrate, and the one in the head of the column shows how to adjust the collection rate. Very simple. Do the maths - if feeding at 12%, and collecting at 85%, then you'd expect to be collection one drip at the head for every seven into the funnel.

Methanol & other Heads

The question remains as to what happens to the heads & tails that you'd normally take the effort to discard. It is not practical (in my opinion) to try and set this up as a multi-stage column to try and collect the heads at the column top, and the ethanol a little lower down - the heads collection rate would just be too small to be practical, and you'd need a fair bit of height between the two locations. To minimise the amount of heads, only use this setup for sugar-wash runs, which are said not to produce any methanol.

All going well, the tails should be exiting out the water from from the boiler. If you suspect that instead some are still turning up in the product, maybe it would be of some benefit to reduce the boiler temperature (eg to 99.0 C ?) This way you'd be losing some valuable ethanol out there too, but also any of the other impurities. It would be an economic choice for you. Personally, I don't think its warranted.

The easiest solution is just to treat the continuous column as a stripping device, to produce a product that you are going to redistill later, and remove any heads or tails should they be present. When I've redistilled the product, I've found it to have little/none of them present.

Materials to Use for Construction

Summary
Use lead & cadmium free solder or brazing. Both aluminium and copper are safe to use, but stainless steel will prove more durable and easier to maintain.

If you do need to make a still yourself, take care to avoid lead solder, etc which could contaminate ya. Use silver solder instead. Use only food grade type materials (eg stainless steel, glass, etc). Mine has an aluminium head on it - which is OK for the limited use it gets, provided it is kept clean & dry when not in use (or else it will pit & erode).

Copper is an interesting case - high levels of it are known to be dubious to your health, however it has been (and will continue to be) used for centuries in commercial stills (because of its excellent ability to transfer heat). This is because any dissolution is at such a low rate that you don't get exposed to enough of it. It is well known that the low wines produced in commercial stills can be a light green in colour due to their copper pick-up, however they are still below limits prescribed for potable water by health authorities. It would also appear that the copper helps convert some of the esters & organic acids present (which affect taste and odour), so that they're reduced. Some people who have built stills without copper have later added some back in (say using copper srcubbers for column packing), to because their highly pure (93%+ purity) spirit still had a smell present, which only went away when they put some copper in the vapour path.

For an excelent article on corrosion of metals, and the problems this causes when building brewing equipment, see Corrosion Problems in Brewing by John Palmer.

For information about using Brass, see http://www.brewinfo.com/mybrewery97/mybrewery3.html

For suppliers of brass needle valves, search the following sites :

http://rswww.com/ (UK), or
http://www.cornerhardware.com/hardware (US)

For heating elements, Reima recommends ..

> *my Immersion heaters can be had at Haymans or CNW Electrical*
> *Manufacturer is "LN Elements" Type RHM 12 and they are in Melbourne*
> *Phone 03 9427 7066*

For basic construction techniques see http://www.brewinfo.com/mybrewery97/mybrewery2.html.

What to Use for a Boiler ?

Http://www.kegs.com is a good place to get beer kegs in the USA. The used 50L kegs are about $20 US dollars. They make good boilers and fermenters.

If you need instructions for how to remove sanke ball valves from kegs, see http://www.stpats.com/oakbarrels.htm

For those residing in Oz, The Visypack plant in Brisbane produces a food-grade 60 litre stainless steel drum. The "full open lid" version, retained with a clamp and nitrile (alcohol impervious) gasket sounds ideal for a boiler. Visypack's address was soon to shift to: 40 Ingham Place, Hammett. The contact person is a Jim Klear (pronounced "clear"), Phone no. in Brisbane: 3890 9777. Price: Aus$154.66. **Update** - have just heard its now $348 - probably a bit too steep to consider !

Rheem Australia the hot water system people has a factory in Bulimba (Inner southeast) Brisbane Queensland Australia. They make the beer kegs etc for the breweries amongst other things and I believe you can also get 60 litre SS drums from them as well.
http://www.skolnik.com specializes in steel drums (including salvage drums and barrels) which would be suitable for distillers.

What Materials are Suitable ?

Coulson, Richardson & Sinnott report that:

- aluminium, aluminium bronze, brass, copper, gunmetal and bronze, high Si iron, nickel, nickle-copper alloys, platinum, silver, stainless steel (18/8, molybedenum & austenitic ferric), titanium, tantalum, and zirconium
- nylon 66 fibre & plastics, PCTFE, PTFE, polypropylene, and furane resin

- hard rubber, neophrene, nitrile rubber, chlorosulphinated polyethylene, and silicone rubbers
- concrete, glass, graphite, porcelain and stoneware, and vitreous enamel

are **corrosion** resistant to alcohols, beer & water up to 100C.

- lead, mild steel (BSS 15), cast iron, and tin
- acrylic sheet (eg perspex), acrylonitrile butadiene styrene resins, rigid unplasticised PVC, plasticised PVC, polyethylene (low & high density), polystyrene, melamine resins, epoxy resin, phenol formaldehyde resins, polyester resins
- butyl rubber & halo-butyl rubber, ethylene propylene rubber, soft natural rubber, and polyethylene rubber
- wood

are not corrosion resistant to them. Now I don't know too much about toxicity - can anyone advise me if some of these are troublesome ?

Plastic

Plastic is basically fine at the low alcohol end (eg the wash, and even the diluted product), but if possible, try to avoid using it where it is likely to encounter strong alcohol. For alternatives, consider using copper tubing from the condensor to the collection jar, and using glass collection & storage jars.

From Ken Schwartz's page (sorry, link dead) about building a plastic brewing setup ...

> *... I made sure the buckets were at least 0.090" (90 mils) thick by checking the thickness "rating" embossed on the bucket bottom -- I found that the cheapo 0.070" buckets I experimented with earlier on allowed the element to sag when it got hot, but the 90 mil units I found were just fine. I ended up changing to a 7-gal HLT (see below), same as my boiler. These 7-gal buckets are both 100 mils thick and handle the heat very well.*

Wal writes ...

> *I obtained a cheap used 60l (25 USgal) plastic drum with a band clamp like those on paint tins. Looked more solid than my plastic jug in the kitchen. So I obtained 2, 240V, 1500w electric jug replacement elements which can be easily attached to the drum by simple drilling and screwing tight (from ray@moonshine.co.nz). Converting beer barrels and hot watersystems did not appeal to me - I like easy solutions as I'm not a*

> *great handyman. I intend to use two for the initial boil, and then use one for my 40mm diam X 1m column which appears right to prevent flooding.*
>
> *What plastics are suitable for boiling washes? See: http://www.plasticsusa.com/polylist.html*
>
> *Appears HDPE and polypropylene are O.K.*
> *Utilization temp (deg. F) for HDPE is -180 to +248 with a melting point of 266.*
> *Utilization temp (deg. F) for polypropylene(PP) is -15 to +266 with a melting point of 338.*
> *Oviously polypropylene is better, but high density polyethylene is acceptable. Plastics are slightly permeable so be careful what they held if purchasing a used one. The inside of my kitchen plastic jug looks vey stained, but then so what.*

Not all plastics are great with alcohol at high temperatures. Ken warns ..

> *The technology of materials is constantly changing but the chemical resistance does not. Food grade, 'Flexible",means modified in most cases and it means plasticisers are compounded into the polymers to make them more flexible,these are not always stable ,especially at elevated temperatures and in contact with alcohol at these elevated temperatures and high concentrations...I do not use any plastic in my operation until I cut it down in strength.*

Ses adds

> *Tygon tubing should be inert. We used to use it for collecting biological distillates. Alternatively, glass piping could be used, but you would need a bunsen burner and some pretty good skill to "bend it" into shape.*

Keith writes ...

> *You can check chemical compatibility here: http://www.coleparmer.com/techinfo/ChemComp.asp Cole-Parmer: Chemical Resistance Database : Chemical Compatability*
> *To search, select at least one of three criteria to search on. If you wish to search by compatability level, you must specify a chemical or material.*
>
> *This helps with identifying different kinds of plastic: American Plastics*

> *Council:*
> *http://www.americanplasticscouncil.org/benefits/about_plastics/resin_codes/resin.html*
>
> *And this helps even more:*
> *http://www.midmichiganspe.org/education/identification.pdf Society of Plastics Engineers, Mid-Michigan Section Plastics Identification*

Hennie writes:

> *Please consider this:*
>
> *PCV a thermoplast is a polymer that can easily be recycled, see:*
> *http://en.wikipedia.org/wiki/Polyvinylchloride.*
>
> *Years ago a soft version of PVC was produced by adding polychlorinated biphenyls (PCB) as a softener. I think that in most of the world the use of PCB's is banned now. But just imagine a company recycling "cheap" soft PVC in their PVC sewer pipes to make them less brittle! Be sure to use food grade PVC pipes and not the (clean new) cheap PVC sewer pipes. To give you an idea what PCB's can do:*
> *http://www.foxriverwatch.com/monsanto2a_pcb_pcbs.html*

Galvanised Metals

Tarvus explains ...

> *Galvanised materials are not safe to use on the condenser side, but if it's part of the boiler or at the bottom end of the column, it should be fine (provided you don't boil so vigorously that your wash bubbles up through your column and into your collecting container. Toxic salts from metals can be dissolved in liquid, but remain behind when the liquid is vaporized (as in a reflux column).*
>
> *For example, you could toss a handful of lead fishing sinkers into your boiler which could well leach toxic levels of lead into the wash. But once the vapor runs through the column, it's free of the lead salts and safe. If you used lead based solder (or galvanized parts) in your CONDENSER, that would be a different story. The hot liquid condensate could leach lead salts from soldered joints or zinc from the galvanized parts and you would wind up with contaminated product.*

Solder & Braizing

(A compilation of newsgroup emails by Robert Warren, Pete Sayers, David Reid, James Witten, Howard Anders, Allan Goldsmith & Scott (the yldog) - thanks guys !)

Solder

Is solder safe to use ? Tin and silver solder is perfectly safe, and in fact is commonly used for soldering copper and/or stainless steel for food use. The main "ingredients" in solder we need to avoid are cadmium and/or lead. BTW tin is the material used to coat the inside of "tin cans" in making of canned foods - ie its very safe to use (Actually steel cans of course, which are plated with tin to make them corrosion proof.) Most states in the US outlawed lead solder back in the mid 70's.

There are a couple types of solder currently sold on the market:

- Silver solder, is mostly tin and a small amount of silver. It does take a bit higher temperature to get it to flow, but has excellent adhering properties. In fact, if you want to solder something which will never come apart, unless you use an even hotter torch than what you soldered with in the first place, then silver solder it. You may want to use Mapp gas instead of propane to get the higher flame temperature (around 650 F / 345 C ?).

  Regular silver solder may have some cadmium in it; Check that you are infact using cadmium free silver solder (for use on food related equipment (stills)).

- The other main type of solder is simply called 95/5, which is 95 % tin and 5% zinc. It flows easily at a lower temp, (around 500 F / 260 C ?) and will just run off instead of sticking if you get the joint too hot. You want to work this solder at close to the melting point. This is what most plumbers have used on domestic waterlines arouund the world for the past 25 years, and it is completely safe, as is the silver solder. Plumbers use 95/5 because it is about 25% cheaper than silver solder.

  Now, given the fact that alcohol is a known solvent, and the other salient fact that you have hot alcohol vapors inside a still, it is reasonable to wonder about the how much tin and such may dissolve. Well, the tin is pretty good at sticking to the copper and also to the adjoining tin molecules, and it really is not very soluable at all. Some geographical areas have well water which is highly aggressive, perhaps a stronger solvent than alcohol. Such water will dissolve out the zinc in galvanized pipes and then continue to react with the iron underneath and you end up with holes in your pipes.The zinc on alvanized pipes and inside water heaters is considered a sacrificial metal. However, the zinc in 95/5 is bound to the tin and is an alloy, so it has completely different properties than the zinc coating on steel pipes. Anyway, the long and short of it is that zinc, tin, and copper are found in tiny trace amounts in our bodies along with gold and silver.

Brazing

To learn more about how to braize, see http://www.handyharmancanada.com/TheBrazingBook/bbook.htm

Brazing definitely makes a vastly superior job to soldering and is also more permanent too.In short there are a number of materials;

- Silbraloy (sometimes mistakenly called Silvaloy) at the bottom of the range starting with 2% silver,
- Silphos with 5% and 15% forms and one or two other proprietary materials, and
- Easyflows which have silver contents from 30 to 56%.

The Silbraloy and Silphos forms are generally a mixture of silver and phosphorous copper whereas the Easyflows also contain other specialized minerals to achieve certain other goals eg. nickel is used for hardness.

Silfos is an exellent product to use. It takes a much hotter flame, so you may need to use Mapp gas or even acetylene (it melts at around 800 F / 425 C ?). Quite high, compared to solder. It is a phosporous bearing product. It is unique in that you don't even have to flux the joint, but it should be thoroghly clean,as with all soldering. It is very strong, and the other feature is that it is strong enough to use to repair a hole in apressurized water pipe (you can't solder with water in the pipe) but it can be worked like a brazing rod and so you can fill holes with it.

Prices start at around NZ$30 kg and go up to NZ$400 kg for the more specialized materials. The more silver and other additives the higher the price.

Also in short you get what you pay for and the skills and experience of the welder then become important. If you have a good welder he could probably use Silphos 5% but I would probably use 15% (Good capillary flow for tight up joints. High stress resistance) if you want a good neat job and you dont mind spending a little more. Either Silphos 15% or a bottom end Easyflow (such as 30% but a bit dearer again. Good gap filling and build up. Good flow characteristics) are probably the best for this job and the little bit more you pay for the material are generally compensated for in the welding time saved. Personally I wouldnt pay more than $80 kg. Consult with your welder as he is the guy with the experience and as long as he is honest and has the skills you should be pleased with the result. If he is an older plumber who did his time using copper plumbing pipe you should have no problems.

John writes ...

> *..Soldering this heavy copper was tricky as the standard small hand-held propane tanks do not provide enough heat. So I bought a canister of MAP-gas. At first it would not work, but a phone call to a plumbing contractor gave me the following:*
> *1. scour the to be soldered surfaces with sand-paper. Any kind will do. But get them clean.*
> *2. use FRESH solder paste. This is an acid paste that melts as the heat is applied, and further cleans the surfaces. Use the paste liberally! I found that I had to restrict the paste to the very areas I wanted to solder, as that is where the solder flows.*
> *3. Use lots lots of heat.*

Is Aluminium Safe to Use ?

Heres what the rec.crafts.brewing Frequently Asked Questions (FAQ) (version 2.12) has on the subject.

> *There has been a good deal of "discussion" as to whether or not the use of aluminum in brewing contributes to Alzheimer's disease. Thanks to Oliver Weatherbee for providing to following:*
>
> *Aluminum has NOT been linked to Alzheimer's disease. The following is taken from "Frequently Asked Questions About Neurological Problems" at The Department of Neurological Surgery of The Cleveland Clinic Foundation (http://www.neus.ccf.org/patients/faq.html):*
>
> *"There is little support for the theory that aluminum causes Alzheimer's disease, the most common cause of dementia in the United States. The exact cause of this disease is unknown, although the risk of Alzheimer's is higher when there is a family history of this disease.*
>
> *[two paragraphs removed]*
>
> *Workers exposed to high levels of aluminum in industrial environments have no increased incidence of Alzheimer's disease. Furthermore, careful studies to*

> *date have not shown an increased aluminum concentration in the brains of Alzheimer's disease patients.*
>
> *Since there is no convincing evidence linking aluminum toxicity with Alzheimer's disease, you need not worry about exposure to aluminum in cooking utensils."*
>
> *Furthermore, Brewing Techniques (Jan/Feb '95) had an article on a parallel brew experiment using an aluminum brewpot and a stainless. Laboratory analysis showed that there was no significant difference in trace aluminum levels between batches. They also pointed out that most of the Al you digest is from your food and water. And for that matter, many medical people consider copper a bigger health risk.*
>
> *As for off flavors, IF this happens (hearsay IMO), it is probably the result of the brewer scrubbing the oxidation layer of the pot during cleaning. Don't scrub, use a soft cloth or sponge and non-abrasive cleaner. This is one of the reasons Al is not used much commercially, its not caustic cleaner friendly.*

About the biggest concern is using aluminium to stew up highly acidic foods (eg tomatoes), where a very long time comes in to play. For more details see ..http://www.alzheimer.ca/ Dr. M. Legendre summarises ...

> *Al has two primary disadvantages:*
>
> 1. *Acidic wash will cause pitting over time, which destroys the vessel. This can probably be mitigated by neutralizing the pH of the wash prior to distillation with some calcium carbonate or similar.*
> 2. *Al cannot be effectively soldered or brazed - and soldering is a primary method of joining still parts for the home handyman.*
>
> *and several advantages: It is cheap & light, easily cut, machined, drilled etc.*

Cleaning Aluminium

Ted advises ..

> *Do not use sodium hydroxide (NaOH) - lye - for cleaning with aluminum!!! the reaction will produce hydrogen gas and eat the aluminum. Treat aluminum like you would copper.*

Is Copper Safe to Use ?

Copper has been used for centuries in still design, despite its slight solubility. This is primarily due to its excellent heat transfer properties, making it excellent at cooling the vapours. Although some copper will leach into the distillate (low wines are sometimes a light green in colour), it is usually well below health limits for potable drinking water.

If you haven't fully rinsed off acids used during cleaning, then it can react to form copper acetate (verdigris). This stuff is toxic, with an LD50 (Ingestion) of 196 mg/kg (mouse). This is a small number - it means that a 90kg person would need to consume 17.6 grams of it (half a scrubber by weight ?). This stuff is slightly different from the "green rust" you see on copper if it isn't dried fully each time after use. However, all copper salts are toxic if consumed in chronic volumes. 2-5 mg / day is essential for good health, however levels above this will be dangerous. 10-20 g is considered fatal. Your body will slowly flush itself of copper, but approx 30% of copper salts ingested will stay in the body. The half life is 13-33 days with 70-150 days to completely clear any one incidence of ingestion. In simpler terms, we're not at risk in using copper for the fittings in the still, as the rate at which we're oxidising the copper is a lot slower than rate our body can handle it. In addition, given that the reacted copper is water soluble, a decent rinsing after each cleaning & use of the still should take care of removing it. The greater likely risk is from inhaling the dust when cleaning dry copper. Make sure that you do your cleaning in a well ventilated room, and possibly use a mask if you're putting dust into the air.

It would be rare to find a commercial distillery that didn't use copper.

Several sites actually recommend some benefits from using copper, as it is said to remove sulphur & form more esters (flavour)

Helge Schmickl of http://www.schnaps.co.at/ writes :

> *According to relevant literature, copper should theoretically reduce the amount of esters/organic acids because of its catalytic impact. Basic rules of organic chemistry point to the same outcome. But we didn't notice any difference in taste/smell when distilling simultaneously with two equipments, one was completely made of glass, the other one of copper. The fermentation has a much greater effect on the result. Esters and especially organic acids arise from misfermentations of leafs/twigs or rotten parts of fruit. Work as clean as possible during the whole fermentation process and use cultivated yeast. Then you shouldn't have any problems with esters/organic acids. Try this: Fill a copper-tube (length appr. 30-50cm) with copper wool. Put this tube between the*

> *distilling pot and the cooler (condenser)- you SHOULD notice a difference.*

The following comments are from the Macallan Distillery at http://www.themacallan-themalt.com :

> *The size and shape of the stills are crucially important. The more contact the wash and low wines have with copper the better, since it acts as a catalyst, removing sulphury impurities (in the wash still) and promoting the creation of esters (in the spirit still) - effectively cleaning and lightening the spirit. Small stills with a broad 'head' (the middle part of the still), such as those at Macallan, are best of all: a narrow head tends to increase the velocity of the ascending vapours and to reduce their contact with the copper walls.*
>
> *Finally, while we are on the question of still design, there is the important matter of the length and angle of the 'lyne arm' - the pipe which connects the top of the still, known as the 'swan neck' to the condenser. Macallan's lyne arms are of average length, but they are acutely angled in a downwards direction. This means that once vapours reach the neck of the still they are more likely to go over and be condensed than to fall back as reflux and be re-distilled. Again, the Macallan is unusual in this: most distillers set out to increase reflux. But then, they may well not achieve such copper contact (with its spirit-enhancing properties) as do Macallan's small stills.*

Hector adds ..

> *I wonder why this German manufacturers swear so much on copper for their material of choice for still making. In a material they sent me says verbatim: "Pot stills are traditionally made of copper for numerous practical purposes: copper adsorbs volatile sulfur containing compounds which are produced during fermentation and the presence of which is undesirable in the distilled spirit; copper is an excellent heat conductor that helps prevent burning of the mash; copper prevents the production of ethylcarbamat which is a toxic substance formed from cyanides (cyanides are found in high concentrations in pitted fruits); copper also improves the quality of the final product, if the quality of the mash is not microbiologically perfect; and, copper —and some distillers might even*

> *argue a particular shape of the copper— improves the aroma of the final product."*

Sunshine Mike writes ...

> *I am a little puzzled by the absence of copper in a lot of your boilers. It took me several months of searching at various libraries to discover why boilers should be made from copper. I accept that, prior to the advent of stainless steel, copper was the logical choice due to its malleability and conductivity . However, large commercial stills are still made from copper and not, to my knowledge, from SS....why? My research turned up the following and I was wondering if those amongst you with a bent for organic chemistry would care to comment. During the heating of the wash fatty acids are produced. These give rise to off-tastes and they are apparently not too good for you as well. However, if they are formed in a boiler made from copper they bond with the copper in some way and do not go through with the distillate. If you use SS they pass through with the distillate. This does not mean that SS is not to be used. All one has to do is to add a couple of handfulls of small copper pieces to the SS boiler.*
>
> *At http://www.drinktec.com/ I found the following which adds to the copper knowledge base ...*
>
> > *Pot stills are traditionally constructed of copper. The reason for this adherence to copper has numerous practical purposes:*
> >
> > - *copper adsorbs volatile sulfur-containing compounds which are produced during fermentation and the presence of which is undesirable in the distilled spirit;*
> > - *copper is a very good heat conductor that helps prevent burning of the mash;*
> > - *copper avoids the production of ethylcarbamat which is a toxic substance formed from cyanides (cyanides are found in high concentrations in stone-fruits);*
> > - *copper also improves the quality of the final product if the quality of the mash is not microbiologically perfect; and,*
> > - *copper improves the aroma of the final product.*

Lars replies ...

> *What copper does is that it catalyses the breakdown of esters and sulfuric compounds. I did not know about the catalysis of fatty acid*

> *breakdown, put it is possible that it does that as well. Exactly as you say you only need to have a small amount of copper present somewhere in your still to get this effect. I use a copper refluxcooler. I don't believe that the copper actually forms a bond with the fatty acids. It is probably a catalysis we are talking about. And the end products probably go through to the distillate to some amount, but not in their original foul-tasting form.*

Mecakyrios added ..

> *have found in my years of distilling, that when the vapor comes in contact with copper it imparts a flavor to the final product. I have also found that, while it does offer a bit of difference, copper in contact with the wash does not have as much of an effect.*
>
> *Therefore, due to my experiments and years of working knowledge, I have come to the conclusion that in order to gain the desirable flavoring that copper adds, it is beneficial to have copper in the area that the most vapor will be in contact with it.*

Jack confirms this ...

> *I just got a 5litre "export still" - the small potstill on your picture pages. For the record- "out of the box" it can get you 55%abv with a starting 15% mash. With half of a copper scouring pad pushed up into the lyne arm- it increases to 65%abv+. The lack of copper gave the first trial batches a sulfur odor, but this went away after two days in corked bottles. The copper scouring pad, and a length of copper tubing force-fitted into the lyne arm took care of that, though. This indicates my previous experiments were flawed. My fermentations take place at low temperatures, as a result, I get very little sulfur production. The "quick batches" I made to try this thing out quickly had enough to carry over into the spirit, a copper plate on the bottom of the still body did nothing to help- the copper placed in the vapor path made all the difference in the world. I guess that is where the copper is most usefull, as far as flavor goes.*

Just a word of warning though - if you're going to use copper scouring pads as your source of copper, make sure that they actually are 100% copper. Dr. M. Legendre cautions ...

> *Don't ever make the mistake of buying these .. they are clearly labeled 'Copper Scourers' but 'Copper Washed Mild Steel Scourers' is more accurate.*
>
> *I ran these in my reflux column - 2 runs. After the second run, I left the still set for a day (my bad) and when I went to break it down, all of the 'Copper' scourers had turned to heaps of black (ferric) oxide. The ones nearest the bottom had the consistency of freeze-dried plant material, whereas the ones nearest the top still had a slight bit of structural integrity - but were still mostly black.*
>
> *I should have tested them first, they stick firmly to a magnet..! If these things are actually plated, they may have had a layer of zinc deposited atop the steel before the copper. Nasty, nasty, poorly labeled junk product. Beware.*

BeerGuy reports:

> *The article is by Lew Bryson and it appears in the Volume 13, number 3 edition of Malt Advocate. The title of the article is Gleaming Guardian: Copper Stills aren't just a pretty face. Mr. Bryson interviewed several people for this article. Among them were Dr. Bill Lumsden from Glenmorangie, Chris Morris and Lincoln Henderson from Brown and Foreman, Barry Walsh from Irish Distillers, and Jim Murray author of Jim Murray's Whiskey Bible. All these guys must know what they are talking about since it is a fundemental part of their job.*
>
> *Anyway, to preface the article and to acknowlege some of the speculation regarding my last post, the culprit of the corrosion and subsequent destruction of copper stills is sulfur. According to the article the sulfur comes from the grain itself, but it can also come from bacterial infection of the must prior to distillation.*
>
> *As the must is distilled the sulphur compounds wind up in the spirit. The copper in the still causes the sulfur to combine with the copper and form copper sulfate. Aside from the copper sulfate there are other oils and fats from the grains and these combine with the copper sulfate as well to form a black compound. According to Lincoln Henderson, this black compound forms on the spout of the spirit safe and he reports at the*

Woodford Reserve Distillery it is quite heavy. The reason why Woodford Reserve has such a thick, heavy greasy black deposit is because they distill bourbon and not whiskey. As you know Bourbon has substantial amounts of corn, and with corn comes corn oil. Chris Morris refers to it as Grunge and it smells heavily of copper. It is also difficult to remove from your skin. According to Chris Morris the grunge starts at the top of the gooseneck, the lyne arm and all the way through the condensation structure. The tail end of the Grunge eventually comes to the spirits safe. Barry Walsh notes that this effect works the other way in copper mining, in this case fats and oils are introduced into a solution heavy in copper to extract the copper from the base solution.

According to Morris the Grunge is actually a polymer called ethyl carbonate and according to him when distillers refer to EC levels in their process it is ethyl carbonate that they are discussing, the copper essentually cleans this out of the spirit.

Morris reports that to clean the grunge out they run a caustic wash through the still, what results is a waste water product that is high in zinc and copper, which cannot be processed by their local wastewater utility. Morris reports that this caustic wash is mixedw with spent mash and sold to farmers, where the addition of zinc and copper is a benefit to dairy cattle.

Bill Lumsden states that the best place to utilize copper is where it is where the hot vapors are condensing. He makes reference to shell and tube condensors which consist of a copper column with 250 narrow copper tubes inside. There is much more copper surface area in a shell and tube condensor versus a worm type condensor. In his experience he states that a spirit distilled using a worm type condensor is much more meaty and sulfury in character than that using a shell and tube condensor.

Column Stills are discussed in the article. Post repeal when the distillery business was starting over from scratch a lot of distilleries started to utilize stainless steel stills. When this occured they noticed the immediately the difference between copper and stainless steel stills. According to the article Seagrams did extensive research to figure out what was going on. Essentially, Morris states that at Jack Daniels 100%

copper column stills are used, while at Old Forrester a hybrid stainless and copper still is used. In the hybrid still all the internal infrastructure of the still is copper. Mr. Henderson also interjects that they also throw a lot of copper pieces into the top of the still, basically just a bunch of short sections of copper tubing, which lasts until it essentually disintegrates. The scrap tubing that they put into the still at Brown and Foreman last about 3 years and when it is eventully removed it is very brittle, about the thickness of paper and will crumble in your hands.

Mr. Lumsden states that the life of a still varies according to the distillation schedule, basically saying the more you distill the more copper dissolves. From his experience he states a 10 year lifespan for the neck and lyne arm, For the spirits still, the main body goes first and that is usually in 8 to 10 years.

The article closes with a few observations. In one, Mr. Lumsden states that the still gives itself up to the whiskey. Mr. Murray puts it more plainly and states that copper is self sacrificial and that every time a copper still boils away it is giving part of its life to the whiskey. Barry Walsh had the most important comment to make, he states that modern distillers could get away with a small presence of copper in their stills, but there is a thing of beauty associated with large polished copper pot stills.

My observations from the article are as follows.

First these are huge stills with very thick sections of metal. The corrosion that they are experiencing is pretty dramatic considering the volume of product they put out and the size of the still. I can't imagine the capital cost involve in replacing a commercial sized still every 10 years or so.

Second, copper is only important in those areas of the still that are exposed to vapor, that way the copper can do it's thing and the end product will still be as good or close to what is produced in a all copper pot still.

For a small 'hobbyist still' and the amount of mash distilled per year, the whole problem with corrosion is insignificant. I do expect that those who

> *use copper in the column packing will probably have to replace their packing every few runs or so.*
>
> *My opinion would be to use a stainless steel tank and attach a copper still head to that, you'd be way ahead of yourself.*

Cleaning Copper

Ted advises ..

> *If you used bleach or any other high pH cleaner, the inside of the copper tubing will corrode and give off dark colors. If you weren't using corroding cleaners then you're not as clean as you think you are. The best cleaner for copper tubing is mild acid like phosphoric or nitric acid. Run a gallon of 5% acid though it about 10 times and rinse with 2 gallons water.*
>
> *If your still is made of copper NEVER clean it with bleach! In fact, it doesn't matter what your still is made of, DON'T USE BLEACH! it corrodes just about every metal out there. I seem to say this over and over but no one listens!!! Bleach is great for sanitizing glass, plastic and wood fermenters and is the only place that you should use it.*

David agrees ...

> *Use Hydrogen Peroxide instead in most applications. This tends to sterilize rather than just sanitise and it also just breaks down to water and oxygen unlike bleach which kills fish and plant life including algae and which end up polluting waterways and the enviroment generally. The chlorides in bleach also attack and destoy metals including ss. This is a point that has irked me for years and one in which the so-called more advanced civilized societies and man in general are so backward and dumb. The only place I tend to use bleach is a few drops in fermentation locks so algae and bacteria dont grow and a little in the bucket of washing liquid when I mop the floors.*

Jack offers ..

> *I just found the perfect cleaning agent for copper. Since I can't get nitric acid, I decided to use whatever acid I had on hand: VINEGAR! I took a copper elbow that was brown, streaked, and corroded and totally covered it with vinegar. In about 20 minutes it was bright and shining. No scrubbing or anything, just a soak, then a water rinse- spotless copper. Try it, it's worth it.*

Winding Copper Coils

Sometimes its hard to make a tight coil without crimping the tubing. Nic writes ...

> *The hardness of copper tubing is determined entirely by the amount of work hardening that it has been subjected to after it was last annealed.*
>
> *So to make winding a tight coil as easy as possible you want to anneal your tubing before you start AND reanneal it whenever you have work hardened it (by bending it etc.) to the point that it becomes unworkably stiff.*
>
> *To anneal copper just heat to bright red, hold for about two minutes and cool. The cooling rate is not critical since copper is not heat treatable. This will make your tubing dead soft.*
>
> *The annealing process will leave a black and/or red copper oxide on surface of the copper. To remove this either scrub it off or soak in warm 20% sulfuric acid until the oxides are removed and polish if desired. Be careful and observe proper safety precautions.*
>
> *You should be able to get 20% sulfuric cheaply as "battery acid" from any auto shop.*

Mike explains about how to bend a coil ...

> *1/4" tubing, if softened first by annealing ... heat until copper starts to change color and then leave to cool (or quench quickly in water ... it makes no difference with copper) should require no filler to bend without kinking. Just wind slowly around a dowel or other former, pulling hard on the free tubing as you do so.*
>
> *If you must use salt to pack a tube, use very fine table salt. If the grains are still too big, you can easily grind it finer with a pestle and mortar ... or even a rolling pin on a hard flat surface. It powders very easily. Taping a cone of paper around one end of the tubing makes a nice funnel that doesn't take up space inside the tubing. Tap the tube often, as advised by 'trailsendag'. Make sure the salt is very dry before you start pouring by leaving it on a tray in a warm oven for half an hour. Even iodised salt soaks up some water from the air and will not pour as easily as bone dry salt.*

Eth&All advises:

*1. Buy tubing with wall thickess of 0.030. This is refrigeration tubing and comes in 50' coils. It's *maybe* five thousandths thicker than standard kind from the hardware or Home Depot/Lowe's type chains (but same price!!!). I'm not even sure it's any thicker, but I know it works perfectly.*

2. Get a mandrel for appropriate size at least a foot long (18" is better).

3. Allow at least 2 feet to overlap the mandrel toward your lap, with the remainder out in front in the floor. Keep the tubing 90 degrees to the mandrel.

4. Now with the 2 foot section in your right hand (let it extend up under armpit if necessary), and the remaining length in the left, pull with each hand in opposing directions as hard as you can (use Zen; become 'one' with it ha ha) while only trying to bend the pipe about an 1/8 to 1/4 turn at most around the mandrel (downward toward the floor). Do NOT go any further.

5. Now examine the tubing; it should be only slightly flattened where you first contacted the pipe. Repeat step 4, pulling with all your might while adding another quarter turn.

6. Now that you're nearly half way around, turn the rig over so that the short end is sticking up in the air. Continue by holding the longer length with left hand still...and pull upward as hard as you possibly can while bending to about 3/4 way around. Repeat and finish one turn

*7. Now here is the trick. You got it around and it isn't kinked and it's tight to the mandrel; now keeping constant tension on the whole works, use the *short end* to make 3-4 turns around the mandrel (leave as much as you want for water connections). Why is it the trick? Well 'cause you've turned the first few turns with the short, manageable end - and now you can grasp it for the remainder!*

*8. To finish means we *switch techniques*: Now stand up...and take the coil in left hand and put a tight grasp on the coil with locked thumb and fingers - and - bearing down on top of your left knee - keeping constant*

> *hard tension on the remaining tubing, *turn your wrists* outward to roll the tubing onto the mandrel. DON'T try to just wrap the tubing around like a sissy or it will not fit tight to mandrel and possibly kink. You can switch hands/legs to get a rest.*
>
> *Roll down, then back up the same way and you'll have a perfect double-helix coil without salt or anything.*
>
> *Figure 10' of tubing for a 4.5"-5" long double-helix for 1.5" column , and 20' for a 6 incher for a 2" column.*
>
> *It's hard work for any method, so just roll a few turns and rest often. Don't rush it, as was advised earlier.*
>
> *Remember, there are 3 tricks: Start with at least 2 foot and wrap first 4 or so turns with *short end*; constant, hard, tension during entire process; change techniques wrapping the last part by rolling wrists.*

Gaskets & Seals

Tarvus gets back to basics ..

> *A bit of white bread and water kneaded into a dough like paste works as a good temporary seal. Use it like a putty. It will dry but retain an airtight seal.*

AuntyEthyl agrees ...

> *Had the pleasure of testing my latest V3 on a water only run yesterday. Had a couple of minor leaks on the column, due to its design (pull apart column) , but enough of a leak to be concerned.*
>
> *Enter flour and water... made a 'dough' mixture and smeared it into the gaps. Start still running, by the time the still hit operating temps... the dough had set.. and no leaks. :)*

Jan Willem writes :

> *I made a still with a soup pan and a doughbowl, the seals I tried were;*
>
> 1. *rubber gasket - too stiff and smelly*
> 2. *silicone rubber tubing sliced open - well ok sort off, not perfect*

3. *silicone gasket or as the packing say's Form-A-Gasket no.6 I aplied it as a thin stripe and let it dry. Now i placed the dough bowl on it and fastened it (check my website I don't know exactly how to describe my contraption) Its been opened and closed now for about 15 times and still ok. And when its damaged easy repair or exchange with a new layer. Oh the manufacterer is Loctite and its called Blue Silicone RTV Catalog number 18869 and is also sold in europe*

Gateswood Quarterhorses confirms this as suitable;

> *High-temp RTV is stable to 650° F. (intermittent) and resistant to most shop fluids. I assume this could include alcohol. It is also pressure resistant. Not recommended for contact with gasoline but I've had no problems with diesel fuel.*
>
> *I would think that after it has fully cured it would be safe and effective for patching a still.*

Rob van Leuven writes :

> *I have used a so-called aquarium grade silicon; after it has cured completely and the vessel (or fishtank) has been rinsed with water a couple of times, it does not release any chemicals. If it did, it would kill the fish immediately, because they are especially susceptable to chemical pollution (especially sea fish). The sealant/adhesive is resistant to temperatures up to 150 Celsius and inert to most solvents, acids etc...*
>
> *If you want to make a removable gasket, you can squeeze a large blob of sealant between two panels of melamine faced chipboard which you have previously covered in dishwashing detergent (fairy liquid). Don't forget to separate the two panels with spacers which have the same thickness you want the gasket to have. After it has cured completely you can cut out the right shape with a sharp knife; put the gasket in boiling water for a while to remove any residues and you have a longlife silicon rubber gasket! Necessity is the mother of invention as the Irish say:)*

Harry advises:

> *The trick is to use non-acetic cure silicone. IOW, if it smells like vinegar when it's curing, it's no good. RTV (i.e. (R)oom (T) emperature (V)ulcanizing silicone works fine. I use Selley's Roof & Gutter Sealant*

> *(look it up). The last seal I made for my copper boiler was nearly 3 years ago now, and it's still working fine. YMMV.*

How to connect the column to the pot lid ? Scott writes ...

> ***use a sink strainer.*** *Mine is nickle plated bronze that goes for $10 here in the US. It has two thread diameters. The larger one is screwed into a hole in my lid that I cut and rounded with a Dremel (this takes a bit of patience). An added bonus is that the strainer has crosshairs that keep the packing out of the pot. The smaller diameter screws into a female, 1.5 in. copper fitting that costs about $4. An inert rubber gasket or aquarium grade silicone provides the seal. I used a beer mini-keg gasket that cost me $1. I also use a bit of PTFE tape on the thread just to be safe, and this cost me $1.*
>
> *The boiler is a 20 quart, el cheapo s.s. stock pot that I got for $14 at "McFrugals" here in California. Because it's thin steel, I use pipe insulation tape that runs for $5.*
>
> *So, the total cost, minus the Dremel, was $35 US for the strainer, pot, gasket, PTFE tape, copper fitting, and pipe thread.*

Using a Keg

See Build a World Class Distillation Apparatus for detailed instructions on using a keg.

In the photos section, you might have seen the pictures of Rays Keg still. Here's how he did it ...

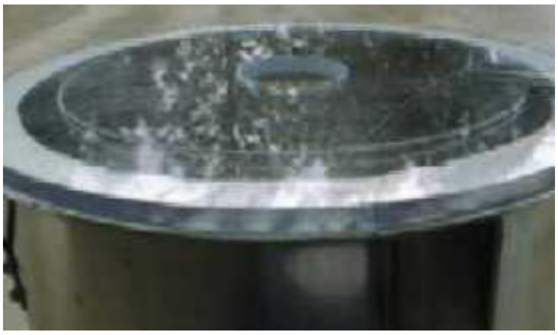
> *I cut the hole out with a friend's plasma torch. I make a fixture using the top piece of the original valve (see the large ring) which fits perfect into the opening. Next, I used a brass nipple, cut it, and turned the inside diameter to match he plasma torch tip. I silver soldered it together using welding rod bent to match the radius of the keg. Kind of a kluge, but it worked well. Here are some pictures of it with the cut out piece.*

At first I had leak problems because the hole I cut into the keg was so close to the seal, it had to be centered exactly, or it leaked. Using the same seal, I cut a polycarbonate disk and placed it against the seal, added a gasket and it worked fine. Leaving a flat surface for the seal, and the keg convex top cant miss the gasket. The gasket width gave me a lot more flexibility with centering to the hole. You can see the line around the opening, the original seal locates inside the line.

Next, I built another lid (untried as of yet) but cut a .5" wide, .075 deep grove around radius, which will center on the keg opening and filled it with RTV. It should be reusable several times, and it fits really nice. The first pix shows the 2-15 degree angles on the copper disk edge, that really helps keep the seal (black) in place. I use a brass pin in the bottom of the column to hold the packing in place, easy to remove so the polycarbonate disk can be slid on.



While I was making plastic circles and a big mess in the garage I cut this one to fit a stainless pot with a flat edge. I used a paper gasket, and lots of clamps to hold it down, that's how I got the mini model (see the photos page). This looks lots simpler without clamps.

> *And, last but not least, (while I was continuing the mess in the garage) I made a smaller disk and put a hole in it to match a carboy. Now, the standard fermentation lock and cork will fit, and I can use the keg for a ferment container. Still working on a good wort recipe, after that I'll try this setup. The brown protective paper is still attached, that gets removed.*

Thomas suggests ...

> *Another way to attach the column after the ball valve spear is removed is to use a 2" tri clamp. A 2" tri clamp fits perfectly around the lip on top of the keg fitting and clamps the column onto the keg tight. Granted its not as easy to clean (i have a ball valve on the bottom side) but sure is easier than building that top assemble.*

Cleaning Glass

Mecakyrios writes...

> *...[for] jugs and bottles that have stubborn residue in them ..what I do is to take a length of galvanized chain -- smaller than the diameter of the bottle opening, and longer then the height of the bottle -- and attach to the fishing line, which in turn is attached to a spare cork.*
>
> *I used to mix a solution of baking soda and water, but now I use a product available in the States known a Oxiclean (http://www.oxiclean.com/ABOUT.HTML) and water. I pour this into the bottle and drop the chain in the bottle as well. I place my hand over the bottle opening to prevent the cleaning solution from coming out and to keep the fishing line in place (the cork is out side of the bottle -- the cork is for easy removal of the chain/fishing*

line). I then shake, swish, and swirl the bottle making sure to get every inside surface as best as I can. Then I remove the chain/fishing line, and pour out the cleaning solution. I then sterilize the bottle with a bleach/water solution, and store upside down until I need it.

I have found that my chain method works better -- for me -- than the gravel method that is sometimes recommended. If the bottle is still dirty after cleaning in this fashion, your best bet is to not use the bottle, as nothing will -- to my knowledge -- effectively clean the bottle.

For normal bottles and small jugs that need regular cleaning, I just use the dishwasher. What I do is invert the bottles and jugs so that their openings are toward the bottom of the dishwasher.

In my dishwasher (and I assume most have this) there are two places that you can place dishwasher detergent -- one regular "cup" that holds the detergent for regular loads, and a smaller cup to hold extra detergent for dirty loads. In my dishwasher The smaller cup empties first and then later in the cycle the regular "cup" is used.

Instead of using dishwasher detergent, I fill the smaller cup up with Oxiclean (www.oxiclean.com), and I leave the regular load "cup" empty (If you don't have Oxiclean, just leave everything empty and run the load with just water). So, what happens is when the load starts the small cup empties the Oxiclean into the wash and gives them a hot bath with Oxiclean. Then the regular cycle kicks in -- without detergent or Oxiclean -- and rinses the bottles with clean HOT water.

Pot Scourers / Scouring Pads

Make sure that your scouring pads are stainless steel or copper. Otherwise they are likely to rust. Some of the cheaper ones might be galvanised steel, and may soon break down. Stainless should be shiny whilst the galvanised is grey in appearance.

If you have found a source of pot scourers/scrubbing pads, but are unsure of how they will perform, Patrick has a simple test ..

> *.. I soaked one in salt water (sea salt) and left it out in the elements for about 2 weeks. No tarnishing or rust.*

Some suggested online sources of scourers include ..

- http://www.cjms.com/easonr/scotstainste.html
- http://www.reckittprofessional.com/find_a_product/products/chore_boy.html
- http://www.cookscorner.com/

Control Systems

Peter summarised the two alternative methods of control required..

> *When you have a reflux cooler on top of a packed column inside, you have to regulate the small flowrate of the reflux cooling water system, to get constantly 94 % alcohol during the whole proces. The flowrate is regulated by the column top temperature.*
>
> *When you have a reflux cooler on top of a packed column outside, you have to regulate the flowrate of the reflux-distillate back into the packed colunm, to get constantly 94 % alcohol during the whole proces. The flowrate is regulated by the column top temperature.*

I haven't yet found the need for elaborate control systems to regulate the heat input or flow of cooling water etc. I believe that you first ensure that the fundamental design is correct, matching the rate of cooling (and reflux produced) to the heat input; once this is in balance the still should really look after itself. Just set the cooling water flowrate, and check it every half hour or so (remember the cardinal rule of never running a still unattended !!)

I think the best solution is that suggested by Robert ...

> *.. What I have found works for me, is a temperature gauge in the boiler; this allows me to see how much alcohol is in the wash. Install a $30 digital thermometer with alarm from Jaycar Electronics in the head (See Below link). This allows me to preset this alarm, so that I can surf the net while the still is in action and when the alarm rings, I go out and adjust the reflux ratio down some more. At the end of the run the alarm will advise me when to start collecting the tails.*
>
> *http://www1.jaycar.com.au/ Indoor / Outdoor Thermometer with Memory & Alarm Cat. No: QM7212 you could also try Dick Smith or Tandy if Jaycar is not in proximity to you or not to your liking.*

Brian adds ...

> *.. Jayco part number QM7212. I don't think they stock it any more. They do have a thermometer module with alarm part number XC0224 Price $39.50 Dick Smith do not stock a thermometer with an alarm.*

Probably what is of benefit to the lay distiller however is the control over the gross heat input. Given the long time it takes to first get the wash up to distilling temperature, there is some benifit in having a variable power input - so you can give it heaps to get it up to temperature, but then back off the power once you're distilling. Two ways of doing this;

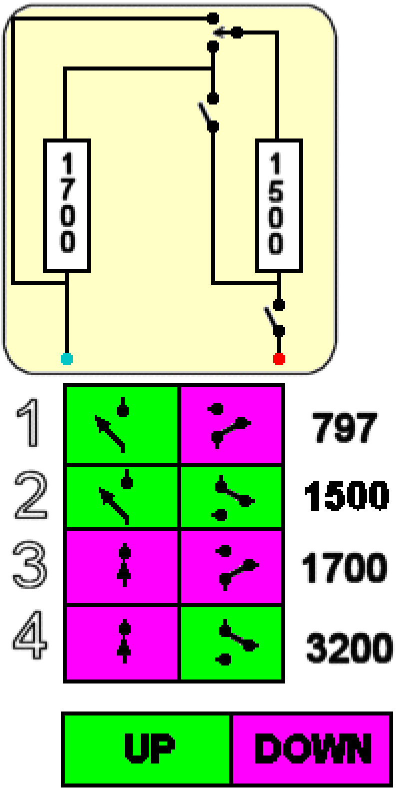
1. Have two elements - one large, one small. Use both to heat up to temperature, then only have the smaller one on while distilling. Or
2. Use a single large element with a variable control on it.

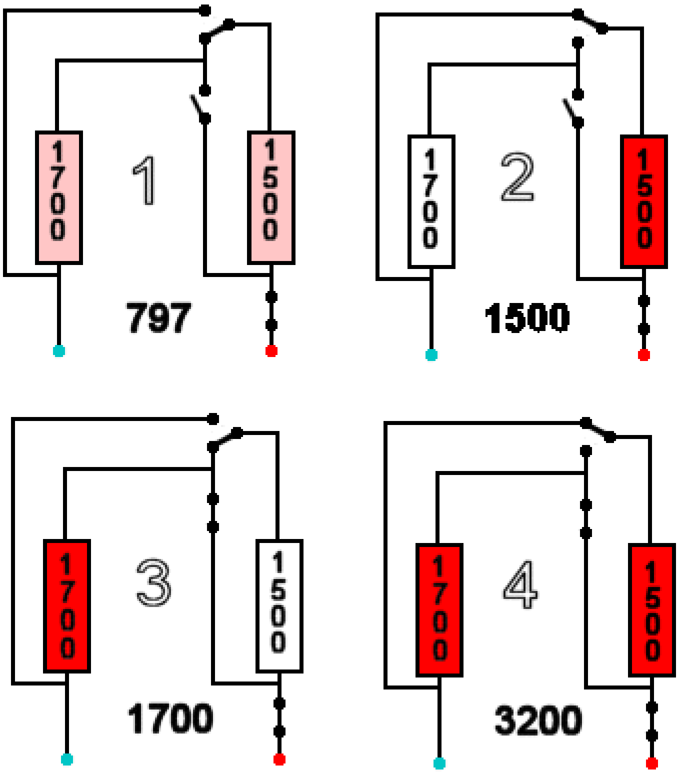
Others find control systems however to be of benefit, and enjoy the challenge of designing & tuning them. So here's their side of things.

Mike offers a simple way of getting variable heat input from just two elements, and a couple of switches :

> *For elements W1 and W2, the relationship is:*
> *1. Wmin = W1.W2 / (W1 + W2)*
> *2. Wa = W1*
> *3. Wb = W2*
> *4. Wmax = (W1 + W2)*
>
> *Be careful to rate the switches correctly. I = TWICE Wmax / V (twice the actual maximum current is good engineering practice) Taking the maximum wattage (in this case 3200W) this means Imax = 13.4 amp at 240V or 26.8 amp at 120V so get switches that can handle 30 amp (240V) or 60 amp (120V)*
>
> *Implicit in this diagram is that the main power switch at the bottom incorporates a suitable quick-blow FUSE and, preferably, a neon to show when it is closed. Also implicit is that the element casings and the boiler are connected to a good EARTH.*
>
> *TRIPLE CHECK that all connections are correct before connecting to mains power! Test first with a dry-cell battery and small lamp bulbs in place of the elements.*
>
> *DISCLAIMER!!!!! I accept no responsibility whatsoever for anyone screwing up and electrocuting themselves, their stills blowing up and burning their house down, floods, pestilence, war, lightning strikes, or any*

> *other act that the capricious gods of distillation may visit upon any hapless distiller using this circuit.*





Mike explains the difference between triac and transformers/variacs, and thyristor/triac circuits

> *If you move a wire through a magnetic field then a voltage will be induced in it, its size and direction depending on how fast you move it and in what direction. The same thing occurs if you move the magnetic field and keep the wire still. A transformer works on the principle that when you apply an alternating voltage to a coil of wire, then it generates a magnetic field that varies and changes in direction with the applied voltage. If this changing field passes through another coil of wire, then a voltage will be induced in it, and its direction will change with the magnetic field, so it will be an alternating voltage. If you make sure that the coils are coupled closely, usually by winding them on a common ferromagnetic core so that all the magnetic field generated by the first coil (the primary) intersects the second coil (the secondary), then the voltage generated in the secondary will be in direct proportion to the number of turns in the two*

coils. For example, if the primary has 100 turns and the secondary has 50 turns, then the voltages will be in that same ratio: Vs / Vp = 50 / 100, so the secondary voltage will be half the imposed primary voltage.

A fixed multi-voltage transformer has one primary coil and several secondary coils, all with the number of turns needed to produce the required secondary voltages. A variac has one primary coil and one secondary coil, and the number of 'effective' turns on the secondary is varied by means of a sliding contact that 'taps' the secondary coil along its length. By this means, you can control the output voltage in tiny steps, each equivalent to one turn.

The important thing to remember with transformers is that the output voltage waveform looks exactly like the input voltage waveform, varying only in amplitude. It is therefore a 'smooth' voltage.

If you want to be precise (and confused), the secondary waveform also lags behind the primary waveform depending on the loading ... the lag increasing as the current load increases, and how inductive the coil is. This is what they are talking about with 'power factors' of motors, as the motor's spinning coil not only acts like a secondary coil in terms of extracting mechanical energy from the imposed primary field of the static coil, but also acts as if it's the primary of a transformer with the static coil of the motor as the secondary. The main supply therefore has a generated voltage 'reflected' back into it which is out of phase with it, and this can adversely affect the power supply if not compensated for. Luckily for you, as you will be dealing with a stationary load (a heating element), you can forget all that garbage! :-))

A thyristor is essentially a diode that passes current in only one direction. However, if you apply a brief 'trigger' voltage to a terminal called the 'gate' during the time that the thyristor is blocking current flow, then the blocking effect will be turned off until the applied voltage falls to zero. So a thyristor will always pass full current in one direction (forward bias), but can be switched from zero to full current in the other direction (reverse bias) at any time you choose. You can apply a steady 'trigger' voltage and have the thyristor act like an ordinary piece of wire, passing current both ways all the time, or remove that 'trigger' voltage and have it act like an ordinary diode. Alternatively, you can get cunning *and apply the 'trigger' at the same time during each reverse bias cycle and have the thyristor switch off its diode blocking action at the same time during each cycle. As you would then be switching the thyristor in time with the phase of the applied voltage, this is called 'phase control'.*

When you trigger the thyristor in the middle of a reverse bias cycle, then you get an almost instantaneous jump in the output voltage from zero to whatever the applied voltage is at the time. This very sharp 'ramp' generates high frequency 'harmonics' that can be so high as to reach radio frequencies. When this happens, your neighbours start swearing as their radio and TV start to be swamped with your 'jamming station'. This can be controlled with appropriate circuits that absorb and damp high frequency currents.

A triac is essentially two thyristors wired in series, but pointing in opposite directions. When the applied voltage is in one direction, one thyristor can pass current, but the other can't, and vice versa, so no current flows. They have a common 'gate', so you can control both at the same time. Apply a steady 'trigger' voltage to this 'gate', and current will flow freely back and forth all the time. Apply the trigger regularly at the same time each forward cycle, and you have got a device that acts like a single thyristor. Apply that 'trigger' voltage at the same time each forward AND reverse cycle, and you have control over the full cycle of the imposed supply voltage, both forwards and backwards, and you have in effect doubled your efficiency. It is also possible to design circuits that trigger at one point in the forward cycle and another in the reverse cycle, but that is getting into the realms of sophisticated applications such as radar pulse control.

So there you have the essential difference between transformers/variacs, which produce smoothly varying sinusoidal voltage outputs (and so need no EM suppression), and thyristor/triac circuits which produce 'sinusoidally challenged' outputs that have bits chopped off the sides of their waveform, so they end up looking like the teeth of a saw (and can radiate like mad is not firmly squelched).

Pilch writes ..

> *A 10 amp motor speed controller can do the job. For those in Australia who want one "off-the-shelf" and not in a kit form, contact Ian at "Likker 'n' Leather" - email: pilch@tpg.com.au If you are not an electronics guru its a good price for one fully assembled.*

Tony writes ..

> *I figured that by not exiting the unwanted parts of the mash, one have a better chance of getting cleaner alcohol. This is how I went about it. knowing that we are only interested in alcohol, one must keep the mash temp constant below 84 C. I achieved this by using a triac voltage control set at (in my case) 90 volts. Initially I start at 240 volts to bring the mash to 84c, I installed a thermostat at the very bottom of the column.when this temp is reached. A simple electronic device incorporation a relay switches on the triac device changing the voltage from 240 to 90volts. This works extremely well. If one plays with the voltage one can find the balancing point for their particular still. As a certain amount of alcohol will come out during the procedure, to improve the reflux and the temp stability of the mash I employed an s bend right near the top reflux control with a constant water drip to replace the alcohol that is coming out. I found this works very well.*

Brian writes ...

> *I was very interested to read about what you call Triac Controllers over there. I thought you may be interested in going to a U.K. website called http://www.sutronics.com. They sell little gadgets there called Burst Fire Modules. One's a miniture circuit board that all you have to do is hang a 100k linear potentiometer, heatsink & triac on & it'll drive a heater up to 4 kW with the right triac & heatsink on it of course. It's negative pole switching so there's no RFI from it either. The other module comes all complete except a suitable heatsink. All wiring diags available on site & the prices are quite friendly at £9 ish for the first one & about £25 ish for the second*

PID controllers

John wrote ...

> *Hello - for all you PID-disadvantaged; this off the web - http://hbd.org/kroyster/definition.html .. "a PID temperature controller does the same thing as Rodney Morris's temperature controller only better. It is a miniature computer the size of a small radar detector that*

> *takes a temperature reading of the wort via a thermocouple and adjusts the power to the heating element accordingly. Its sophisticated "brain" actually "learns" how your system reacts and uses calculus to determine how to boost your temperatures to your desired set point as fast as possible and then backs the power off as it gets close so as not to over shoot the set point temperature. So now I simply enter the set point temperature on the digital read out and it does the rest! "*

Mecakyrios advices ..

> *You can buy them from the same place that the article author bought his: http://www.omega.com/ppt/pptsc.asp?ref=CN8590&Nav=heap01*
>
> *Now, when you go to the web site, you will see many different options as to what you can purchase. This is where I recommend you to go to the originating web site of the article:http://hbd.org/kroyster/*
>
> *Once you get there, click on the link on the left hand side of the page that says "Design Details." This will take you to a page that explains his "Recirculating Infusion Mash System." If you scroll down toward the bottom of the "Design Details" page, you will find the author's details about how he used his unit. NOTE: the link that the author has on his web site to the manufacturer of his PID is not correct anymore. They, Omega, has re-arranged their web site a bit. The link that I have posted at the top is the corrected page.*

Tim wrote ..

> *"PID" is an acronym for "Proportional, Integral, Derivitive". This means the device uses calculus in its calculations. This also means that the device incorporates a microprocessor and operating software. So, to build one of these would be a SERIOUS project in and of itself. It would take HUNDREDS of hours to design, build and write the code for one of these. I've been building and programming microprocessor controlled devices for years - and I wouldn't attempt one of these.*
>
> *I use a controller from a company called "CAL Controls". I purchased one new several years ago for about $120. Two months ago I purchased the same model from a surplus place for $50. They're out there if you keep looking. I imagine that any temperature-type PID controller would do the job.*

..I use mine in a RIMS (that's another TLA... a three-letter-acronym ;-)) That means "Recirculating Infusion Mash System". When I do a mash for beer brewing, the PID controller monitors the mash temperature. The wort (same as the wash in distilling) is recirculated from the bottom of the mash tun, through a pump, past an in-line heating element, past the thermocouple, and back into the top of the mash tun. The controller has an "autotune" or "learn" mode. When this mode is activated, the controller turns on the heater full-blast for a short time. It then monitors the rate of temperature rise and the resulting temperature achieved in a specific amount of time. It then "knows" how your system behaves. That way it can turn on the heat to get a maximum temperature in the shortest amount of time, and then start turning the heater off and on (very quickly) to control the approach to the setpoint. This results in reaching the setpoint as quickly as possible, but not going over the setpoint. Then, when the temperature begins to drop (normal cooling of the system), the controller gives the heater just enough power to keep the temp where you want it. You should expect to be +/- 1 degree C from the setpoint. In a still, this means that when the alcohol is about gone and the temp starts to rise, your heater will turn off and the distillate will stop. It will, however keep the remaining wash at the setpoint, so some water vapor will still be condensing.

Check these out:

- *http://www.cal-controls.com/ look under "Temperature Controllers" - Mine is the 9900*
- *http://www.omega.com/ppt/pptsc.asp?ref=CN9000A&nav=temp03 I think Omega just re-sells CAL Controls' devices...*

Also - there is a "Manual Heat %" mode on these controllers that will allow you to set the heater power as a percentage anywhere from 1%-100%. This mode uses no thermocouple. So, if you have a 2KW heater, set it for 100% for heat-up, then crank it back to 50% (for 1KW) for the run. This would make far more sense than trying to control the vapor temp, 'cause it's going to boil at whatever temp the ethanol/water mix allows...

John then asked ..

> *the Cal website details the 9900 as having 9 thermocouple spots. Does that mean one can hook up this PDI with input from up to 9 thermocouples, spread all over the still?*

to which Tim answered ..

> *Nope - what that means is that the controller can accept input from 9 DIFFERENT KINDS of thermocouples. I.E. - J, K, T, R, S, etc. Each type has a different temp range (even though some types have overlapping - or even the same - temp range). Each type has different physical characteristics too. Some types are more corrosion-resistant than others. I use a type J.*
>
> *For a really good tutorial on thermocouples, go see: http://www.tinaja.com/glib/muse144.pdf (This web site is amazing! - go read everything there - you'll learn a lot!)*
>
> *The controller has only one thermocouple input. There are 2 outputs from the controller. One is relay contacts (slow operating), and one is the "contacts" of a solid-state-relay (SSR).The SSR is used to control a mash or still heater.*
>
> *.. I did some checking and found a web site where a guy built and programmed his own RIMS controller. However, it's not PID, but it probably would work if the code were changed some. He provides a schematic and the code to program a BASIC STAMP. Check it out here: http://chattanooga.net/~cdp/rims/rims_inf.htm*
>
> *Also do a search for "RIMS Controller" on a search engine. eBay has quite a few temperature controllers for sale.....*

Rob offers ...

- *http://www.rs-components.com.au/index.html for electronics, thermocouple and PID controls*
- *http://www.ascon.com.au/ for thermocouple and PID controls*

Roberts solution

> *I had the same problem with lowering my input power to the boiler because I didn't want to install a new element and had to work with a 2400W element. Variable transformers that can handle up to 8A are very*

> *expensive and triac controller would take longer than I wanted to build so I need to put a resistor in series with the Heating element. Unfortunately to cut down the wattage to about 1000W the resistor would need to be able to dissipate a similar amount of power.*
>
> *The idea came to use a stove element. By measuring the resistance in the stove element and adding it to the resistance of my 2400W heating element in the formula P=(I^2)*R and V=IR. I found I could cut the power in half, or in thirds, depending on what size stove element I used. (Stove elements are almost free in 2nd hand stores). So My problem was solved very quickly and VERY cheaply.*
>
> *Some warnings:*
> *a)This system makes it very easy to electrocute oneself, so electrical knowledge is ESSENTIAL. (It's only a simple circuit but it can kill very easily if stuffed up).*
> *b)The stoveplate gets very hot and needs to be in a spot where it can't get trodden on or have stuff dropped on it.*
> *c)The element needs to be in a ventilated area, any open space will do*
>
> *Apart from that it's all hunky dory, it's not pretty, or clean, and has a terrible power factor, but it works extremely well and can be made in 5 minutes.*
>
> *I hope you find that an original idea to a common problem. I have built a triac controller now, but in the beginning this was my original method.*

Andrews Microprocessor

Andrew writes ...

> *The still we are in the middle of building now has a 40l tea urn, a 1m tall reflux column (now packed with SS after reading your site), a peristaltic pump to control draw of rate and has a whole host of electronics hanging of it. The main things my controller will do is*
>
> 1. *Measure input and output temprature of cooling water, then adjust flow rate to keep a steady wattage of cooling.*
> 2. *Measure temprature of still head and Log the data (so you can later graph it on a computer to check that everything went OK.*
> 3. *Measure temprature of wash (and again log this).*

> 4. *Control a perstaltic pump to draw of the distilate at a controlled rate (like the ~~4mL per minute that Stone/Nixon suggest) instead of arseing around with a needle valve.*
> 5. *Control a moterised lazy-susan/conveyor belt that changes collection vessels at appropriat times.*
>
> *All this will be done by an itsy bitsy little microcontroller and the entire board should cost less than $150 for others to build. (it there is enough interest I can also make a run of them for others).*

Stay tuned here ...Andrew has offered to describe & detail it all, etc - a big thanks to him !!. Andrew also cautions about triac controllers ..

> *..may be hesitant about the triac controller is that in most places around the world it is now illegal to use triacs to angle fire loads above a few hundred watts. Angle firing large loads upsets the power factor significanlty.*

David

David Reid writes ...

> *You should use at least a constant load triac controller tied to a decent temperature sensor probe such as a thyristor otherwise you are wasting the advantage of a decent column design for start off.*
>
> *If you dont want to do that because you cant afford it or are too tight to spend the money at least go and rip a decent simmerstat out of a stove from an inorganic rubbish collection round and at least use that.*
>
> *You definitely need some type of control over the heating system. The chances of it being exactly spot on are almost negligible; it will more likely than not be too hot at times which means it needs turning down a bit. (Too cold and you could have done with a bigger element for a startoff but 750w should be adequate apart from bringing the mixture up to temp. Too hot and you are boiling the guts out of the mixture stuffing up the separations).*
>
> *Remember you get what you pay for.*
>
> *I use a solenoid valve to turn the water off and on and a manually adjusted needle valve to control the flow. Please note temperature at takeoff point is different to temperature in boiler, and can vary*

> *depending on still. This is a point where there is a bit of disagreement over location of sensors. Some people argue that because you want to control the temperature in the boiler which is what controls most of the other temperatures in the column etc that this is where you need the sensor and work from that point. To a degree they are right. I and most people who know what they are doing adopt a slightly different attitude knowing that the most critical temperature point in any still is at the takeoff or condensation point. I therefore mount the critical sensor there working backwards using insulation and other aspects of the design process to minimise the differences between temperature at this point and the boiler. The ideal situation is where you have 2 or 3 sensors each monitoring different points but then the controls and the monitoring situation become a lot more involved.*
>
> *The temp sensor must not touch the cooling coils. You need to measure the vapour temp at this point. Please note that water vaporised expands to something like 1500 times the volume. Location and depth of sensor is critical. So many of the people designing stills dont have the first clue and there is so much false information out there. Before going further and designing a controller that might work go out and research the subject properly and read a few decent books. Most of the people designing stills are too lazy or too arrogant to do even that. If you can see how someone else achieved a certain goal you can admire it or fault their thinking. Quite often you can even improve upon ther original concept. Firstly you need to separate the chaff from the wheat. That way you may design a controller that works. PIC controls certainly have their place and proper intergration of these in the stills of the future will be commonplace and is one of the better solutions available.*

Jan-Willem's Triac

Jan writes ...

> *When the power input is too much then everything is going ballistic. There must be a sort of relationship between power input, boiler volume and cooling capacity. So if you start of with a nice soft boil then that thing is covered. With gas its easy (?) to turn it up or down, with electricity its somewhat more difficult.*
>
> *I don't know if you can build it yourself, if you do on my site is a very simple triac controller, and that one can do 2.5 kW. Its a very basic*

> *straightforward controller. I experimented with a proportional controller with temperature feedback but that was a bit overkill in my opinion. But than again i don't run a MEGASTILL with continuous output etc etc Its just hobby and when its running I am VERY nearby...*
>
> *You can find my homepage (if my provider is still running) at http://home.planet.nl/~jwdob/ then go to distilling*

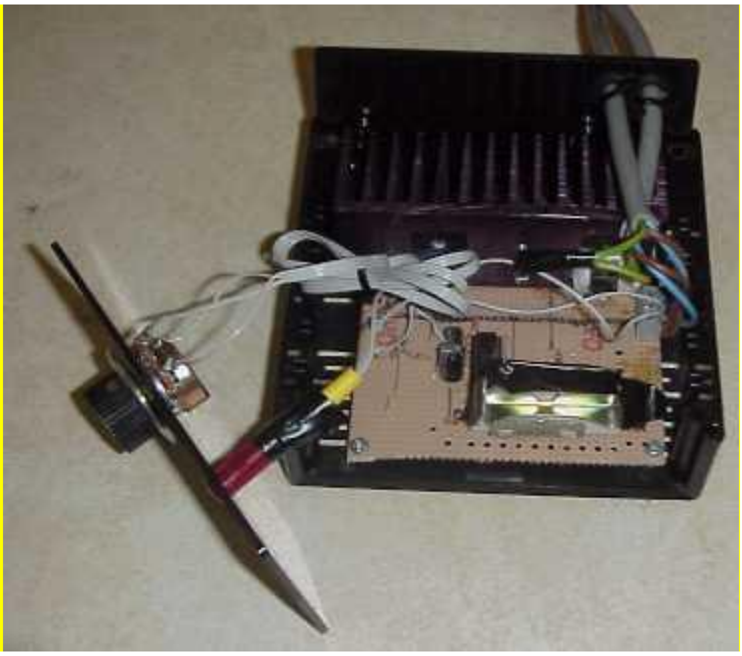
Ross's Time-clocks

Ross uses time-clocks to help with the long distillation times involved with operating a high-puirity Nixon/Stone still ...

> *I have both my units gravity fed from a 200lt drum upstairs on the veranda. Using the 10 odd metres of cooling coil I find that a flow of 250 mls/min is sufficient. My problem is I'm on tank water and the pressure pump downstairs under my bedroom, would cut in every 30mins and keep waking me up :((*
>
> *Now I have a solenoid water valve on a time clock which refills the 200lt drum every 12 hours. This is kinder on me and the pump. Running time clocks and solenoids on the both stills, I can start the stills at 1am and the SS unit has dropped about 6-7lts of 60-70% impure and [my still] has just equilibrated nicely by 7 am. The whole system is very user friendly.*
>
> *It is a little early to get accurate times yet, but 5lts of water (to cover element) and 20lts of 60-70% impure takes about 48-50 hours before the temp rises above 80C and I turn off*

Smithers Triac

Smithers (of http://go.to/distil), who is a electronic technician by trade, suggests the following ..



IMPORTANT : READ FIRST

DO NOT ATTEMPT TO BUILD THIS CIRCUIT UNLESS YOU ARE QUALIFIED OR EXPERIENCED WITH MAINS VOLTAGE. THIS CIRCUIT INVOLVES SWITCHING AN ELEMENT THAT CAN DRAW 10AMPS, IF YOU FUCK UP-THIS WILL KILL YOU. YOU CAN BUY CONTROLLERS LIKE THESE (COMMERCIAL) FROM ELECTRONIC SUPPLY SHOPS, BUT FUCK THEY'RE EXPENSIVE.

I ran with the I.C controlled (TDA1023) without using a temp probe. The specs on this (and application data) can be found at http://www-us2.semiconductors.philips.com/cgi-bin/pldb/pip/TDA1023#applications (or download it from me here (267 kB).

You will need to download the above PDF file (page 14,15) to understand what I am talking about below.

There were a few changes that I made for safety and to compensate for the 240V 10Amp supply that we have. They are as follows :

- *D1 1N4007*
- *RD 6.8Kohm 10W*
- *RS 180Kohm*
- *RG 110ohm (100 and a 10)*
- *Triac was a BT-139-800*

- *Heater (load) is a 1380 Watt element. In theory this circuit could handle 2.4KW*
- *Ct 1uF 63V*
- *Rntc I replaced this with a 22kohm resister as I didn't require temp feedback*
- *R1 18kohm*
- *pin 5 of TDA1023 goes to earth to give you 400mV range control*

I played around with resistors between pin 11 and Rp (40kohm) and also between Rp and Neutral (37kohm), this was only to trim the potentiometer into the range that I wanted.

I also placed a neon indicator across the load to give me a visual on when power was applied to the element

Cooling

The Triac requires a fair amount of cooling, I used a finned heatsink (100mm x 45mm x 45mm) this keeps it reletively cool, I also used plastic screws, heat compound and a mica washer to electricly insulate the triac from the heatsink.

The Resister RD dissipates approx 5W, so I advise that you heat sink this as well, this item does get fucking hot if you don't. Mount it all in a well ventilated preferrably plastic box

That is about all I have to say about that. It works really well and I have used it faultlessly for about 25 (6 hour) runs now. The neon indicator is a good idea and lets you know everything is working ok.

cheers
Smithers
http://go.to/distil

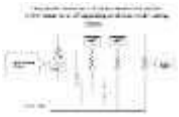
Andrews Temperature Control Circuit

Andrew Graham supplies details (diagram, parts list, and explanation) for how to build a cheap, simple temperature controller at http://www.shortcircuit.com.au/EVCA/tcc.htm.

Reimas controller

Reima writes

> *I used to run my old SS-beer barrel with a 0,6 kW immersion heater (the ones with a 1" BSP male thread on), then I burned it up and found that they are not made any more, so I decided to buy two 1,2 kW heaters and run them parallel connected to get up to temperature (2400W) and then switch them to series = twice the resistance and half the current = 0,6kW.*
>
> *Here in Queensland you do not need any more if you do not have a lake of your own for cooling water.*
>
> *I have also a teeny weeny 100W cartridge element in the barrel, this is hooked up to an ordinary dimmer switch, so this gives me 600 + (100W with stepless adjustment for fine tuning).*
>
> *PS. Dimmer switches can take up to 300W for fine adjustment-heater and would be better wintertime, but you take what you have ;-)*
>
> *See schematics below (click to enlarge).*



Neils phase angle controller

Neil writes ..

> *For people wishing to regulate power output of larger power elements (3-6kW) down to a lower power. Forget large rehostats, variacs etc. Use a 6kW phase angle controller. Search for them on RS components web site http://rswww.com you will need to find a local agent , or pull info off the attached file and find a local supplier*

Controlling Gas fired Boilers

Craig offers :

I have a gas (propane) fired boiler and control the heat input by measuring the discharge temperature of the condenser cooling water to get an estimate of the heat input to the boiler. The scheme that I use is as follows:

- *As the boiler is heating up and producing no vapor/steam, I establish a water flow rate through the condenser which is measure by timing the time it takes to fill a 500 ml graduated cylinder. I then convert it to L/min (example 500 ml in 35 sec = .5L/35 sec * 60 sec/min = .875 L/min) and plug that number into the "Flow" variable in my HP 48SX Scientific calculator. Also at this time, I measure the outlet water temperature of the condenser and because there is no heat input into the condenser the inlet temperature (Ti) is equal to the outlet temperature. I plug this temperature into the "Ti" variable in my calculator.*
- *When boiling starts, I cut back on the boiler heat input and from experience I shoot for a condenser outlet temperature say around 55° C. After the outlet temperature has stabilized, I enter this temperature into my calculator and run the program to determine the heat input to my condenser which should closely approximate the heat input to the boiler. While on total reflux, I adjust the boiler heat input to the desired Watts.*
- *I have an Omega digital thermometer with dual inputs. With one of the thermocouples I am able to monitor the head temperature; the other I use to monitor the condenser outlet temperature. Because the thermocouples are of a fine gage, I was able to make pin hole, about chest high, in the clear vinyl tubing (5/16" ID) and insert the thermocouple directly into the condenser outlet water flow stream. This arrangement helps me set and monitor the cooling water flow rate. I adjust the flow to a point where the thermocouple pin hole just quits sucking air into the cooling water flow stream. If flow increases the pin hole leaks water; if it decreases it sucks air.*

The calculator is programmed with the following equation:

$Q(watts)=Mr \times Cp \times (Ti-To)$

Ti = *Condenser Inlet Temperature °C*
To = *Condenser Outlet Temperature °C*
Mr = *Condenser H_2O Mass Flow Rate Kg/sec*
Cp = *4200 (Watts · sec)/(Kg · °C) – Specific Heat of H_2O @*

approximately 50 °C

The specific program for the HP 48SX calculator is:

Set up the variables "Watt", "Ti", and "Flow"
*Key in < < Ti-Flow*4200*60 / > > and store it in "Watt"*
Store the inlet temperature in "Ti"
Store the flow rate in "Flow"
Enter the outlet temperature into the display
Press the Watt's key to run the program
The watts should display

Note: The flow, even though measured as a volumetric rate, closely equates to a mass flow rate at the temperature ranges involved (1 Liter H_2O *~ 1 Kg* H_2O*)*

The First Run

Before you use a still for the first time, be it made or bought, make sure you have cleaned it well - get all the grease, solvents, polish residue etc off it.

To clean a new still, Ted advises :

- *For stainless steel use a 3% sodium hydroxide (called NaOH, lye or caustic soda) solution at 180 deg. F. Red Devil lye - 1 tablespoon for 2 liters of water works great...NaOH is basic old lye. You can get it at the drug store, the cheaper the better because many expensive brands like Drano have zinc in them to help raise the temp in the drain pipe.*
- *For copper use a 1.5 to 2% solution of mild acid (nitric, phosphoric, muratic, strong vinegar) at 150 deg. F.*

> *Use lots of hot water to rinse these chemicals out and you should have very clean surfaces.*

Zeke writes ...

> *A paste made of vinegar and equal parts baking soda and table salt applied to the copper for a few minutes will make it shine like a new penny.*

Peter writes ..

> *you can just sand down the weleded parts. If they are awkward you may need to use pickling paste or passivation paste, cheap but hard to find, go to a car garage (or welding place) they should have lots and probably give you it free*

Jack adds ..

> *Household vinegar works great as a cleaner/degreaser. Avoid bleach at all cost. It will etch the stainless steel, pit the surface, and ruin the finish. Trust me- I ruined a keg this way.*

George writes ...

> *if you have a drain on the bottem of your still you can back flush through your tower by hooking up a hose to your drain and then to a small pump with another hose to your cooling coil and back flush the whole thing, or just to the top of your tower. I run a good boiling mix of boiling water and a 1 cup of tub mate through the whole thing. Tub mate is a high alkaline low foaming all purpose cleaner put out by hotsy Detergents it works extremely well removing grease and oil. Its safe to use on copper, brass and*

> *stainless steel. After I run this through for about 10 to 20 minutes after which I back flush boiling water for a little while to make sure that all the cleaner is out. I check for cleaness by distilling water through the system.*

Russ writes ..

> *Formic acid is just excellent for cleaning out the pipes. Dilute some with boiling water and let the pipe soal for about 30 mins. THis stuff will eat everything from limescale to general nastiness and leave things looking like new. Give it a really thorough rinse through and there you go. You can by the acid from a plumbers merchant. I also use it for my boiler - works really well*

The first run should be a water-only occasion. Put enough water in it to prevent it boiling dry, and let it rip. The steam will :

- help remove any remaining dirt/grease etc,
- give the expansion fittings a try-out (does everything still fit well once its hot/expanded/softened ?), and
- is a safe way of finding leaks.

If you have used stainless steel scrubbing pads as the column packing, you will probably need to first boil these up in some water by themselves, to remove any residue left over on them when they were machined (or else you'll get a nasty taint to the flavours).

Water only is good for checking if it leaks, seeing how long it takes to get up to temperature, and cleaning out any dirt or oils etc left over from construction. It also lets you check that your final condenser is efficient enough to fully condense all the energy that you're putting its way.

But it can't be used for "practicing" distilling. With water only, reflux is meaningless, as there is no second component there to enrich or strip. It will only put out a vapour in the high 90's (depending on altitude, thermometers etc) and nothing will change the way it runs.

As a practice run, add some cheap alcohol - eg old beer or wine etc to the water and see what happens. The more alcohol present the more marked the change will be. You should notice that the head temperature is quite a bit cooler initially, slowly increasing as you run out of alcohol. You may even have enough there to try seeing what different reflux ratio's do. You'll notice too that the flow rate of distillate will be greater than that during the water only run, as it is easier to vaporise alcohol than water.

Then its time to do the real thing. Make up just a cheap sugar-water wash, ferment it out fully, let it settle, then decant into the still. Make sure that you leave about 1/4 of the still empty as headspace at the top for foam, bubbles, splashing etc. Bring the still up to boiling temp, and try it with as much reflux occurring as possible. You may want to change the plumbing on your cooling, so that you can alter the flowrate in the "through tubes" independently of the main condenser.

Ideally you'd want to start your column off under total reflux. That lets you concentrate up any impurities (foreshots) and remove them first. With your design, total reflux may not be possible, and you may just need to settle for as much as you can. Find out how much that is. You'll notice that the temperature should stabilise around 78-low 80's. As you decrease the reflux this will rise. Take this first run as an experiment - don't worry too much about the quality that you collect at. Instead, use it to see the relationship between the cooling water flowrate, the amount of reflux it causes (how much does the output slow by?), and the resulting purity. Try it with no reflux, and compare the difference. Listen to the sounds its makes - often you'll pick up changes by ear - gurgling , hissing, thumping etc . Try a whole range of different conditions and learn what your stills response is. Measure the distillate flowrate under these different conditions. What's the corresponding change in head temperature (and purity) Remove the column insulation and note any changes that occur to quality. Learn how long it takes the head of the column to re-equilibriate after you make a change to the reflux - some take quite a while and shouldn't be fiddled with in the meantime. How touchy are the control valves ? As the boiler starts running out of alcohol, see how much more reflux you now require to get that same purity that was so much easier at the start of the run.

On those first runs, really play around and learn your still. Keep all the distillate you collect. Even if its got some nasty heads or tails in there, its simply a matter of redistilling it at a later date, and it will clean up nicely. No point ever throwing good alcohol away.

John advises ...

> *you should not expect to produce palatable drink the first few times that you power up your new still. You will have to get used to temperature variations, cooling rates, etc., and that just takes a little time.*

I suggest that when you are ready to roll, begin with a couple liters of water - that will show you how long you need to heat up to around 79oC, which will become your distilling temp. But with the water in your kettle, just let it go on its own - fiddle with the cooling rates, etc.

The second run - I repeated the couple quarts of water but added a bottle of the cheapest wine I could buy at the store, and ran that. Now you will be in alcohol distilling territory, and you can observe the way the boiling rate really runs on its own, and what it does at around 78 or 79oC.

Third run - run 4 quarts, and this time as much old or whatever wine of any kind. I had some fermented apple juice so I added that in. This is just to get more experience.

Fourth run - a sugar wash.

Finding Leaks

Do not use your still until you are sure it is leak-free & clean.

Other ways of finding leaks are to :

- completely fill it with water (to the top of the top), or
- fully immerse it (if small enough) in a bucket of water, and look for air bubbles

Once you have spotted them, mark them with a water-proof permenent marker, so you can find them again later.

Equipment

My recomendation: contact Rick at Brewhaus

Here's a brief description of the basic equipment you will need for doing basic distillation. If you can't find it locally in a homebrew or winemaking shop, try contacting the commercial suppliers in New Zealand like Spirits Unlimited, or Brewhaus in the States. See my links page for more listings. International postage is quite cheap these days, and you should a good rate against the NZ dollar (approx NZ$2 = US$1 at present).

New ! - see the list of Suppliers at the bottom of this page.

Thermometer

You will need several thermometers. One for the fermenter, and one for the still.

The one on the fermenter doesn't need to be too accurate; it's only a guideline. It should show between about 10 C and 40 C. I simply use one of those stick-on types as used on tropical fishtanks (about NZ$5). Using a thermometer with the fermenter means you can keep your yeast happy - keep it in its ideal range; without one you may get it too cold (yeast goes dormant and you'll be waiting forever), or too hot (yeast dies).

You want a reasonably good thermometer for the head of the still - say from 40 C to 105 C. Mine cost NZ$15. The longer the thermometer, with the more space between the markings, the more accurate it will be. You can always check its accuracy - an ice/water slurry should give 0 C, and boiling water 100 C (at sea-level). If it is out by more than a couple of degrees, adjust your reading accordingly, or get a replacement. Using a thermometer to track the vapour temperature at the head of the still will allow you to know how the purity of the run is going, and when the tails are starting to come over (when the temperature starts to increase at the end of the run).

I've just bought a cheap digital thermometer from "Dick Smith Electronics" (http://www.dse.co.nz) (sorta like RadioShack ?) for NZ$28. Really accurate (to within 0.1 &degC), and battery life of 1500 hours. It has a 4 inch stem on it. Highly recommend it.

Tom recommends

> *I just bought a new digital thermometer and it is great. It is a Taylor 9878 Digital Pocket Thermometer. It cost @$25 US, it is accurate to less then +/-1.5, reads in either C or F, has a wide -50 to 260 C (-58 to 500 F) temp. range, can be recalibrated, has a 5" stainless steel probe, easy to read face, and received an A+ mark from Cuisine Magazine at http://www.cuisinemagazine.com but don't take my word for it check it out yourself. I bought mine from http://www.knifemerchant.com but they don't have a picture. A picture can be found at http://www.benmeadows.com/ and it can be purchased there as well.*

Hydrometer

Again, you will need two of these; one for the wort, and one for the spirit. Each is about NZ$15. These work by measuring the density of the liquid. If the liquid is dense (eg water with sugar in it), they will float up high in the liquid; if the density is low (eg half the liquid is alcohol), they will float lower in the liquid. Its that prinicple of Archimedese' which got him running naked through the street, etc.

Why two of them ? The one for the wash is the standard hydrometer used by beer or wine-makers, good for specific gravities of 1.100 to about 0.970. You use this to work out how far the wash has fermented, and therefore how much alcohol you have in the wash. The one for the spirit is made for much lighter specific gravities. It is usually made with the scale reading between 0 and 100% alcohol, so it saves you having to do any maths. This is the one that is pretty important. It takes all the guesswork out of the distilling. Measure the % purity as you go, and you'll be fully confident that you've got a good product. None of this sniffing/shaking/holding a bead business.

Hydrometers are designed for use at a particular temperature. If the liquid is hotter (or colder) it will give a false reading. There is usually a conversion table supplied with them to help correct readings by. The instructions which came with my hydrometer advise the following corrections to the final specific gravity reading ...

Temperature Correction

10 &degC	-0.002
15 &degC	-0.001
20 &degC	none
25 &degC	+0.001
30 &degC	+0.003
35 &degC	+0.004

Fermenter

This is just a clean bucket or tub or barrel. Just go to a homebrew-beer shop, and buy a ready made beer-fermentor kit (about NZ$50). See - two hobbies in one - you also get the opportunity to learn how to make decent beer for yourself, at about 50c a bottle.

The fermenter has to be able to be easily cleaned and sterilised. It should have a good lid on it to keep out dust and bugs, and also an airlock. The airlock is usually about NZ$2, and is a "S" shaped bit of tubing that holds some water in it - outgoing gases can bubble out through the liquid, but nothing tends to find its way in. A simple alternative is to just run a tube from the top of the fermentor, ending in a jar half filled with water. Why the airlock ? Once the yeast is off and running, you want there to be no oxygen in the system, or else the yeast will forget about making alcohol, and just make more yeast. So don't have it breezy. But you don't want it airtight, or else the carbon dioxide (CO_2) made by the yeast will build up in pressure and blow the lid off. You also want a tap near the base of the fermentor, so that you can easily run off the wash once it has finished fermenting. Mine has a wee do-hiky on the inside of the tap, which is basically a wee bit of slotted tube. This causes it to suck from the top side, and not draw in any of the yeast which has settled down below the tap.

You also need to be able to keep the fermentor warm. You can use immersion heaters, or have heating elements or pads on the outside of it (warp around, or sit it on them). You may also want to have some form of stirring in there too.

Still

See the pages Purchasing a Still and **Making a Still**. The bought ones range from about NZ$100 second hand / NZ$300 new to NZ$700 ??

Economics

That's really about all you need. You should be able to set up for around NZ$400-500. Now that you're making your liquor for about $1 alcohol + $5 flavour, you are saving about $20 a bottle. This means you'll have it paid off after about your 25th bottle. How long is that going to take you ?

Miscellaneous

There are a number of further gadgets you can also buy ... wall mounted carbon filtering systems, water purifiers, measuring spoons, oaks, essences, casks, etc, but you only do these as you feel inclined .

Suppliers

(note that the comments aren't mine, but those of their customers)

Contact Info	Supply
New Zealand	
The Brewers Barn - Pete Sayers 291 Dee St, Invercargill, NZ ph/Fax +64-3-214-1202 email : brubarn@xtra.co.nz	Stills & accessories, yeasts, carbon, essences. Winemaking & brewing supplies too.
Gary Gluyas Professional Business Systems Ltd **Mill-Ford Lodge Homebrew Shop** - Gary Gluyas 125 - 127 Allens Rd, Allenton,Ashburton Web : http://www.pbsltd.co.nz email : gluyas@pbsltd.co.nz Phone +64-3-308-7519 Fax +64-3-308-7517	Winemaking & distilling supplies and equipment. World-wide mail order service.
Spirits Unlimited - Malcom Willmot Glamorgan St, Moeraki, RD 2, Palmerston, East Otago, NZ ph/fax 64-3-439-4688 Web : http://www.spiritsunlimited.co.nz/ email : spirits.unlimited@xtra.co.nz	Stills & accessories, yeasts, carbon, essences. World-wide mail order service
Moonshine Supplies - Ray Toms PO Box 1094, Taupo, New Zealand Web : http://moonshine.co.nz/ email : ray@moonshine.co.nz	Stills & accessories, yeasts, carbon, essences.
Australia	

Grumpys Brewhaus 115 Mt Barker Rd, Verdun SA 5154 Ph +61-8-8188-1133 Fx: +61-8-8188-1190 Web : http://www.grumpys.com.au email : info@grumpys.com	Yeast, Essences, Carbon, Equipment.
Eureka Home Brew and Gifts - Sue 1/3 Ungrer Street, North Mackay, Queensland. ph 49533829 email : watjamie@bigpond.com.au	?
Canada	
Brewhaus (Canada). Calgary, AB Telephone: 1-888-388-9463 Fax: (403) 201-9815 http://www.brewhaus.ca/ email : mail@brewhaus.ca Canadian distributor for Brewhaus (America) Inc. Distribution / wholesale / retail.	yeasts, distilling supplies, carbons, essences (Gert Strand products)
North America	
Brewhaus (America) Inc.. Fort Worth, TX Telephone: 817-271-8041 http://www.brewhaus.com email : info@brewhaus.com North American importer and distributor for Gert Strand. Manufacturer of the Essential Extractor (our stainless reflux still). Sell to wholesalers, retailers, and at a mail order level.	stills, yeasts, distilling supplies, carbons, essences
Mile High Distilling web: http://www.milehidistilling.com Mike builds and sells high quality stainless steel distillers, and also sell all the distilling supplies such as yeast, essences, activated carbons, etc.	
BrewSupplies.com Web : http://brewsupplies.com I have used this one for many things. They are quick and courteous. They ship UPS or USPS if the rate is cheaper. They accept credit card and other online payment methods. They are informative as to your order. You get a confirmation by email when it is recieved, when it is filled by warehouse people, when it is shipped, and also the UPS shipping confirmation and tracking service. I am happy with them. I have bought malted grains, regular grains, (they grind and crack for free) gypsum, acids, PH papers, enzymes, glass test equipment, fermenting buckets (from 5 to 50 gallon), corks, rubber stoppers, airlocks ..... ect ect they also have a large selection of downloadable brewing and fermenting software. much more there than I can list here in a few words. They have a "specials" section. You can search the site for what you need if you cant locate it thru their drop down menus... I just bought a refractometer from them. $114. What a cool instrument!	Brewing supplies & equipment.
Indigo Instruments Web : Lab glassware They give volume discounts. If you buy a box or case of the item, then the price is roughly half. They ship more than the ordered count to make sure broken in shipment is replaced. **** Buy quality, no frills science educational supplies on- line 100% Uncompromised Privacy, Secure On-Line Ordering™	Lab glassware & equipment

**** This is printed on top of the page.	
Brooklyn Thermometer Web : http://www.brooklynthermometer.com	Digital & glass thermometers
McMaster-Carr Supply Company Web : http://www.mcmaster.com/ These people sell just about any fitting and pipe or hardware item that you can think of. If you type "copper fittings" or "copper pipe" in the "Find Products" box, you will find them. The prices are sky high. I have not bought anything from them. I use the site to plan out modifications as to what fittings are available. Then I locate a local supplier and buy it in copper.	fittings, pipe & hardware
Omega http://www.omega.com/ North America This place has some high end computer interface equipment. They also have electrical immersion heaters and temperature sensors and controllers. They make the senders and indicators for temps at various places in a still head. These are even internet communication capable. Say you want to control still head temps by computer. They also have hand test equipment. They accept most major brands of cards.	controllers and sensors
http://www.hannainst.com/	ph meters, thermometers etc
Eagle Stainless Containers Web : http://www.eaglestainless.com/ Expensive ($US350) but good quality.	Stainless steel boilers etc
Yankee Containers Web : http://yankeecontainers.com/buckets/#ssteel	Stainless steel buckets
American Science and Surplus http://www.sciplus.com/category.cfm?subsection=4	all kinds of cheap labware
The Original Homebrew Outlet 5528 Auburn Blvd. #1, Sacramento, Ca. 95841 Ph#(916) 348-6322 E-mail: jjjaxon@cwnet.com Web: http://go.to/homebrew_outlet/ They ship all orders in 24 hours via UPS. They accept Visa, Mastercard, American Express, and Discover. Ordering online is a tax free order. They carry about every grain (milled for free) and hop you can name, along with premade beer kits, Whitelabs liquid yeast, wine concentrate kits, refractometers, proof hydrometers, as well as the standard tubing, airlocks, stoppers, buckets, carboys, demijohns as well as all chemicals needed for homebrewing/winemaking. They also now carry the Top Shelf and Classic Flavors brands of flavor essences by Still Spirits. The malt syrup they carry is the Alexander's brand (no watered down/ half sugar syrup stuff) and they carry the pale, amber, dark, wheat, and Munich syrups, along with local wildflower honey, all at $1.65US per pound. The staff has a combined total of about 27 years of brewing/wine- mead, and sake- making experience- along with a few college degrees related to food science and fermentation- so any questions can be answered	brewing supplies and distilling essences
Vendome Copper & Brass Works, Inc web: http://www.vendomecopper.com email: office@vendomecopper.com	stills

Custom fabricator and manufacture stills of all sizes and shapes in all different price ranges in addition to this 100 gallon still. There are stills from 5 gallon up to 5000 gallon in our picture gallery.	
ElectrodesDirect.com web: http://electrodesdirect.com Factory-Direct Supplier of pH, ORP, Conductivity, CO2, Dissolved Oxygen, Ion Selective and Titration Electrodes, Meters, and Monitors for the laboratory, process, and biotechnology industries.	equipment
United Kingdom	
Swedish Connections Web : http://www.swedishconnections.co.uk email : RespMarketing@aol.co.uk Supplier of Gert Strand's products.	Finest quality essences, turbo yeast, carbon, measuring equipment, cleaning agents etc
Portugal	
Destilarias Eau-de-Vie email : homedistiller@copper-alembic.com	Portuguese Copper Alembic Stills - size range from 0,2 to 750 L.

Which Wash to Make

It depends on what sort of still you have, and what you are trying to make.

If you have a reflux or fractionating still, only use whatever is cheapest (usually **sugar**), as the refluxing will strip out all the flavours anyhow.

If you have a pot still, and are after a bourban or whiskey, then you need to go the **grain** route, or **mollasses** if after a rum.

If you are trying to make a neutral spirit for flavouring, go for sugar. See Mikrobios' pdf Wine for Distilling on this topic - you still need to take some care to get a really smooth neutral spirit.

You can also use **fruit**, if have it available. Again, using a pot still will result in a brandy/grappa/schnapps, whereas a reflux still will just strip it down to neutral spirit.

Unfortunately (maybe fortunately ?) , there is no rule of "if it can rot it can be fermented". In order for the yeast to work, it needs the sugar available to it in its simplest form, usually glucose (sometimes dextrose). The enzymes like alpha & beta analyse do the breaking down of the starchs & sugars in grains & fruit to this form. Unfortunately there is no way of breaking down protein (meat) like this, so there is no way of utilising animal byproducts etc for alcohol (drinking or fuel).

Preparing a Sugar Based Wash

Summary
Dissolve 5 kg of sugar & 60g of nutrients in 20L of water, and cool to below 30C before adding hydrated yeast. Different sugars will result in sweeter or drier alcohols.

Ok, either knock up a "thin" wort (pronounced "wurt") for vodkas, etc (via a reflux still), or get fancy and do a full grain recipe for whiskey (using a pot still).

If you are using a reflux still, it's no point using anything other than a thin sugar/water wort, because the reflux will strip out all the flavours. So no point in paying heaps for grains, malt extract etc, when sugar is so cheap.

If you're after a neutral spirit, one thing you can do different is to add some activated carbon to the wash (eg with the sugar). This will take out the cogeners as they form. Just make sure that you filter/decant off this carbon with the yeast, so that it doesnt go into the still (and release the nasties when heated).

Thin Wort

This is by far the easiest to do, to produce basically a flavourless vodka, which can be flavoured using either commercial flavourings, or use fruits to convert to liqueurs.

See Mikrobios' pdf Wine for Distilling on this topic - you still need to take some care to get a really smooth neutral spirit.

Also Viktors econ-o-wash.doc A cheap, well researched (720 litres over 6 batches) supermarket ingredient sugar based wash.

Thin Wort Recipes

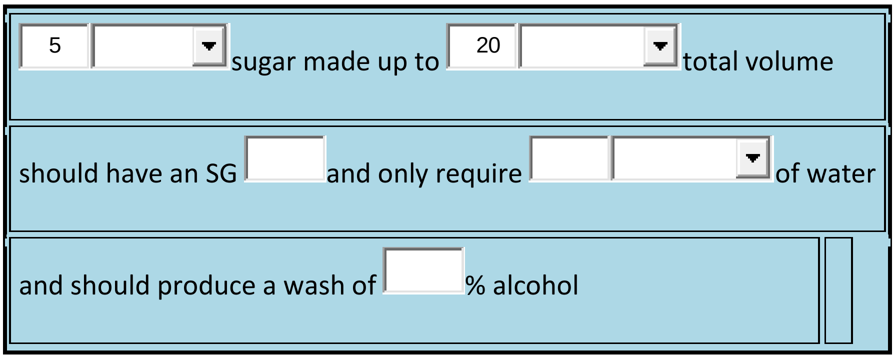
- **Vodka** - sugar/dextrose only.
- **Rum** - use molasses instead of sugar, diluted to a SG of 1.06 - 1.07 If you use more than 50/50 molasses/sugar you'll get a heavy rum. "Fancy" (high grade) molasses will give a better flavour, and has more fermentable

sugars than say blackstrap molasses. You can also use brown sugar instead of molasses.

Method

Basically the same as for beer making, but a lot easier. Use a 25L beer fermentor, sanitised by soaking full of water + 150 mL bleach for half an hour.

Dissolve 5 kg of white table sugar and 100g of yeast nutrients in 4L of boiling water, then top up to a total of 20L using cold water.

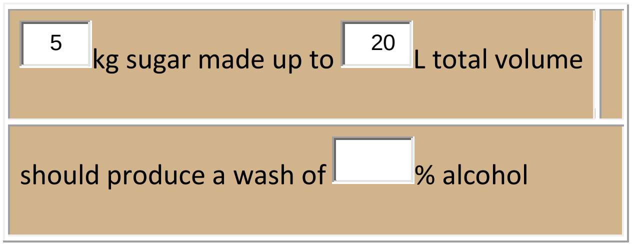


5 sugar made up to 20 total volume

should have an SG and only require of water

and should produce a wash of % alcohol

You require approx 17g of sugar for every %.litre of alcohol you want to make. Eg if you want to make 20L of a 14% alcohol wash, you need 17 x 20 x 14 = 4760g = 4.76 kg of sugar.



5 kg sugar made up to 20 L total volume

should produce a wash of % alcohol

Dr. Legendre's One Dollar wash (TM)

(Product name may not reflect actual cost)

> *PREFACE: A recipe you might want to try... this is working well for me. Comments & criticism are welcome. Email: DISTILLER@ARABIA.COM*
>
> *Ingredients (with approximate costs)*

- *5 gal (19L) potable water (cost?)*
- *12lb. (5.4kg) white sugar (3 x 4lb sacks @ $1.48 ea = $4.44)*
- *1/2lb. (220g) crushed 6-row malted barley (1/2 lb = $0.50)*

- *20g DAP (5 t. = $0.25)*
- *10g Wyeast nutrient (if doing a good long boil, try using half this amount or less 20g = $0.64)*
- *3T. Acid blend ($ 0.25)*
- *2 x 5g Lallvin EC-1118 (2 @ $0.85 = $1.70)*

(Total cost approximately $7.70; optimum yield 3.15 liters@95% ABV or 7.5 liters@40% - about one US Dollar per liter of drinkable spirit. In contries where Cuban sugar is not under embargo (read: most), you will pay about half of this..)

In a pot with a good lid, heat 1 gal. water to 142F (61C) and add the barley, stirring well. Cover, insulate with a coat or blanket and leave set for at least 90 minutes. After 90 minutes, uncover the pot and bring to a boil. Boil the barley for at least half an hour, an hour is better - 15 minutes before the end of the boil, add the Wyeast nutrient. After the boil, add another gallon of water, the acid blend, DAP (see note 1), and the sugar - 4 lbs at a time, mixing until all the sugar is disolved. Add this mixture to the clean fermenter, along with enough water to make 5 gallons or an original SG of approximately 1.105 (14% potential ABV).

Take 1/2 pt of the new wash in a quart jar, and dilute it with 1/2 pt. of warm water. Following the package directions, rehydrate the 2 packages of yeast and add them to the diluted wash in the jar, (which should be about 72-74f) to make a starter. Let the starter work for about 2 hours then pitch into the wash - 15 minutes before pitching time, aerate the wash with a stone. Stir well and seal up the fermeter. You can further aerate the wash in the first 48 hours to stimulate yeast reproduction (budding), but not thereafter or alcohol yield will suffer. Ferment between 72-82f, the higher of these figures will speed things up. Hopefully finishes in 5-7 days at 14%.

NOTES:

1) The DAP can (and probably should) be divided into three doses, spread out over the first few days of fermentation; seems like excessive initial concentrations of Ammonia compounds stress the yeast.

2) Watch the pH in the first day or two of strong activity; the barley will *serve as a buffer for the acids produced, but the pH should still be casually checked and kept in the 3.4-4.0 range. Potassium carbonate or calcium carbonate may be used to correct if the pH drops too far, but this is probably not necessary.*

3) Stir several times a day for the first day or two, until it is obviously working well - this is important. Later when the activity begins to slow, stir daily to re-suspend the yeast.

Smudges Recipe :

I'm sure I'm not the only one who's never had any luck (until recently) getting them to work, so I thought I'd share my recipe.

From experience, its easy to make a brew that will ferment out to 10%, but to make the effort of distillation worthwhile, you really want something closer to 20%. Simply adding more sugar to a basic 10% recipe doesn't work, even when using a high-alcohol tolerance yeast. They seem to stick with plenty of sugar left.

While Turbo Yeasts are great, they are expensive (around $9) costing more than the sugar itself. My recipe (excluding sugar) costs just over $2 for a 25-litre batch, and is a little more in keeping with the home brewing ethos.(All prices are in Australian dollars)

Here's my recipe for a 100 litre wash

- *Sugar 28kg*
- *Molasses 2.5kg*
- *Di-Ammonium Phosphate 175g*
- *Marmite 100g*
- *Yeast - ICV K1116 35g*
- *Fermaid K 25g*
- *Yeast Hulls 25g*
- *Magnesium Sulphate 25g*
- *Baking Soda 25g*
- *Tea 4 cups*

With a 95% conversion efficiency, this much sugar will produce about 14.5 kg of ethanol which is about 18.5 litres.

Combine all the ingredients (except the yeast) with warm water so the *resulting mix is between 35 and 40 degrees. Aerate with an aquarium pump and air-stone.*

Rehydrate the yeast as per manufacturer's instructions, and add to the brew. (http://consumer.lallemand.com/danstar-lalvin/danstarrehyd.html)

Continue to aerate for 4 hours. Use a thermostatically controlled heater to maintain the temp at 25 degrees (once it drops to 25 degrees).

I achieve the following fermentation rate:

Hours	SG
0	1.110
12	1.105
24	1.070
36	1.040
48	1.004
60	0.997
72	0.990

It's pretty much all over in three days, with the result best described as an unpleasant tasting beer, but containing plenty of alcohol.

A breakdown of the ingredients is as follows:

Molasses - contains sugars but is mostly included for its vitamin and mineral content. The fermentation rate halved when I didn't include it. Molasses is a waste product of sugar refining and can be assumed to contain bacteria. Do not dilute molasses if you do not intend to add yeast immediately as the bacteria will get established. This amount of molasses with this yeast does not foam over, despite the rapid ferment. Buy it from a stock feed supplier - 25kg for $22

Di-Ammonium Phosphate - Source of yeast assimilable nitrogen. Its need is well documented. About 350mg/L of Nitrogen recommended for *fermenting this much sugar. This recipe provides 375mg including the DAP in the Fermaid K. Buy it from Winery Supplies (www.winerysupplies.com.au) 1kg for $8.*

Marmite - Source of B group vitamins. If you don't know what it is already, then you probably live in North America and won't be able to buy it anyway. Often used in mead recipes. Fermentation sticks when not included.

Yeast ICV K1116 - Produced by Lallemand. Alcohol tolerance listed as 18%. Buy it from Winery Supplies (www.winerysupplies.com.au) 500g for $35. Lallemand (www.lallemandwine.com/products.php) also market a range of distillers yeast. Danstil A is claimed to have an alcohol tolerance of +20%. According to Lallemand Australia the exact same yeast is marketed to winemakers labelled L2226, which is easier to obtain. I will try this yeast next. Keep it refrigerated in an airtight container.

Fermaid K - General yeast nutrient, produced by Lallemand. Do a web search if you want to know whats in it. Buy it from Winery Supplies (www.winerysupplies.com.au) 1kg for $23. Keep it refrigerated.

Yeast Hulls - General yeast nutrient, prevents stuck fermentations. Buy it from Winery Supplies (www.winerysupplies.com.au) 1kg for $23. Keep it refrigerated.

Magnesium Sulphate - Epsom Salts. Source of Magnesium for yeast and plants alike. It's need is well documented. Buy it from the supermarket/hardware store/chemist.

Baking Soda - Sodium Bicarbonate. An inexpensive pH buffer, but molasses, tea and Marmite may also do the same job. Buy it from the supermarket for $6.50 a kg

Tea - Source of tannin. Often appears in mead recipes. No identified role in fermentation, but it occurs in grape juice, so included on the basis that it can't do any harm when I was trying everything I could think of might help.

This recipe works, but probably includes excessive amounts of some

> *ingredients. The annoyance of a stuck fermentation outweighs the likely savings, so I've pretty much stopped experimenting.*

Sugar

For more details about sugar, see the Sugar page.

Wal summarises ...

> *Sugars are important to distillers. I found the various terms confusing, so I searched around and made some notes from various web sites:*
>
> *Sugar is the chemical sucrose that occurs naturally in plants. 'Saccharum officinarum' is the species of basic importance to the history of the sugarcane industry.*
>
> *The first evidence of crystal sugar production appears at about 500 BC in Sanskrit texts that indicate it took place in northern India. Knowledge of this technique spread from northern India eastward to China and (along with the cultivation of sugarcane) westward into Persia, eventually reaching the east coast of the Mediterranean about 600 AD.*
>
> *The sugar industry entered the Mediterranean basin as part of an agricultural revolution carried out by the Arabs. To mill sugarcane, the burgeoning industry borrewed existing Mediterranean technology for extracting olives and nuts and, in a second operation, used screw presses to obtain more juice from the bagasse. The juice was then clarified, reduced to the point of crystallisation in open pans over furnaces, and the resulting syrup was placed in conical pots from which the molasses drained, leaving a loaf of sugar in each pot.*
>
> *It was only after 1700 that sugar was transformed from a luxury product into one of everyday use by even the poor. This took place as Brazil and the new West Indies colonies began producing sugar in such large quantiities that price was significantly reduced.*
>
> *From http://us.cambridge.org/Books/kiple/sugar.htm ... The above process is still common. This is unrefined non-centrifugal sugar. In India it is called 'khandsari', 'jaggery' or 'gur'. In Latin America it is called 'chancaca', 'panela', 'raspadura' or 'piloncillo'. The sticky brown sugar variant is the mixture that comes out of the crystallising pan. The liquid*

molasses remaining after this first boiling and removal of the crystallised sugar is called a 'light molasses'. When boiled again, the molasses remaining is called a 'dark molasses'. After a third boiling the remaining molasses is called 'blackstrap molasses'. This is normally used as cattle food and alcohol. The darker sugarcane jaggery is produced from these later boilings.

Types of sugar :

- *The nearly pure sugar crystal formed by the crystallisation process is covered by a thin film of molasses which is not stable in storage, and needs to be further purified to yield the stable, pure sweet sugar. Centrifuges are used to drain the molasses off from the sucrose crystals in the first stage. It is further refined to produce white sugar crystals. See 'How Sugar is Refined' http://www.sucrose.com/lref.html and 'Growing and For the different types of sugars see 'Cook's Thesaurus:Sugar' http://www.foodsubs.com/Sweeten.html. The size of the crystal determines the refined sugar's use:*
  - *Standard white granulated sugar.*
  - *Confectioner's/Icing/Powdered sugar - pulverised, and usually with about 3% cornstarch to prevent lumping.*
  - *Superfine/Ultrafine/Castor sugar - finely granulated. Dissolves well in cold water.*
- *Molasses contains chiefly the uncrystallisable sugars as well as some remnant sucrose. In England, molasses is called treacle. The sucrose remaining in the molasses can be inverted to produce a honey-like syrup containing glucose and fructose which ensures that crystallisation does not occur during storage.*
- *Raw sugar is approximately 96-98% sucrose. Unrefined or partially refined natural sugars tend to vary in color and have many names depending on their country of origin:*
- *Demerara (UK) - golden brown crystal sugar from first step of refinement (not moist)*
- *Raw sugar (n Australia) - golden crystal sugar similar to Demerara (not moist)*
- *Turbinado - light brown sugar (not moist)*
- *Muscovado - dark brown sugar made by crystallising dark syrups (not moist)*
- *(Moist brown sugars these days are produced by adding molasses to refined sugar.)*
- *Beet sugar is derived from sugar beets and is also pure sucrose like cane sugar.*
- *Beet sugar molasses though is not used for human consumption.*

- *Palm sugar is similar to sugarcane jaggery or gur and is produced from the sap of palms, including the coconut palm.*
- *Golden Syrup is made from thickened cane syrup which is partially inverted.*
- *Light and Dark Treacles are made from partially inverted light and dark molasses.*

Rum may be made from either fresh cane juice, cane syrup, or from molasses.

Yeast Nutrients

The yeast nutrient is necessary because refined sugar has no additional nutrients in it. If you try using just sugar, water & yeast, with no nutrients, you will get very little alcohol. Not much will happen without nutrients present. The alcohol you do make will contain more of the undesirable byproducts, like aldehydes and higher order alcohols. To grow, yeast needs amino acids, minerals, and enzymes, so that it can form the proteins the new cells will need during its "budding" to form daughter cells. It provides the necessary potassium, nitrogen, and phosphates needed (that would in other brewing usually be provided by the malt). If it can't "bud" to form daughter cells, it will still be able to reproduce a couple of times, but it does so using up its own reserves. The resulting cells aren't quite so skilled at the job of making ethanol, and tend to do a couple of extra other things instead.

Use yeast nutrients at the rate of 3 grams per litre of wash (eg 60 g for 20 L). It is typically made of the following, and/or similar:

- diammonium phosphate
- magnesium sulphate
- yeast (usually deceased,but imparts vitamins and minerals)
- folic acid
- niacin
- calcium pantothenate, and
- thiamine hydrochloride.

The "Great New Zealand Home Wine Making Book" suggests to ... "buy some ammonium sulphate or ammonium phosphate, and some pottassium phosphate or potassium sulphate and add 2g (1/2 teaspoon) of each to every 4.5 L. Another valuable addition is vitamin B1. You can buy these as tiny 3 milligram tablets from your local chemist or pharmacy and add one of these each 4.5 L" ...

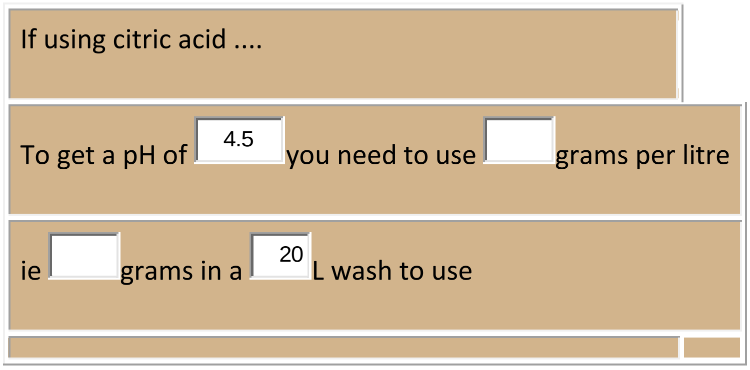
This is why sometimes in some recipes you might see tomato paste or vegemite being touted as a "secret ingredient" that helps produce cleaner alcohol with less off-flavours to it. This is because they are acting as a primative mix of nutrients. It is far better however to use the prepackaged nutrient mixes, as these specifically target the needs of the yeast, based on quite a bit of laboratory testing & research. See the Turbo yeast and AllTech company web pages for more details about yeast and nutrients.

Jack writes ...

> *Making sugar only washes isn't as straightforward as it seems- 2 pounds of sugar, a tablespoon of acid blend, a teaspoon of diammonium phosphate, and a gallon of water should never fail to ferment out completely- but half the time I try it (especially in large amounts) it doesn't work. The easiest way I found to prevent stuck sugar mashes is to just add SOMETHING that I find laying around the house. Only honey and maple syrup have failed as an "insurance additive" to otherwise pure sugar washes. Molasses, malt syrup, grains from beer making, cornmeal, whole wheat flour, and dry malt extract have all been tried, and all the batches with one or more of these materials prevents the ferment from sticking. I tend to use the malt extracts and grains the most- a half pound of malt syrup/dry malt extract, or a pound or two of the cheap crystal grains from the homebrew shop are enough for 5 gallons (20 liters).*

Acidity

The other important thing is the acidity of the wash. Getting it right should achieve better utilization of the sugar, a slightly higher alcohol %, and less other alcohol congeners. The wash should also take less time to ferment. The "Autofuel Manual" recommends that the optimum pH for mash is between 4.8 and 5.0 to keep the yeast happy, and to retard the growth of lactic acid micro-organisms. They also state that .. "Most grain mashes have a naturally acid pH of between 5.4 and 5.6 after malting or conversion has been accomplished. Other materials, notably saccharine substances like molasses and fruit pressings, have a naturally alkaline pH and must be acidified prior to fermentation." For sugar washes, the optimum pH is more like 4.0 to 4.5



If using citric acid ....

To get a pH of 4.5 you need to use grams per litre

ie grams in a 20 L wash to use

Wal writes ...

> *Wine makers aim for a pH of 3.5 which equates to 0.6% acidity and which is equivalent to 6g of citric acid/litre of water, or 2 lemons/litre of water.*
>
> *(1 lemon is roughly equal to 3g of citric acid or 1/2 tsp.)*
>
> *A pH of 5.0 equates to 0.4% acidity and is equivalent to 4g of citric acid/litre of water, or 1 large lemon/litre of water.*
>
> *1.2g of citric acid raises the acidity of 1litre by 0.13%.*
> *i.e. 1tsp. (2lemons) raises acidity of 5litres of mash by 0.13%*

Tim Watkins comments ..

> *for acidifying the mash, I've always used lactic acid (88%) that I bought at the local brewshop. Use it sparingly though. In a sugar/water mash there is practically nothing to buffer the acid, so a little goes a long way. I can recall acidifying only water (about 16l or so) in to the appropriate range with only about 1/4 of a teaspoon.*

Don (Nighthawk) adds

> *..... as an amature wine maker I always test the must just before pitching the yeast, and adjust it to .6% using acid blend (a combination of malac and tartaric acids) available at most brewing supply places. During fermentation the acid level will usually increase by about .1% which is where I like my finished product (.7% acid). I understand a slightly acid environment gives the best results from the yeast and is a mild preservative, and have always had good results, so when I do a batch of sugar/water I balance it to a pH of .5% (using the ratio of 4 oz. acid to 30 Imp. Gal = .1% increase) as the basis for calculating how much to add.*

> *On a number of occasions when I was out of acid blend I've used canned frozen orange juice which seemed to work just as well, and once I even resorted to vitimin C, but this was when the stuff was dirt cheap. LOL Buying acid blend in bulk makes it very inexpensive, so I never brew anything without it, but this is just my way of doing it.*

Asking at my local homebrew shop, I was told that the yeast nutrients in with the Turbo yeasts etc can often contain up to 45% citric acid, purposely to acidify the sugar washes. I can't confirm this myself, as I can't even find decent Litmus paper in this wee town ...

Using the new alcohbase yeasts, the mixture can ferment up to 21% alcohol.

Inverting Sugar

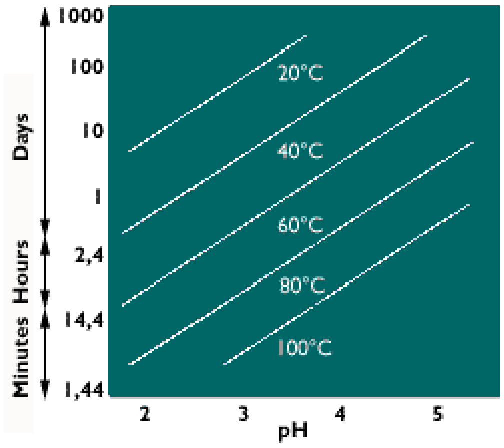
Some people "invert" their sugar, saying that it makes it easier for the yeast to ferment it. Others reckon that it makes no difference at all. For more details see the Sugar page. Wal writes ...

> *Some recommend to turn the sucrose syrup into an invert sugar syrup by adding an acid such as citric, tartaric or cream of tartar (potassium hydrogen tartrate).*
>
> *For 2 lbs of sugar (1 kg.), 1 pint of water (500 ml.), add 1/4 tsp. (1 g.) acid (or juice of 1/2 lemon). Bring to boil and simmer for 15 minutes. Cool.*
>
> *There is a relationship between pH, temperature and time. At 100C, and a pH of 3.6 (6g acid/litre) you need to simmer for 15 minutes.*

From http://www.dansukker.com/ :

> Inversion is the process by which sucrose is cleaved to form invert sugar, i.e. a mixture of equal parts of glucose and fructose. Inversion is catalysed by acids or enzymes.
>
> In acidic products, especially those with pH under 4 (jam, fruit purée and many soft drinks) more than half of the sucrose added is inverted to glucose and fructose when the products are consumed

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + \underset{\text{water}}{H_2O} = \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{fructose}}{C_6H_{12}O_6}$$



Yield

How much alcohol can you expect to make, knowing how much sugar you put in ? Easy. The theoretical yield is 51.1%, but you will get less than this, around 48% because you lose some of the sugars to forming the small amounts of other alcohols, esters, etc (eg 480 g (610 mL) of ethanol for every 1 kg sugar). All going well, you should be able to capture approx 90% of this, ie 550 mL pure (100%) ethanol per kg of sugar. So ... for say 5 kg of sugar, you should be able to get 0.55 x 5 = 2.75 L of pure ethanol. I collect mine at 75% strength, ie I get around 2.75 / 0.75 = 3.7 L of distillate . If you run a pot still at 40%, this means you will get around 6.9 L of distillate. Knowing how much alcohol is present then lets you know when your run is about to finish.

If start with 5 sugar and the still makes 40 % alcohol

You should collect around of Distillate

Bakers yeast will produce a maximum of around 14% alcohol, whereas the "turbos" can generate up to 20% alcohol. Obviously you'd use different amounts of sugar for either case. To estimate the sugar you need, multiply the wash % alcohol by the volume and by 17 grams, eg to make 20L at 13% you'd use 20 x 13 x 17 = 4400 g = 4.4 kg.

To make 20 L of wash	at 13 % alcohol
Use kg of sugar	

Glucose (dextrose) can be used instead of sugar, and is sometimes said to produce a "cleaner" wash. You will need to use slightly more (12.5%) by weight to get the same result as using sugar (eg use 1.25kg of glucose for every 1kg of sugar needed).

To get the same result as using 5 kg of sugar,
use kg of dextrose (glucose)

Maximum Sugar Concentration

Why not just add heaps of sugar ? Because the yeast won't be able to handle it, and will burst. The better yeasts (ie alcobase) can take up to 0.35 kg of sugar per litre of water, but most other mortal yeasts won't. Keep it to around 0.20 to 0.25 kg/L unless otherwise specified on the packet.

To make 20 L of wash	at 0.25 kg/L
Use kg of sugar	

However, Donald advises ...

> *When making thin worts for distillation achieve higher alcohol yields by "stepping up" the fermentation, usuing yeast nutrient and real distilers yeast. To "step up" simply add (50%-100%) more fermetables after primary fermentation and repeat until yeast is maxed out. Do not use this procedure if you want to re-use yeast. You may however, harvest enough yeast (1/4 of total) to re-ptich then step up the rest.*
>
> ie .. so start out with the regular routine of say 5 kg sugar in 20L of water, to get an SG of around 1.07. Ferment down until about 1.0 or 1.1 (ie starting to slow down), then add another 3-5 kg and see what happens ? (me asking) *Yes, but keep those yeast nutrients in there & make sure it includes diamonium phoshate.*
>
> *With proper yeast strain & yeast nutrient a complete end fermentation is common past 20% so getting 17%-20% at home is only a matter of watching the hydrometer. Adding too much sugar or adding too much all*

> *at once will result in the wash foaming up when distilling, or burning onto the element.*

Simple Moonshine

Patrick writes ...

> *One of my favorite recipes is simple: in a 5-gal (20L) bucket throw in 10-12 pounds (5kg) of white sugar, pour 2 1/2gal. (10L) of near boiling water in and stir well. then mix 2 gal. (8L) of your favorite fruit juice. I've found that the more exotic the fruit the better flavor you get. toss a good sized handful of yeast on top, stir well cover the bucket and leave in a warm place for 2 weeks. Siphon into your still and cook at 180 degrees F (82C) and collect the spirit. One way to tell when to stop is when the liquid will no longer burn a bright blue flame.*

Harry's Grand-dads recipe:

> *How to make Rum out of Molasses and Brown sugar.*
>
> *Take 4 gals molasses and 10 lbs sugar. Mix these together in 16 gals water. Now you commence setting mash in large wooden casks (not in any tin vessels) - only a wooden cask for good results. Put the above in cask the 1st day then when nearly cool add 1 ale bottle full of yeast (which is to start mask working). Remember when you put in the 4 gals molasses and the 10 lbs sugar into cask - have a little paddle made for stirring and stir constantly for fully 1/4 of an hour to blend things together, these will be mixed in hot water (not boiling) but just so as you can put your fingers in it without getting scalded. The hot water will melt the sugar and molasses splendidly and will give you more spirits and better rum. After you're finished stirring the 1st days lot also boil 8 lbs of old potatoes in muslin bag and put into the mash with yeast. And also with the yeast and 8 lbs potatoes you boil about 3/4 of a milk bucket of old maize in a sugar bag tied like a pudding and dont forget to drop this in the 1st days mash with the potatoes and yeast and again stirr well. This finishes the 1st days mash and dont take them out till the mash is fit to go into the boiler on the fire for distilling.*
>
> *Second days setting. Put another 4 gals molasses and 10 lbs sugar into cask on top of the 1st days setting and stir well for fully ten minutes. This finishes the 2nd days setting.*

Third days setting. Add another 4 gals molasses and 16 gallons water (no sugar) and again stir well (this finishes the setting of the mash).

To know when this is fit to put through you will see a little scum of bubbles will come to the top now and again. This will continue for two days sometimes three days then when scum is at its highest and starts to drop (Brew it). Don't forget when you finish the 3rd days setting to put a bag over the top of the cask then the lid belonging to cask on top of bag and a weight on top of it to keep warm and airtight. Have an occasional look at the cask when you finish setting the 3rd day because it works sometimes in 36 hours according to the hot or cold weather. In summer time it works a lot quicker than winter so a good idea is to brew in the summer time and stow away to get a bit of age so as it will not be too new to the taste, then sell in winter time when rum is more freely drank.

Now to make good rum to sell you want to know when distilling when to cut off the good rum from the second class stuff and the only way to do this is to get a hydrometer. (High means good spirits, low means poor spirits). You place this under the end of the worm in whatever you are catching the spirits in and as this vessel starts to get more than 1/2 full this hydrometer will start to float and register whatever proof the spirits is that you are making.

Now you always want two vessels one to catch the good 1st class spirits and immediately the hydrometer begins to register too low a reading pull the 1st class vessel away and pop the 2nd vessel under in its place to catch the 2nd class spirits. After a good while just have a teaspoon with you and dip same into the the 2nd class and throw a spoon full now and again into the fire and if it flares up like kero or meths that would be thrown in keep on as this is a sign there is still good 2nd hand spirits in the brew but after a while when what you throw in fire quenches the fire like water stop as this is the sign that you have taken all the spirits out of the mash. Anyhow you can taste it and if it has an alumny taste draw the charge from boiler and fill up again for another boil up.

Now the 2nd's have to be stowed away to themselves in a vessel and all the good 1st class stuff put to themselves as this 1st class brew is ready for sale without further distilling but in order to bring the 2nd class stuff to 1st class you have to put it through the still the 2nd time then it *is 1st class and can now be stowed away with the other 1st class brew.*

Now the next thing to know is how to do up your white spirits and tone it up for sale. Here is the rinkle. Aways put your spirits away in a large cask, or a wine cask is the best as rum and wine taste alike. Never put rum in a cask that beer has been in or you will spoil its taste. When you put it in the wine cask leave the bung hole open for 24 hours and as soon as you put it in the cask make a small curtain bag and put about a match box full of cloves in it and let down the bung hole tied with long piece of string so as you can lift it out. Then get a good well ripened pineapple and peel it and cut it in narrow strips about the length of a cigar and twice as thick and poke these down the bung hole, then get about 3/4 of an ordinary teacup full of seeded raisins and put these down the bung of cask into the spirits with the others, then put the bung back in cask and stow it away. Then when you are ready to sell your rum it is in its natural white state. Now you have to colour it for sale. Now to properly colour rum use white sugar not brown because it will make the rum too cloudy and dull and dark looking.

So in order to have a good clear clean bright looking spirit in a glass for drinking always use white sugar for colouring purposes. Buy a small frying pan for this purpose and dont use it for any other means because any greasy sediment will show in the coloured spirit. To colour say 5 gals rum put about 1/2 teacup of white sugar to start with in the pan, not over a blazing fire but on red hot coals; these should not be too strong to overburn the sugar or your rum will have a bad burnt taste so be careful and burn sugar to a good clean dark brown bubble. Keep moving the sugar in the pan with a long stirrer so as to evenly brown every grain then pour a cup of cold water in the pan on top of sugar at the same time stirring. When sufficiently stirred pour into a good clean bright quart bottle for colouring with. Of course you keep on burning sugar making bottles of the colouring till you have sufficient to colour your rum as it will keep in a bottle for a long time. The best guide is to buy a few shillings worth of good rum in a bright bottle and have this alongside of yours when you are colouring and you can compare the two so as you will not overdo things in the colouring or not give it enough colour.

Now everything is ready & OK for sale.

Finally i nearly forgot to mention when you are taking the rum out of the cask for colouring. When you colour, strain thoroughly before you put away for sale as the pineapple and cloves and raisins always leave a sediment and you in order to have a real clean article must strain real well.

Don't forget to get fully 22 feet of pure tin piping for the worm and 1 inch which means 7/8 waterway and when the worm is made must be coiled so as a gradual incline to lead the spirits through and no uphill position in the making as this means a blockage in flow and cause the mash to boil over. Get a good plumber to make the worm for you, should you not be able to get the pure tin you will have to get copper. But tin is more easy to clean all you have to do with tin after you finish each grew is to pour a bucket of cold water through it and it is always bright and clean. Understand when you are setting worm in cask at bottom it sticks out about fully 3 or 4 inches on a slight slope through a watertight hole through cask into catching vessel.

When distilling the 2nds in the white spirits state be careful not to have too strong a fire as this is very inflammable and will blow up so be carefull.

Say you have 5 gals of 2nd class brew cut off from the 1st class. When you put this into the boiler to distil put about 1/2 gal clean water in with it and it wont blow up, the water wont harm the brew, it will be of benefit to it and the rum wont be so fiery to taste.

For any second treatment the putting through of white spirits a person really wants a very much smaller boiler as the 50 gal boiler is too big. You only really need about a 10 gal boiler and you can have one made at the same time to just have the same size neck so as to fit the lid & pipe & worm & all and when boiling a mash use the 50 gal boiler, you never want to fill the boiler with mash - only slightly over 1/2 full or it will boil over in spite of you as it is just as hard to keep from boiling over as milk.

Poteen

Maurice writes ... This is a recipe from County Fermanagh, taken from a book called "In Praise of Poteen". I've never tried it myself.

- *7lb of bakers yeast*

> - *3 stone of brown sugar*
> - *4lb of treacle*
> - *1lb of hops*
>
> *Steep ingredients in 3 gallons of lukewarm water at the bottom of a 40 gallon barrel after steeping fill barrel to three quarter full with cold spring water. Leave in a cool place to settle. After several weeks transfer to your still.*

Samogon (Vodka)

Wal ...

> *Found a site that has a version in a computer variety of English. Interesting to know the state of homedistillation in Russia. See http://ago.fromru.com/index.files/samogon.htm Click on the British flag icon to get the English version.*

Molasses

To find large quantities of molasses, try farm stock feed dealers. They will sell black strap molasses for horse or cattle feed supplements. Different types of molasses have different sugar contents. (See http://www.syrupmakers.com/ for different kinds of molasses and the mills and plants / procedures that go into making them.) It therefore pays to measure the specific gravity (SG), until you get the desired concentration. Due to its high osmotic pressure, it needs to be diluted to less than 25 Brix (weight % sugar), or else the yeast wont be able to get started on it. Unfortunately, due to it sometimes only having around 46% sugar, this means you only get a sugar content of 14%, and a final alcohol of around only 6-7%. To get around this, you may need to feed the molasses to the wash in several stages.

In response to some questions about using molasses ..

> *I intend to produce fuel ethanol using molasses as a feedstock. This will provide the sugar source but I have been told that on its own it does not contain enough nutrients for optimum alchol conversion.*
>
> *Somebody suggested that you can add corn steep liquor (CSL) - does anybody have experience of this and what ratio of molasses (at 49% sucrose) to CSL would you use? Or is there a better alternative.*

David replied ..

> *This is simply not true most of the time. Molasses generally contains more than enough nutrients although where high temperatures have been used in its processing it can occasionaly be a little deficient in one or two vitamins (generally not a problem as yeast require very small amounts of these). The problem is not the nutrients but the presence of bacteria and wild yeasts which molasses contains a lot of. To get round this you need to introduce larger than normal amounts of yeast and to have your pH right so the good yeast quickly get the upper hand and quickly dominate. This then leads on to the proper fermentation temperature as too quick a fermentation raises the temperature and can quickly kill the yeast. If you look after both these aspects you should have very little problem.*
>
> *One of the problems with molasses is that it often dosnt have the sugar content that the seller claims and it therefore will not produce as much alcohol. There is often a lot of unfermentable material as well. A standard 44 imperial gallon drum (US 55 gallons) contains something like 260 to 280 kg of molasses. This contains a lot of inert material. If buying and using molasses for this purpose one needs to constantly monitor and check the brix level so you get what you are paying for. Note: not the theoretical or claimed level but the actual level.*
>
> *The addition of CSL will generally improve the fermentability but you will probably need the addition of enzymes and this adds to cost. Note that CSL generally has much better starch levels than molasses. Molasses is invert sugar which still has a fair amount of the sugar content remaining but from which a lot of the easily extractable sugar has been removed. A lot of the sugar remaining is in the form of more complex starches so it is all not utilisable. Again the use of enzymes can help remarkably. Hope this is some help.*
>
> *B.r., David*

Randy writes ...

> *with molasses you wont need to add sugar. Molasses is sugar in the liquid form. Brown Sugar is an economics alternative. It may be less expensive that molasses. You will have to adjust your mixture with water to get the brix (sugar content) number that you want. You should know that there are more than one type of molasses. The kind made from sugar cane is*

> *clear. The kind made from sorgham or a similar plant is darker. I only have sorgham available to me here. But with a mill located only a few miles away, it does have a cost effective angle for me. I found a link about the processing of sorgham into molasses syrup if you want to read it. It is interesting in that it describes the temperatures that the sysrup is added to storeage containers to prevent fermentation. It also describes the addition of enyzmes to convert starch to sugars and to invert sucrose to glucose and fructose.*
> *http://www.ca.uky.edu/agc/pubs/agr/agr123/agr123.htm.*
> *One thing to keep in mind though is that you wil need to gently stir the fermentation buckets daily to keep the syrup in suspension.*

Rum

Make sure you read the section on distilling rum too.

Wal summarises the various recipes ...

> *The French have two categories of rum - one from the molasses by-product of milling and refining sugar (rhum industriel) and one directly from sugarcane juice (rhum agricole). The 'Household Cyclopedia' of 1881 has a method for making rum which scaled down is about 800 g of molasses/5 litres of water or about 1 l.5 lbs/1 US gal of water. This would give a wash of about 5%abv. To make the equivalent of sugarcane juice, we need 1 cup of white granular sugar, 1/3 cup molasses and 7 cups of water. This would give a sugar content of about 15% which is equivalent to sugarcane juice.*
>
> *1)Traditional ('Industrial') Rum (20 l or 5 US gals)*
> *(molasses used in proportion of 1 kg molasses/5 l water) 4 kg (9 lbs) molasses for 20 l (5 US gals) of water*
> *This is equivalent to 100 g sugar/ litre*
>
> *2) Traditional ('Industrial') Rum for the Homedistiller (high alcohol)*
> *4 kg molasses and 4 kg white sugar for 20 l water*
> *This is equivalent to 300 g sugar/litre*
>
> *3)'Agricultural' Rum (French rhum agricole, Brazilian cachaca)*
> *3 kg white sugar and 1 kg molasses for 20 l of water (17% sugar)*
> *This is equivalent to 175 g sugar/litre*

> *4)'Agricultural' Rum for the Homedistiller (high alcohol)*
> *5.5 kg white sugar and 1.5 kg molasses for 20 l water*
> *This is equivalent to 310 g sugar/litre*
>
> *Rum gets additional flavor from ex Bourbon barrels and caramelised (burnt) sugar. A suggested proportion would be 5-10 tsp/litre of rum which would give a sweetness of 2.5-5% which is in line with what is added to other liquors.*

Jack writes ...

> *I've made good rum by using half sugar and half molasses. IF the molasses is bitter tasting (most feed store molasses is), then it's strong enough to make a solid flavored rum, even when it only makes up half of the fermentables. Hell, a 4 gallon bucket of molasses, 25 pounds of sugar, and 20 gallons of water made a good (and cheap) rum for me more than once.*
>
> *In my experience (molasses from Hawaii, piped into a bucket from a tanker), molasses needs to be diluted down to about 10 to 15% potential alcohol- it will ferment out only halfway (15% potential alcohol will only drop down till you end up with 7.5% alcohol by volume- molasses is only 50% fermentable). It doesn't need yeast nutrient, but a quarter ounce of acid blend per each 5 gallons of mash has shown to give a better flavor.*
>
> *I use two of those little 5 gram packets for each five gallons of mash. I don't stir at all- there is no grain/fruit to mash down, anyway. It typically takes about a week to ferment out and to begin clarifying on it's own.*

PK writes ...

> *I use a 7L pot still with thumper so I have to make 3 runs per batch (you just can't argue with free). It comes off at 75-80%. My wash is made from about 8kg cheap brown sugar and 50g yeast nutrient in 23L bucket, it finishes at about 15% alc using champagne yeast. I found that aging in toasted oak for at least a week, undiluted, made a product that would fool my friends. Noticed an even grater improvement when I got lazy and didn't discard my oak chips and just added more. Great taste when diluted to about 45%.*

> *The foreshots are easy. Even with a 7-8L batch I discard the first 50-60mL. I stop collecting when the temp. off the thumper reaches about 185 F (85C). I notice that at this point % alc. begins to fall as well and the smell changes.I still keep going till the temp off the still reaches about 195 F (90.5C)*
>
> *I have found a quick way to make charred oak chips. I wrap a tinfoil packet of oak chips about 3 layers and put them on my stove element at less than medium... Here's what keeps the fire out, a big old iron frying pan placed on top. In about 1/2 hr. good Smokey oak. I also sometimes add some caramelized brown sugar if the batch seems a bit harsh.*

In a later update, PK writes ...

> *..I would like to suggest that first run distillers stick with brown sugar for the first couple of washes, at least to get comfortable with your pot stills temperatures.*
>
> *My recipe (I wouldn't let my old buddy "Captain Morgan" place my bags in my berth!):*
>
> - *In a food grade bucket, big enough to hold 23L, dump 5Kg of molasses plus 4Kg brown sugar into it. (Just a guideline. I generally add brown sugar to 16-17% potential on hydrometer)*
> - *Rinse the molasses container a couple of times to get it all out using hot water.*
> - *Dump 50g of yeast nutrient into wash and add water while stirring to you have as specific gravity that aims for about 16%(17% is ok, but I just don't like to push the yeast too far... myself).*
> - *Add lavalin EC-1118 yeast at temperature around 70-75F. stir in!*
> - *After a good violent fermentation the wash will be ready in 7 days keeping the ambient temperature 70-75F.*
> - *Let it settle... or don't. I've found no difference. Dump into still and let 'er rip.*
>
> *My still:*
>
> *I'm using, out of convience (If it ain't for free, it ain't for me), 2 8L syrup containers from a commercial milkshake machine. Stainless steel.*

First I dump the tails from the last lot (first time... ohh well, next will be better!) along with a healthy portion of previous thumper juice(the stuff that accumulates in the thumper). I heat this on my stove because it has more power. When boiling I transfer to my hot plate (1200w) and wrap pot in insulation blanket.

Connecting pot to thumper and thumper to condenser, I operate the hot plate on max as well as a plate warmer under the thumper (125w).

More about the thumper. After experimentation I find that just enough liquid to cover the inlet is sufficient... any more reduces yield. (Note: first timers should use a little wash for liquid, after that thumper juice. My thumper is the same size as my primary and I suspect that this allows for a lot of reflux allowing me to attain 80% purity from a 15% wash.

Get the meth out:

As Tony says discard the first 50mL. I've seen it, smelled it, and measured it. After 50mL of my wash is collected it will, seen, stop spitting... smell, a lot better... measured, the temperature stabilizes, mine is about 169-170F.

Collection continues between 169 and 173F (measuring temp. of thumper head). As smell changes (173F), I mount my thermocouple to my primary still and continue until its head temperature reaches 194-195F. I do not collect above the 173F(non smelly) point of the thumper. Well I do but its recycle. I should mention that as the first drops appear at the still I back off my hot plate temp a little bit, somewhere around ¾.

Aging:

In a bottle add toasted oak chips to distillate. If second time, add distillate to used oak and add a little more. 2-3 tbsp per 1L distillate. Yes distillate... Don't dilute!

So far I haven't seen such thing as too long a time sitting on oak. However after a week or 2 I find it quite acceptable. Filter and dilute to drinking strength.

> *On parting:*
>
> *Know your still. I'm sure every pot still with thumper has is unique operating characteristics. PLAY!*
>
> *I only hope this helps you demote the "Captain Morgan" to Stewart 2nd class as it did me.*

The "Household Cyclopedia" advises ...

> *Mix 2 or 3 galls. of water with 1 gall. of molasses, and to every 200 galls. of this mixture add a gallon of yeast. Once or twice a day the head as it rises is stirred in, and in 3 or 4 days 2 galls. more of water is added to each gallon of molasses originally used, and the same quantity of yeast as at first. Four, 5 or 6 days after this, a portion of yeast is added as before, and about 1 oz. of jalaproot powdered (or in winter 1 1/2 oz.), on which the fermentation proceeds with great violence, and in 3 or 4 days the wash is fit for the still; 100 galls of this wash is computed to yield 22 galls. of spirit from 1 to 10 overproof. If the molasses spirit, brought to the common proof strength, is found not to have sufficient vinosity, it will be proper to add some sweet spirits of nitre (ethyl nitrate); and if the spirit has been properly distilled by a gentle heat, it may, by this addition only, be made to pass with ordinary judges as French brandy. Great quantities of this spirit are used in adulterating foreign brandy, rum, and arrack. Much of it is also used alone in making cherry brandy and other cordials by infusion; in all which many prefer it to foreign brandies. Molasses, like all other spirits, is entirely colorless when first extracted; but distillers give it, as nearly as possible, the color of foreign spirits.*

Andrews tale ...

> *I just tried out the first product from my new still on the general public (ok, it was family and friends at a tailgate) and it was a hit! Everyone agreed that it not only smelled and tasted "just like real rum" but that it was yummy. I am very excited.*
>
> *I made an all molasses mash, pitched champagne yeast, and ran once through my reflux still. My condensor is attached to my column so I don't really have a good way to de-reflux my still. I took off distallate at an average of about 150 proof, and then kept the tails seperate when they droped to about 125-130 proof and the temp at the top of my column was about 90C.*

I made about a 22L mash. I used a lot of molasses, around 7L, I'm not really sure of the amount because I went by my hydrometer. I added enough to get my potential alcohol up to around 16%. Nothing magical about that number, something I pulled out of a hat considering I was going to pitch champagne yeast, and noting that the molasses itself has a lot of dissolved solids in it that aren't sugar and will raise the reading.

I charred toasted oak chips by baking in my oven wrapped tightly in foil at 500deg F. I cut the alcohol to about 90 proof and soaked on the charred oak as well as uncharred oak. It had been soaking about 3 weeks before I dressed it up for the big night out. After filtering out the wood with a coffee filter, I carmelize sugar and add about a teaspoon to 500mL.

Two ways that I know of to carmalize sugar. The way cooks do when they make carmel and need to melt alot of sugar: dissolve the sugar in water first, boil until all the water goes away, and continue until the desired color is reached. It's quite a frothy mess and takes awhile. Since I don't need much what I do is just put a small coating of sugar in a dry saucepan, just enough to cover the bottom. heat on med to med-high and toss the sugar around in the pan alot. It will melt and then slowly change color. You have to do a lot of swirling of the pan so that you don't burn the sugar locally while some of the other sugar is still crystallized. It requires constant attention, but you're done in about 5min. Watch yourself on that liquid sugar, it is HOT and sticky. I.E. if you get a dab on your finger, it will burn and you can't get it off quickly.

Mostly made mixed drinks since it's still young (I can taste a little something back there but it's faint), but with further ageing and mellowing I'm sure it will be even better.

A couple people were interested in how I was able to get flavour through my reflux still. I have some ideas, but thought I'd also put this out for discussion. My reflux column has good surface area and insulation, but no cooling water in the column itself. I control the temperature of the top of the column by the heat input to the boil. My guess is that at the temperatures I run at, although I do a good job of knocking down the water vapors, there is still plenty of flavor coming over to my condensor.

> *The oak chips also definately impart flavor to the liquer. Seeing as scotches, bourbons, ryes, tequilas, all age on oak as well, this can't be the flavor that makes it taste like rum, but is more of a backbone and mellower, I am guessing.*

Jeanette writes ...

> *In my limited experience, (4 batches of rum, only 2 worked ok) I reckon that you have to have some molasses in your brew. The brown and dark brown sugar has enough in it to give some flavour, but if you want to make a good strong rumbo, go with the molasses. At the start of the run, you may have to throw out more than the usual amount of meths. You've gotta do it or you may ruin the entire batch. So collect in 20 - 50ml lots at the start so it is easier to segragate the off stuff. Keep a close check on the smell and taste of the rum when you get close to the end of the run.*

Mike writes ...

> *The recipe according to me for CAPTAIN MORGAN SPICED RUM is (starting batch)......*
>
> - *6 kg brown sugar ,*
> - *100 gm (extremely good) yeast nutrient*
> - *2 packages (5gm per each) Lalvin-EC-1118 yeast. Make sure you bring the yeast up to a good foam (1/2 hr @ 80 F (26C) in 150 ml of the wash).*
> - *Add yeast to wert and add heat band to keep fermentation to 74 degrees F (23C) untill it reaches 0.998 specific gravity.*
> - *After that...you must filter the must through a wine filter(# 3 VINAMAT) filter pad to get rid of as much yeast as possible before distilling.*
> - *Distill as per Tony's rules and collect in a big enough container to allow the cut down with distilled water (as per Tony's calculators on his website). Make sure the alcohol is 53%.*
> - *Add 1 Tbsp toasted (white American Oak chips) take that any way you like....HA HA HA....,*
> - *1 tsp ground cinnamon,*
> - *1 tsp ground ginger,*
> - *2-dried cloves.*
> - *You may add as much caramelized white sugar as you would like to deepen the colour of the spiced rum*
> - *Let this soak for 1-2 weeks (or per taste or smell)*

- *you mus t put the spiced rum through a coffee filter before you drink it unless you like alot of stuff going down your throat that does not belong there.*
- *The way I distill is I use 60 oz. bottles for the distillate. After the first one is full I take a hydrometer reading. Same with the second and the third and so on. I finish when the coloumn temp reaches 90 degrees C temp. Then I take 2 minutes of tails for flavour and then I shut it down. Too much more will give you brackish yuck flavour!! After the run is finished I combine all the 60 oz. bottles and take a final gravity reading.Usually around 85-92%. This is then split in half with distilled water (unless making spiced rum which has to stay at 53% to get the vanillins out of the oak chips). The spiced rum can be dilluted down to 40% but it is quite good at 53%. By the way...I use brass scrubbers in the still because the don't impart flavour like stainless ones do.*

and then have a PARTY!!!!!!!

Update ! - Mike has a new improved recipe ..

Mike's Canadian Spiced Rum

- *800 mL 80% rum (fermented from 6kg brown sugar, 25gm citric acid [to invert the sugar] , 25gm Supervit (Italian) yeast nutrient. 10gm Ec-1118 yeast from Lalvin (ferments HIGH ALCOHOL!!!) Run this stuff through a good reflux coloumn.*
- *1/4-tsp ground cloves*
- *1/4-tsp (generous) powdered cinnamon*
- *1/4-tsp (generous) powdered ginger*
- *1-tsp-Crosby's Cooking Molasses (Blackstrap will do !)*
- *1-Tbsp-Toasted White Oak Chips (Check your local wine shop as this is a popular addition to Red Wine !)*
- *Now....after all this CRAP....let this stuff macerate in a 60 oz (1.7L) bottle (plastic or glass...your choice) for at least 7 (SEVEN) DAY'S (PLEASE!!!). SHAKE-THE-CRAP-OUTTA-THIS-BOTTLE-EVERY-DAY for the whole week (make's the flavours blend incredibly well). If you want an even fuller flavour...leave the bottle (or bottles) to macerate (soak) for another week... (let's the spices and stuff impart an even stronger flavour). Play with it....see what you like!!*
- *After this...you must run your (YUMMY-STUFF) through a coffee filter 2 (TWO) times at least (more filtering...clearer product!!!).*
- *After this...you must top off the bottle (SORRY) to the top!!! This will give you about 38% alc/vol...which is perfect for this type of rum. I know that the Captain Morgan Rum is 3% less in alcohol...and it is much sweeter... I find this version BETTER! (only*

> *my opinion!). Oh...and yes...when I say TOP OFF THE BOTTLE...I mean,top it off with filtered or distilled WATER!!!*

Mike elaborates on his recipe ...

> *I thought that I would tell you how I keep my primary fermentor at about 78 degrees F. I use 10 feet of Pipe heating cable (this stuff is self regulating in watts,therefore controls the temp to keep it at an ambient temp of 75-78 degrees F) like your typical room temperature. I put an old plug (off an old clothes iron) on the end,wrap this around a SMOOTH WALL glass carboy and then wrap packing tape (you know...the clear pain in the butt stuff) around it about 5 to 6 times to seal it good and tight. If you dont know what I mean by pipe heating cable...check out the cable that you put on your roof to prevent ice dams in the winter. Fill up your carboy (check the temp before adding yeast).Plug this BAD BOY in to the outlet. If temp is Too high...put the airlock in and wait about 8-10 hours...then add hydrated yeast. This is guarranteed to ferment a 6kg brown sugar plus 50g Supervit yeast nutrient plus 10g Lalvin EC-1118 yeast ,wash (with a starting gravity of 1.100) down to 1.002 in just 7 (yes that is seven) days (just did it...I am not kidding!!!). And yes...I use brown sugar because what is it really...it is cheap($3.89 per 2kg Canadian) and it is white sugar laced with pure molasses. It ferments out completely and in a reflux still...comes out at 85% pure,lots of flavour,and tastes great if left full strength on toasted oak chips for about 8-10 days,then cut to 40%.You end up with a beautifull Golden Rum.*

Wal writes ...

> *Making rum from molasses is well known. But why not make a cousin liquor from **palm sugar** ? Sweet sap from various palms is fermented to make 'toddy' (India), and then distilled to make 'arak' which is similar to white rum. Palm sugar from palm sap is available in Asian groceries. More than one kind of palm yields sugar, among them the toddy or kitul palm (Caryota urens), palmyra palm (Borassus flabellifer), coconut palm (Cocos nucifera), sugar palm of India (Phoenix sylvestris), sugar palm of Java and Malaya (Arenga saccharifera). Those most prized are the palmyra and kitul sugars. The sugar ranges from pale honey-gold to deep dark brown in color with variable consistency. In India it is known as 'gur', while in Indonesia it is known as 'gula jawa'(coconut palm) and 'gula aren' (sugar palm). It is used on a daily basis in these countries as a sweetener. Read the label carefully to make sure you are getting pure cane sugar as unrefined cane sugar is also sold in these shapes.*

John offers his recipe ..

> - *6kg blackstrap molasses*
> - *1 pkt yeast nutrient*
> - *1 pkt lalvin EC1118*
> - *3kg white sugar*
>
> *In a 25litre fermenter with air lock, disolve the molasses and nutrient in warm water to around 22 litres at 25degC, pitch the yeast and keep the temp around 25degC until all bubbling stops. Add the 3kgs of sugar giving a quick stir and let it go at 25degC and leave for a couple of days after bubbling finishes. Decant, leaving the sediment behind (save the sediment in a sterile jar for the next batch).*
>
> *When you distill, drop something in the boiler to aid bubbling when it boils (I use a couple of copper pipe offcuts (about 1"x1") to stop surging and give it just enough heat to do the job.*
>
> *Throw out the first 50mls and collect the rest to about 88 to 90degC. I pull it off at about 80%.*
>
> *Toast some american white oak in alfoil until smokin, let cool, then mix with the rum with about 2 tablespoons of golden syrup (cocky's joy, treacle) and 1 tablespoon of foodgrade molasses for every 2ltrs of rum for about 4 to 5 days. Filter through a coffee filter and water down to 40% (80 proof) and enjoy.*
>
> *Dont forget to shake the bottle every day while on oak.*

Hector writes ..

> *Molasses (as strange as it may sound for you guys who pay such exorbitant prices for it) is a waste by-product of sugar refining. It comes from concentrating the water in which they wash the semi refined sugar that later in the process becomes brown sugar (a necessary step towards obtaining white as they tell me). Molasses is rich in yeast nutrients and doesn't have that many fermentable sugars in it but being so dirty cheap, at least hereabouts (32,4 NZ$ for a 300 kilo drum is the last price I paid 2 weeks ago) you can stretch the osmotic effectiveness of your yeast to 20-22 degrees Brix in your mash and ferment away in large, though inefficient batches.*

Anyway, what I wanted to tell you (and this fact I both read about and observed empirically) is that the only mayor difference between rum and whiskey is the main ingredients fermented in the wash. I think it was our never sufficiently praised Wal who once pointed to a link to Islay island distilleries and there I was amazed to find that they use exactly the same source of oak kegs (2nd run ex-bourbon) as does a close-by rum distillery .

However, you can't obtain the same organoleptic profile for rum from sugar washes (brown or white) but you can get a better, more subtly flavored product by fermenting "panela" or "papelon" as we and Colombians call it. I have been able to buy some in the past while living in South Florida, USA, in small Latin food grocery stores. Panela is solid unrefined evaporated cane juice molded into box or conical shapes and it's 98-96% fructose (100% fermentable by any brewing yeast), and has lots of nutrients for yeast. It gives all of the flavors of molasses with a better alcoholic yield but at a higher cost (0,35 NZ$ a kilo in my town's supermarket).

A tip: same as black pepper in the whisky profile, cinnamon plays a small but key part in replicating rum's authentic accents. Vanilla pods too and in still more subtle tones cloves and nutmeg. I don't know why but we people of the Caribbean tend to spice everything up with the same things.

it is essential to reproducing the rum taste profile to use molasses as your main wash ingredient. I've come to the notion that not all sugar refineries are the same, technologically speaking. Here in Venezuela I've found that old and small sugar factories (usually technologically backward) produce better molasses for distilling purposes simply because there's more sugar in them. Perhaps there's an artisan sugar factory near your home, or you can get sugar cane molasses from one such industry. It's worth to find out. I haven't tried this myself because we have a cheaper alternative hereabouts that's called "papelon" or "panela" that's simply boiled sugar cane juice to the point of crystallization that's then emptied and cooled into conical or box like molds (Venezuelan moonshiners use it almost exclusively as their wash sugar material), but you can try and make an all brown sugar wash. Try to make it from the darkest sugar available to you and if you can find it in naturist stores

> *(and it's cost-effective for you) add some sugar cane molasses also to this wash.*
>
> *Yeast love molasses. They find every nutrient they need there, so when using molasses don't add any yeast energizers or such. Brown sugar is mostly fructose (Typically more than 60-70%) and sugar cane impurities, so it will be more easily fermented by yeast than white sugar (mostly sucrose, a more complex molecule, not directly fermentable by yeasts). Industrially, rum is distilled as vodka, to it's azeotropic max (96%), but when diluted to 40% you can taste the difference from a corn or malt alcohol, for instance. Then it is aged in ex-bourbon oak (sometimes ex-brandy) barrels for no less than 2 years and in each barrel they put secret quantities of cinnamon, cloves and nutmeg and they add a very small quantity of a "mother rum" that's typically aged as long as the first batch made at that distillery (local Santa Teresa's is more than 200 years old). I've tried this stuff and it's heavily scented (specially with vanilla tones) and very smooth. I've found that using vanillin (I buy mine in the drug store), which is a powdered substance that artificially evokes vanilla's smell and taste, and some natural vanilla extract helps reproduce the subtle tones any rum must have. For oaking try to find some ex-bourbon (American white oak) barrel pieces or sawdust and make an extract from the alcohol you'll make diluted to 60-70% in water. Also try adding a tiny bit of raisin extract (soak some raisins in 90% alcohol) because this tastes like brandy and higher end rums have some brandy tones owing to the French oak barrels. Hope this helps.*

Flaming Pinto writes ...

> *I have a light rum/neutral spirit recipe that is working very well for me. I thought I would pass it on.*
>
> *15 lbs (6.8 kg) white sugar*
> *24 oz molasses*
> *5 tbsp yeast nutrient*
> *2 tsp yeast energizer*
> *yeast starter (see below)*
>
> *To make yeast starter: Dissolve 4 tbsp Red Star brand Distiller's Yeast in 3 cups water at 93-97 degrees F (34-36C). Add 1 tbsp molasses, and 2 tbsp white sugar. Stir or shake until disolved and cover. Let sit, shaking*

> *occasionally for 1/2 hour to 1 hour.*
>
> *Heat 1 gal (4L) water to almost boiling, pour into fermentor. Disolve 10 lbs sugar, molasses, yeast nutrient, and yeast energizer into hot water. Top up to 6 Gallons (23L) with cold water keeping temperature at 85- 89 degrees F (29-32C). Stir until well mixed. Pour yeast starter into fermentor and stir briskly. Put lid and air lock on fermentor.*
>
> *After a few minutes, the ailock should start bubbling briskly. Keep wort at 85 degrees F (29C) for the duration of fermentation.*
>
> *After 3 days, stir in remaining sugar.*
>
> *Airlock should bubble vigorously throughout fermentation.*
> *I have been using the recipe for a few months now and it never fails to produce 15-18 percent batches in 6 to 8 days. I use a pot still and run it through twice to achieve 85% purity with an output of around 1 gallon (3.8L). Flavor and aroma of final spirit is that of a very light rum.*
>
> *Cost in sugars and nutrients is around 12-14*

Honey

Wal writes ...

> *Bees collect nectar, which is mainly sucrose and 40-80% water. They process this using the enzyme invertase, and by evaporation into a product containing 18-20% water we know as honey:*
>
> - *Water 18%*
> - *Fructose 38%*
> - *Glucose 33%*
> - *Sucrose 1.5%*
> - *Maltose 7.2%*
> - *Higher sugars 1.5%*
> - *Minerals 0.2%*
> - *Total acid (as gluconic acid) 0.6% (pH 3.9)*
>
> ***Mock Honey**. Not to be outdone by bees, we can also process granular sucrose to make a home-made 'honey'. Here is a mock-honey recipe (a form of invert sugar syrup), based on the above, using 4 units of granulated sugar to 1 unit of water:*

- *2000g raw sugar (say 8 heaped cups). For a darker color substitute with soft brown sugar (1 cup)*
- *5tbsp. malt extract (maltose)*
- *500ml water (say 2 cups)*
- *6g or 1tsp. acid (a mixture of various - tartaric, citric) or juice of 2 lemons. A pH of 3.6 is equivalent to 6g of citric acid/litre or 1tsp.*

Boil water, add acid and sugar and simmer for 15 minutes. Cool. When cool add 1tbsp raw sugar (sucrose). This produces about 1 litre of mock-honey syrup. SG of honey is 1.5kg/l.

You could infuse dried flowers (camomile, roses, citrus flowers) to provide a floral aroma. If you are making a heavily spiced mead, and you want to save money, the recipe is appropriate.

For low technology brewing techniques using honey, as still practised in East Africa, see "Honey Beer" http://www.fao.org/docrep/w0076e/w0076e08.htm
For brewing using honey as practised in Medieval times, see "A Guide to Mead" http://www.pbm.com/~lindahl/articles/guide_to_mead.html.

"Spirit of Honey", distilled from a honey mash, consisting of 1 part honey to 5 parts water is mentioned in "Delightes for Ladies" by Sir Hugh Plat, 1609

Vikings made mead and sometimes added honey to malt when making ale. In Tudor times a mixture of honey and ale fermented together and spiced with pepper was called 'braggot'. Prior to hops the herbs (gruit) used to flavor ale included bog myrtle, rosemary, yarrow, alecost.

For making mead or a honey mash see "Mead" http://consumer.lallemand.com/danstar-lalvin/InFerment/Mead.html
Honey is basically an invert sugar lacking in nutrients and the advice on nutrients is useful. The addition of acid is not recommended. Also "The Basics of Mead Fermentation" http://consumer.lallemand.com/danstar-lalvin/InFerment/Mead_Basics.html Another good site is "An Analysis of Mead Making and the Role of its Primary Constituents" http://www.solorb.com/mead/danspaper.html Also "Mead" http://www.fao.org/docrep/w0076e/w0076e07.htm

***Honey Liqueurs**:*

Found 3 German honey liqueurs that use Mexican Yucatan honey - "Barenjager","Barenfang", BarenMet" - http://www.schwarze-schlichte.de/produkte/boniglikoer_met.htm The Polish firm "Polmos" makes a honey liqueur called "Krupnik" and "Medos" http://www.honeyvodka.com/ingredients.html

Honey is used to sweeten and flavor whisky liqueurs "Drambuie", "Glayva", "Irish Mist". "Stag's Breath" is a sweet mead fortified with whisky to liqueur strength. In Portugal "Brandymel" is a brandy flavored with honey. For those who want to make their own honey liqueurs, here are several recipes:

***Krupnik** (Poland)*
1 bottle of vodka (750ml)
2/3 cup of water
1 and 1/2 cups honey
1/4 vanilla bean
1/4 nutmeg
3 cinnamon sticks
1 strip of orange or lemon peel

2 whole cloves
Combine honey with water, spices in a large saucepan. Bring to boil, cover and simmer for 5 mins. Add vodka, remove from heat. Serve hot or cold.

Poland and Lithuania were part of a Commonwealth, which explains the similarity of the names - Krupnik, Krupnikas.

***Krupnikas/Viryta** (Lithuanian)*
1 litre alcohol
4 cups of water
900g (2lbs) honey
2 tsp caraway seed
10 cloves
10 whole allspice
4 sticks cinnamon
2 sticks vanilla

> *2 pieces ginger*
> *2 pieces galangal*
> *10 cardamon seeds*
> *1/2 nutmeg*
> *3 strips lemon peel*
> *3 strips orange peel*
> *1 pinch saffron*
> *Boil spices until water reduced to 2 cups. Strain. Pour spiced liquid into honey and stir. Add alcohol. Allow to cool.*
>
> ***Spices for Polish Mead** (5 gals or 20 L)*
> *hops - 2ozs (50g)*
> *1 tsp ginger*
> *1/2 stick cinnamon*
> *1/2 stick vanilla*
> *pinch of nutmeg*
> *6 cloves*
> *2 peppercorns*
> *lemon peel*
> *orange peel*

Honey Mash

One of our Utah mates recommends this. Ferment for 75 days and distill. Said to taste great and the mash comes to about 18% alcohol.

- 5 lb of honey
- 4 gallons water, with
- some yeast and
- a little lemon juice..

Mead Brandy

Jacks recipe for Mead Brandy ...

> *I think this would be close to the ancestral roots of Krupnik (the honey sweetened vodka). First step: make mead*
>
> - *Per gallon (4L)*
> - *3 pounds of honey*
> - *one TEAspoon of yeast nutrient*
> - *one TABLEspoon of acid blend*

> *Dissolve everything in the water - then pitch a dry champagne yeast (I prefer Lavlin's K1V-1116 over the EC-1118 because the '18 tends to develop a stale, brackish taste over time that can follow into the spirit). Once fermented till dry - distill twice in a potstill or just go by taste in a reflux still.*
>
> *It's good as a clear spirit, but I prefer to water it to 40 to 45% and age it on a quarter teaspoon of charred American oak until it gets a Glenmorangie (10 year) gold color. This takes maybe a month in the bottle. Age it at this lower strength as vanillins tend to interfere with the honey aroma of the spirit, and the bitter - sweet taste of this wood tends to balance well with the honey - the sugars in the wood that are extracted at this low strength also tend to smoothen out the spirit.*

For more on mead : http://consumer.lallemand.com/danstar-lalvin/InFerment/Mead.html

Maple Syrup

Your Brother in Magick, The Omnipresent Mecakyrios writes about using maple syrup..

> *Yes, you can use maple syrup to make alcohol. How? Well you take a recipe, follow it and BAM you have your brew. What if you don't have a recipe? Well most people I know substitute maple syrup for honey in their mead recipes. What is you don't have a mead recipe? Well, darn, do I have to do everything for you? Just joking, if you don't have a good mead recipe I will include one that has been in my family for years:*
>
> *--*
> *This is exactly as it is written. My comments with be enclosed in [brackets]. I will write the metric version below the original.*
> *--*
>
> *Honey Wine*
>
> *Makes 1 Gallon [US Gallon]*
>
> *3 Pounds Honey - Any Kind [Just substitute maple syrup for the honey]*
> *1 Large Lemon Juiced [Only use the juice]*
> *1 Tablespoon very strong English Breakfast Tea*
> *1 Large pinch of bread crumbs*

> *1 Package of good wine yeast ["good" means a strong alcohol content]*
>
> *Fill a pot half way with clean water [basically, if you can drink it, it tastes good, and you don't get sick from it], and bring it to a boil. Turn of the heat and add everything except the yeast. Stir to mix everything real good. Let sit for 20 to 30 minutes [I assume uncovered, as this is what I have done and everything turns out fine]. After the wait, fill the pot to make one gallon, stir, and put into the bubbler [the fermenter with an air lock]. When the brew is room temperature, float the yeast [sprinkle the yeast - not mixing it in] and add the top [put the air lock back on the fermenter].*
>
> *Let sit kicking away [producing CO2, or bubbling] for one month. After a month, pour [siphon] the green wine [fermented solution] into another bubbler [a secondary fermenter with an air lock] and let sit until clear. Once it is clear [about 2 to 6 months] bottle the new [not aged] wine. Let the wine sit for as long as you can so the flavor will loose it's bite [let the mead age for about 6 months to a year in the bottles].*
>
> *---------------*
> *Metric version*
> *---------------*
> *Honey Wine*
>
> *Makes 3.78 Liters [Litres]*
> *1.36 Kilograms of Honey*
> *1 Lemon Juiced [Just use a lemon not grown in the States]*
> *15 cc. English Breakfast Tea*
> *1 Large pinch [use the fingers of a person not from the USA] of bread crumbs*
> *5 gm. of good wine yeast ["good" means a strong alcohol content]*

Lactose

Wal writes ...

> *Wine and brewer's yeast won't ferment lactose - they in fact use it to sweeten beers and lemon brews. You need a special lactose fermenting yeast.At least 2 are found in kefir - candida kefir & kluyveromyces marxianus. Commercial distillers use the latter with whey, a by-product of cheese making. Apart from pure lactose you could use whey powder,*

which is 80% lactose. The only problem is getting the lactose fermenting yeast. I saw a source from Germany; http://www.gbf-braunschweig.de/dsmz/strains/no005422.htm

Airag is fermented horse milk, a frothy, thick, alcoholic milk (about 3%a.b.v.) that fueled Genghis Khan's warriors and still remains a local favorite today. Mongols who like airag will drink up to 20 litres in a single day. It can be distilled to produce arkhi with an alcoholic content of about 12%. A Chinese style still is used. It is basically a pot with a wok filled with water over it, acting as the condenser, with the condensed alcohol on the underside of the wok dripping into a centrally placed ceramic jar. These days cheap vodka is readily available. Mare's milk is not readily available, so I have thought of using milk whey powder (75% lactose), and the lactose fermenting yeast kluyveromyces marxianus. 1.5kg of whey powder/5l water would be equivalent to 1kg of sucrose/5l water.

Lactose accumulates an estimated 1.2 million tonnes annually as a by product of the dairy industry. Lactose is a disaccharide like sucrose, and it can be converted to its monosaccharide components, glucose and galactose by acid or enzyme hydrolysis. 100g of lactose will produce 50g each of glucose and galactose. The lactose converting enzyme is also sold to people who cannot digest lactose in milk products. For the distiller unfortunately, converting the lactose won't work very well, as wine and beer yeasts will ferment the glucose, but for some genetical reason not the galactose when the two are combined. Even separately, galactose is fermented slowly. So using the lactose fermenting yeast, kluyveromyces marxianus is the way to go.
Milk whey is about 4.8% lactose
Milk whey powder is about 75% lactose

Concentrate your whey by boiling. You use your fermenter as a water distillation unit to get distilled water and a concentrated whey of say 25% lactose which you could ferment using kluyveromyces marxianus - you get 12% alcohol.

I thought of using lactase. Lactase enzyme can convert lactose to glucose and galactose, which is fermentable by ordinary wine/beer yeast but unfortunately because of genetics, when the two are together you get a

> *poor fermentation.*
>
> *You could I suppose also first ferment your 5% lactose whey using kluyveromyces marxianus, and then add sugar (1 kg/5l) and a saccharomyces yeast to ferment the sucrose. Whey contains a lot of soluble proteins and minerals which are a source of nutrients for the yeasts. This uses the whey as a source of water and nutrients. Note, this is a theoretical proposal.*
>
> *The Golden Cheese Company of California also makes alcohol from its whey after removing the protein. See: http://ourworld.compuserve.com/homepages/gccc/alcoholp.htm*
>
> *Utilization of Whey Through Fermentations*
>
> *From "Alcohol from Whey" ... "First, the whey must be concentrated: that is, some of the water is removed. This is done by a process called reverse osmosis,.....Then the protein in the whey is separated out (precipitated and filtered)....What is left is chiefly a mixture of water, the milk sugars and some minerals. By conventional fermentation technology, the sugars are converted into alcohol,.....from which it can be recoverd by distillation."*
>
> *For those in New Zealand, Anchor Ethanol was the first company in the Southern Hemisphere to manufacture alcohol from casein whey on a commercial basis.*

Don advises ...

> *A micro distiller in the US is making vodka usuing only lactose sugar with the yeast strain Kluyveromyces marxianus and yeast nutrient. The yield is high and the alcohol is very very pure due to the pure nature of the raw material. This allows for great results even from modest equipment. It's a home distillers dream come true. Worse equipment and better product! I works on mares milk alcohol for the Mongol hordes and it will work for you too. Give it try, you'll be impressed with the results.*

Preparing Grain Worts or Mashes

Summary
To make a grain mash for whiskey : Heat 4 kg cracked or crushed malt with 18 L of water to 63-65 &degC, and hold there for 1-1.5 hours. Heat to 73-75 &degC, then strain off and keep liquid, using 250 mL of hot water to rinse the grains. Cool to below 30 &degC (should have an initial specific gravity of 1.050). Add hydrated yeast & leave to ferment. To get the same effect, you can also do a malt-extract brew (like making beer kits), then boil 1-2 kg of grains or cracked corn and add them for flavour. Only use a grain mash if you're specifically after a whisky/bourbon, of if making a vodka and it is cheaper than sugar to do so. You need to use either malt or enzymes to convert the starch into sugar so that the yeast can use it.

To make a grain wort requires Malting, Gristing, Mashing, Brewing, and Fermenting. Check beer related books, homepages or discussion groups (eg Alan & Melissa's Homebrew, Spensers Beer page), http://www.howtobrew.com/ for heaps more details, but don't get put off by some the minutia they sometimes get into.

See also ...
Avoiding Post-Fermentation Problems
How the Mash Makes Wort
Boiling and Hops
Bodensatz Brewing

Only use grains if you are after flavour (eg making a bourbon or whisky), or if for some reason they are really cheap for you to obtain. Generally, a reflux still will strip out all the flavours and leave a neutral spirit. But, you can actually use a reflux still to make flavoured spirits such as whisky, provided you detune them a little, and then carefully pay attention to how you make the cut. Details are given by Ian Smiley in his book "Making Pure Corn Whisky" (http://www.home-distilling.com/)

An excellent way to remove the grains after fermentation is to have used a "grain bag" - eg a large bag made of mesh or muslin to hold the grains. You then simply lift this out of the mash when they're all spent, and its easy to rinse them. Far easier than using strainers, seives etc.

Big tip ! It generally pays not to distill a grain wort with a still with an internal element. You get too many solids / complex sugars remaining that WILL burn onto the element. The whisky will stink, and the burnt flavour can't be removed. And its bloody difficult to clean the element properly & remove all the char (trust me). The one thing all the old time moonshiners always talk about is the skill needed to "fire a still without scorchin' the whiskey". Jack has a theory "everyone should have 2 stills: one column equipped, run on heating elements (for sugar spirit), and one stovetop potstill (for whiskey and rum mashes)".

The differences between Scotch whisky, Irish and American whiskeys is outlined at 'The Macallan' site: http://www.themacallan-themalt.com/.

> ***Scotch whisky***
> *It is now generally agreed that there are six regions and these are based on taste as well as geographical location. Lowlands, Highlands, Speyside, Campbeltown, Islay, Islands. The distillate is 75%abv, which is diluted to 63.4%abv and stored in oak casks (average is a 250litre hogshead). Depending on casks used, the spirit picks up color and flavor. Casks that held bourbon, sherry and port are reused.*
>
> ***Irish whiskey***
> *Irish whiskey differs from Scotch Whisky in that it is usually distilled 3 times. The malting process is also different as the Irish use sprouted barley dried in a closed kiln which is then mixed with unmalted barley before being ground into a grist. This can be said to account for the lightness of Irish whiskey and its 'non peaty' taste compared to Scotch.*
>
> ***American whiskey***
> *North American whiskies are all-grain spirits that have been produced from a mash that usually mixes together corn, rye, wheat, barley and other grains in different proportions, the resulting distillate then generally aged in wooden barrels. These barrels may be new or used, and charred or uncharred on the inside, depending on the type of whiskey being made. The U.S. government requires that all whiskies have to be made from a grain mash and be distilled at 90%abv or less. The whisky has to be reduced to no more than 62.5%abv before being aged in new*

> *oak barrels (American white oak) and then be bottled at no more than 40%abv.*

Why go to the bother of using grains ? and why do you need the malt present ? Cornfed explains ...

> *Malted grains: Are grains that are sprouted and then have the growth stopped. This process naturally produces the enzymes necessary to convert starch to sugars. The enzymes are called amylases. You can also get enzymes from a supplier and add them.*
>
> *For an extremely over-simplifed botany lesson: Plants exist to survive and reproduce. They are only tasty to us by coincidence. A kernal of grain needs to be mostly a sugar form in order to grow larger than a sprout. The kernal is meant to supply the necessary food so that it can grow. But sugar is prone to spoilage and to rapid fermentation from natural yeasts and from insects. So the food is stored as starch for safekeeping. When needed, the kernal produces enzymes to convert that starch to sugar. You add malted grain to mashed grains to convert the starches in the entire bunch to sugar. Mashing is the process of heating grain to the point where the starches are released from the solid kernal.*
>
> *The reason to ferment grain is to get the flavor from the grains and save it in your beverage. The cut off points when distilling determine how much flavor or odor is included in your beverage. Same theory as getting too much instant coffee in the cup. Too much makes it a nasty sip. Just enough makes it pleasant. Not enough makes it weak and watery.*
>
> *You need to use grains to make a traditional whisky recipe. Otherwise you are making a clear vodka and then adding syrups to flavor it enough to call it whisky. If you grind up a steak and drop it on a bun after frying it, is it still called steak or is it hamburger? If a tree falls in the woods with no one around does it still make noise? If a man speaks when no women are around is he still wrong? Lots of questions with out clear answers.*
>
> *The payoff for the effort that is invloved is the satisfaction knowing that you accomplished something diffucult, and did it with a certain amount of skill. Bragging rights are important sometimes. The proof is in the cup.*

Where do you find cracked corn and other grains suitable for brewing with ? Try rural feed supliers. As long as you get the grain after the cracking process and before they add the fortifications to the animal feed you will be alright. Tell then you want cracked corn to make homemade corn meal or flour and they should give you the right stuff.

Using Malt Extract

I'd be really keen to hear if you've had success, experience or otherwise using either just beer kits (liquid malt), or partial mashes of kits and a small mash. Please e-mail me with your comments.

Donald advises ...

> *Malt (unhopped) extract makes great whiskey, never boil the extract just stir it into warm water. Boiling can carmelize the malt extract (which has already been boiled once) making more non-fermentable sugars. Obtain the lightest all malt non-pasturised extract possible for the best results. Mixed extract (50% wheat 50% malt) with or with out corn sugar, produce flavorful products which are greatly inhanced by yeast strains.*

A mate of Jacks has had sucess with just using malt extract ...

> *I have tried a whiskey made out of unhopped liquid malt extract. It was made with 12 pounds of pale malt syrup boiled for 10 minutes in 5 gallons of water and was fermented with a dry ale yeast with a high alcohol tolerance. It was distilled in a 5 gallon pot still equipped with a one liter mason jar as a "thumper". It was then distilled out to 80% alcohol, diluted down to 63%, aged in charred American oak with a splash of cream sherry, then when the distiller thought it was ready, it was cut to 50% and bottled. One of the best I've had. The only problem is that the mash liked to foam A LOT in the boiler (yes, it was finished fermenting), but the thumper caught the spillover. It would be a good idea to keep a close eye on the temp when distilling this one, and/or use an anti-foaming agent.*

If you are planning on using a malt extract, make sure that it doesn't contain any hops ! They will do serious bad things to the flavour, and basically ruin any chance you had making a half-decent product.

Jack suggests about this is ...

> *I just talked to the man that made the batch of whiskey out of malt syrup and found out it was his third attempt to make it. The first 2 got contaminated (I don't know how, he is known to be a beer maker with solid sanitary brewing skills) , and the 3 foamed over, and there was no thumper to catch any of it. The reason heavily hopped beers don't spoil as easy is because the hops have an antibacterial property to them. Unfortunately, the oils would carry over into the whiskey and ruin it's flavor.*
>
> *Here's the good part: While studying lambic brewers in Belgium, I noticed that they use AGED hops (mostly Northern Brewer hops) when they make their beer - aged hops offer almost NO bitterness, and NO aroma to the beer, but the antibacterial properties REMAIN!!! Lambic brewery hops are typically three years old; rather than go to that extreme try leaving them in your car in the sun so they go stale quickly, then when you make a malt extract whiskey add them (maybe 1/2 to 1 and 1/2 ounces) to the boil. Boiling for about 45 minutes should do it. Since the mash will most likely end up around 10% alcohol, the amount of syrup in the mash will make it so thick that what brewers call "hop utilization" will be low (another way of saying the mash is so thick that the bitterness can't get out of the hops- but the antibacterial effect can). Granted, I haven't tasted any whiskey made this way, but it would have saved my friend a couple of spoiled batches.*

Tim writes:

> *I am a beginner at the home distilling lark but I have made some pretty good whisky with the following :- 2 tins of Maltexo brand malt extract and 1 kg of ground roasted malt + 1kg of sugar made up to 20 litres , fermented out (using Still spirits Turboyeast) and distilled twice with an electric pot still - resultant spirit aged on sherry soaked oak chips. I made a cock up with calculating the OG and likely yield (didn't allow enough for the non fermentable solids in the ground malt) and ended up with a low total yield of whisky(approx 1.5 litres 43%) however it is has an excellent taste and is indistinguishable from a scotch single malt.*
>
> *Also an easy recipe for cider brandy / calvados - 20 litres apple juice 3kg sugar - turbo yeast , 2 x pot distillations- need to carefully fractionate heads and particularly tails and biff anything with an off smell , cut to 40% and age for a few weeks oak chips-this is also a good tasing drink.*

Grain Recipes

- **Bourbon Whiskey** - 6 parts Corn, 2 parts Rye, 2 parts Barley. Only malt the barley, but grist all the grains and proceed.
- **Pure Rye Whiskey** - either only Rye (malted, gristed etc), or 9 parts Rye (not malted) and 1 part malted Barley.
- **Irish Whiskey** - 10 parts malted Barley, 7 parts fresh barley grain, 1 part fresh Oats, 1 part fresh Rye, 1 part fresh Wheat. Grist & proceed.
- **Gin** - 16 parts Corn grain, 3 parts malt, 1 part Rye

Ian Wisniewski (whisky and spirits writer, and author of Classic Malt Whisky (Prion Books)) wrote about barley at Whisky World (big thanks to Whisky World for letting me copy these extracts !)

> *The main talking point is always a distillery's water source, with the influence of the stills, peating levels and wood policy more recent additions to the debate. But what about barley, which seems to be taken for granted, as though it's merely a starting point before all the other influences take over? Ordering barley is, however, far more involved than simply stipulating quantities and delivery dates, with numerous options for the distiller to consider.*
>
> *Most of the current barley varieties used for malt whisky are two-row, as opposed to six-row (which is indigenous to countries such as Sweden, Norway and Finland, where it is the basis for Finlandia vodka). This numerical distinction refers to the fact that the ear (or 'head') essentially contains two rows of seeds, while six-row barley contains six rows of seeds. An ear of two-row barley contains a total of around 24 to 34 seeds, depending on the variety and environmental conditions. Those with higher totals can have smaller-sized seeds, while varieties with lower totals may have larger-sized seeds, which pretty much evens it all out. Moreover, the amount of seeds is not as important as the overall weight of the grain. Another distinction to draw is between winter barley (sown in August to September and harvested in late July to early August), and spring barley (sown in March to early April and harvested in August to September).*
>
> *While both can offer the same flavour and level of quality, spring barley is a standard choice in the industry. This is despite the fact that agricultural yields are typically slightly lower, between 2 and 2.75 tonnes per acre, compared to winter barley at around 2.5 to 3.5 tonnes per acre. However, as spring barley usually has higher levels of starch and lower levels of nitrogen, the yield of alcohol is higher – which clinches it for the distiller. Barley is generally cultivated along Scotland and England's eastern coastline, locations that offer the most favourable conditions. How influential any element of terroir may be, in comparison to the barley variety cultivated, is another consideration. As a barley variety that may inherently give a good level of starch also depends on the*

climate to achieve this potential, it's generally considered to be a fairly even split between the barley and the climate. While annual weather conditions can affect starch and nitrogen levels, some barley varieties are better at surviving adverse weather, and are more resistant to certain infections. This explains why another school of thought is that the barley variety is slightly more significant than climate.

Scotland's milder climate, with long daylight in summer, can certainly be a great advantage. Steady amounts of rainfall are ideal after sowing spring barley, while sunshine is required when it flowers in late June. Flowering lasts about a week, and the seeds begin to form after pollination occurs (conveniently, barley is self-pollinating).

Although lower levels of nitrogen are ideal for the distiller (it's a straightforward formula, the less nitrogen, the higher the starch content), nitrogen is added to the soil, together with phosphate and potash. These are combined in a compound fertiliser, usually applied a couple of times, at sowing time and mid-way through the growth cycle. The farmer calculates the mineral levels in the soil, and how they need to be supplemented, with each element of the fertiliser performing a strategic role. Nitrogen promotes growth and the production of green pigments which are used for photosynthesis, while phosphate and potash benefit the roots.

Photosynthesis (which occurs during daylight) starts to build up starch granules within the seed, together with rising levels of nitrogen. Starch continues to develop until the grain is harvested, with a straightforward hierarchy emerging: the largest starch granules being the oldest. A ripe grain contains numerous larger and smaller starch granules, with the aim of the plant being solely to produce seeds that ensure the subsequent generation of barley. Different barley varieties are termed 'early' or 'late', depending on the date of maturity, Chariot being early and Optic late. The difference between early and late can be a case of one to two weeks, which may not sound long, but this is a significant time-span for the farmer (particularly in September when the weather is certainly less than reliable).

Once harvested, most maltsters subject the barley to indirect air drying, using a system of heated pipes, like central heating. The other option is direct air drying, when air is heated by a flame created by a furnace. Either way, barley is dried to a moisture content of up to 12%. At this point the grain is dormant, a schedule imposed by nature to ensure that grains begin growing during the appropriate season.

As barley can only be malted once ready to germinate, the length of dormancy is

> *a relevant factor. A traditional variety such as Golden Promise can be dormant for around two months, whereas Optic is ready for action after four to six weeks.*
>
> *Emerging successfully from dormancy also depends on appropriate, watertight storage at the right temperature, which enables barley to be stored for up to a year, or longer (though supply and demand essentially determine the length of storage).*
>
> *The main barley varieties currently used are Optic, Chalice and Decanter, which were developed during the 1990s. Optic took the top ranking from the previous leader of the pack, Chariot, in the year 2000. Chariot had commanded 40 to 45% of the market since the mid-1990s, but as it's a fast-moving business Chariot is now fading from the scene. In fact, the rate at which newer varieties replace earlier generations has become more rapid, and is currently around three to five years. This compares to Golden Promise (originally developed in the 1950s) which reigned supreme from the mid-1960s to the mid-1980s.*

Yield from Grains

How much alcohol can you expect to make, based on your Grain recipe ?. Check out Mash Effficiency and Yield which I have stolen in its entirety, from a posting from John Palmer which was sent to the ***rec.crafts.brewing*** discussion group. Sorry, but its still in imperial units (points/pound/gallon (ppg)).

Whats the differences between 6 row and 2 row barley ? Dick explains ..

> *The numbers refer to the number of ears around the central stalk. Two row barley has the ears lying (believe it or not) flat in two rows either side of a central stalk while in 6 row barley the ears are all round the central stalk. The important difference is that 2 row barley tends to have a much lower nitrogen content than the 6 row and is therefore much more suitable for malting for brewing and distilling. A high nitrogen content in the barley results in a high protein/lower starch content in the malt/mash which in turn results in less ethanol & more higher alcohols + other nasties after fermentation. 6 row barley is used to produce bread flour etc., while whisky distillers/ maltsters will put very strict limits on the nitrogen & moisture content of any barley they buy. One of the reasons Scotland started producing such good spirits & beer was that 2 row barley would grow in our much poorer soils and needed much less fertilisation than 6 row.*

Andrew adds ...

> *A few weeks back I wanted to work out optimal vs actual conversion rates for a few different mashes. I converted a few of the points/pound/gallon rates on your mash efficiency and yield page to points/gram/litre, and thought I should send the formula through to you as well:*
>
> *x p/p/g = x / 119.8264 p/g/l*
>
> *e.g.:*
> *1/2 kilo 2 row lager malt*
> *3 kilos wheat flakes*
> *17.5 litres of water*
>
> *using the optimal column:*
> *37 ppg for the 2 row is 37/119.8264 pgl, or .30878 pgl*
> *36 ppg for the wheat flakes is .30043 pgl*
>
> *500 gms x .30878 = 154.39*
> *3000 gmx x .30043 = 901.29*
> *total: 1055.68*
> *1055.68 / 17.5 = 60.32 points*
> *divide the actual number of points the mash yielded by 60.32 and you have your mash efficiency, just like using the original imperial rates in John Palmer's post.*
> *It took me quite a while to find the correct conversion method so I thought it might help out someone else trying to do the same thing without thinking in imperial.*
> *PS -- I assumed the author was using US Imperial units -- if you know that they were in fact UK units please let me know. The conversion factor in that case would be x/99.77633.*

Malting

Malting is the process of allowing the grain to start to germinate & sprout, so that it will generate enzymes (amylase) to convert its store of non-fermentable starch to a sugar.

If there are no enzymes present, the yeast will not be able to use the starch - it must first be converted into sugars.

Not all the grains in each recipe require malting. As long as some (at least 20%) have been malted, there should be sufficient enzymes (amylase) present to convert the starch in the other grains. Note: this is why you can add amalyse (Speedase? - commercial name) to help speed/complete malt and grain beers & worts, but it won't do a thing for thin sugar based worts (no starch to convert).

Jack advises ..

> *Malting for home use is not a difficult procedure, but it should NOT be attempted with oats or with rye.*
>
> *These grains, when malting, tend to attract butryfying bacteria - these organisms, by themselves are poisonous, and so is the butanol isomers that these bacteria produce (see page 127 (for oats) and page 130 (for rye) in the book "The Homebrewer's Garden" by Joe Fisher and Dennis Fisher, Published in 1998 by Storey Books (www.storey.com)).*
>
> *If you have a need for a malt of either of these grains - purchase it ready made rather than poisoning yourself with the homemade type.*
>
> *If you want a good rye flavor that can add a bit of flavor to a vodka, you would be better off using flaked rye or ground rye from a feed store that you boil for 30 minutes, to gelatinize the starch, then cool down to 155F before adding 10% by weight of six-row malt. I've tried it both ways, the malted rye tastes alot like malted barley when run up to 90%abv- the spicey/creamy flavors from the rye totally vanish- you might as well be working with barley malt syrup for all the rye flavor you get. When made with flaked (or boiled) rye and a little 6-row is added, the rye "heaviness" tends to come through a lot better, and makes for a more interesting spirit, vodka or whiskey.*

I haven't done the following, as malted grains can normally be bought from beer-homebrew shops. Check beer related homepages for more details; I've summarised the following steps from a couple of books.

- Soak grain for 24 hours, change the water, and soak for another day. Toss away any thing that float. Try to keep the water between 17-30 C; too cold and the grains won't grow.

- Spread grain out (2-5 cm deep) on a wet surface, and keep at 17-30 &degC, until it sprouts (7-10 days). Turn grain over daily & keep moist, so that all get a chance to sprout. Wait until sprouts/rootlets are 5 mm long.
- Dry the grain - either spread out real thin in front of a breeze, or oven dry SLOWLY. Don't exceed 50 C until grain is dry (couple of hours), then 55 C for an hour, then 66 C for an hour. If it gets too hot, the enzymes present will be destroyed, and not work during mashing.
- Clean and de-sprout the grains - place in a sack/bag and bang against a hard surface to knock off rootlets. Shake & toss in a sieve to allow crap to fall through holes.

Drying the grain isn't always necessary if you're going to be using it all straight away. Ted advises ..

> *There is no reason that you must dry your malt before mashing. My grand father would soak bags of corn until it sprouted and then grind it up and mash with it. The reason brewers dry the malt is to remove DMS from the grains, this isn't necessary for distillation but it is always better to have a clean smelling ferment for the peace of mind that it gives.*

Jack gives his method for malting ...

> *Malting is easy -*
>
> - *Soak the grain for 72 hours (change the water every 24 hours) while soaking put an aquarium pump/airstone in the water so it bubbles through the bed of grain (it should have a good few inches of water over the top of the grain).*
> - *After the soak, put the grain in a bucket with hundreds of little holes drilled in it, then sit this bucket into another bucket that has a couple of inches of water in it. Put the airstone from the air pump into the bottom bucket so it bubbles up through the water- leave the lid on loose so the air can be exchanged by the pump. The air pump is scrubbing out the CO2, preventing mold growth, and preventing heat buildup.*
> - *Once the rootlets are roughly the length of the grain (for barley- for corn, wait until the root is about 2" long), dry the malt- this must be done in the dark - a food dehydrator is best.*
> - *You can also use the malt without drying it- this is called "green malt" just make sure the original weight of the grain is recorded to make recipe formulation easy.*
>
>   *It's a pain to get it to grind when it's wet, though. It will have a higher enzymic activity - but not noticably. The real problem is that green malt (if you are making a malt whiskey) can give a funny flavor to the spirit. If the wet malt is only used for it's enzymic*

> *ability (ie. Bourbon) then it won't make a difference - use it wet in that case.*
>
> *Drying is complete when the malt weighs the same as the original amount of grain you started with.*

This system (using 5 gallon buckets) works best with 5 pound amounts at a time (starting weight).

To make Scotch, just put the malt in a commercial bar-b-que smoker and smoke the grain dry (using the coolest heat possible), but use peat from the garden store as your fuel/smoking agent. Baled peat can be had for about $16US for 4 cubic feet at most big garden stores- just make sure there is no fertilizer in them (read the label). That's all there is to it.

Jack offers more help on **How to peat your malt**

Right, some people on the distillers' group asked for help with Scotch- now I find out "I can't get peated malt in Austrailia"- fine- here's how to do it at home

You can peat either barley you have malted your self or malt purchased from the homebrew shop: If it's home malted, then just take the freshly sprouted grains and dry them for 24 hours in the lowest setting of your oven (they should be half-dry at this point), for purchased malt, buy some 2-row from the homebrew shop and soak it for 24 hours in cold water, the grain is now ready to smoke. Soak the peat (from a garden store- a 4 cubic foot bale costs $15US) overnight in water. Prepare a bed of coals in the normal manner in a standard bar-b-que grill, or set your gas grill to low/medium. Drain the water off of the peatand place it in an even layer over the hot coals/burner. Put the grain on a clean, fine-mesh screen over the fire/peat bed. Cover the grill (with the vents wide open) to get the smoke in solid contact with the grain. Stir the grain every 5 minutes to prevent burning/scorching. Smoke the grain from 15 to 40 minutes until the grain is fully dry. When it's cool, it's ready for use.

Update ! *I just got through talking with someone at the Hugh Baird malting company- this is what I found out: By soaking some basic 2-row malt in water until you get a 28% moisture level, and then dring the malt with an open (low) peat fire, you can make your own peated malt. No need to mess about with smokers or charcoal grill. i.e.:*

  - *soak 1,000 grams of 2-row in water (unmilled, from the homebrew shop), until it weighs 1,280 grams (when the excess water is allowed to drain off).*
  - *Take this grain and place it on a tight-mesh screen, like metal window screen, and then put another layer of screen over the top of the grain, to prevent ash from falling onto the grain, which would cause a creosote like flavor in the malt.*
  - *Start a small fire under the screen with a bit of peat from the garden store.*
  - *Dry the malt over the fire slowly to prevent the malt from browning/charring- misting the fire and the grain with a water spritzer helps.*
  - *When the grain is back down to weighing 1,000 grams- you're done- you now have peated malt.*
  - *Mix it 50/50 with some unpeated 2-row, and brew an all-grain malt batch.*
  - *Ferment and distill it however you like- if it is too heavy in peat for your taste, just make a batch of straight 2-row malt whiskey, and blend however you like.*

> *I also finished an experiment in Scotch moonshine- "peatreek". Soaking a pound of commercial or homemade peated malt in a gallon of water at 155F for 40 minutes, straining out the grain (and rinsing with a cup or two of 155F water), then bringing the water to a boil and adding two pounds of table sugar, makes a nice, but one-dimensional Scotch. No nutrients are needed- the one pound of grain provides enough free amino-nitrogen to get a healthy ferment for that much sugar. It has a nice smokey flavor, with no real malt to back it up. It's nice in cocktails and the like, on it's own, it tastes like a bottom- shelf, bargain basement blended whisky- with better wood aging, a dash of sherry, a dried apricot or two, and it could compare nicely to the essence based Scotches made out of sugar spirit/vodka.*

For more on malting, see :
Chris' Excellent Home Floor Malting Adventure
Malting
Malting Equipment
Malting process in a nutshell

Ian Wisniewski (whisky and spirits writer, and author of Classic Malt Whisky

(Prion Books)) wrote about malting at Whisky World (big thanks to Whisky World for letting me copy these extracts !)

> *Malting comprises three essential stages: steeping, germination and kilning, which provides the distiller with direct access to the grain's starch content. Starch is present within the endosperm (the main interior section) and serves as a food source, enabling the grain to produce the energy required to develop roots and an acrospire (shoot). The starch is initially enclosed within protein-lined cell walls, which the embryo begins to break down as it grows, in order to utilise the starch. Once the starch has been liberated, further growth is arrested by kilning (applying heat), otherwise a lower starch level would reduce the yield of alcohol.*
>
> *Steeping effectively 'awakens' the barley by hydrating the grains in steeps (vessels), with up to three separate batches of water raising the moisture level from around 12 per cent to 40 to 45 per cent. Simultaneously, 'pressure aeration' can be applied, which means blowing compressed air from the base of the vessel. This aeration is assertive enough to move barley from different levels of a steeping vessel, but gentle enough not to cause any damage; some movement promotes more consistent growth. Otherwise, barley remaining at the bottom of a steep would receive less oxygen during what is termed an 'air rest', diminishing the growth rate.*
>
> *Draining the steeps in between each batch of water gives the grain an air rest of several hours, or longer. During this period 'suction aeration' can also be used to introduce fresh air into the steep, while carbon dioxide is removed to ensure even growth.*
>
> *Air rests may seem to extend the timetable, though grain left continually underwater can actually take around twice as long to process. Air rests provide more oxygen which raises energy levels, and makes it easier for the grain to absorb water. This explains why the uptake of water is far more rapid after the first air rest, once the grain is 'energised'. Moreover, the micropyle (opening) at the tip of the grain is the most efficient conduit for taking in water, whereas the outer layers of the grain are relatively waterproof (and water uptake through these outer layers is slow).*
>
> *The water used for steeping at Port Ellen Maltings on Islay is piped direct from Leorin Loch in the nearby hills. A seasonal adjustment involves heating the water to between 13.5 and 14.5°C from mid-September to late May. Otherwise, adding colder water would simply prolong the time required to initiate germination, and enforce longer air rests. Moreover, as grain generates heat during steeping, adding a subsequent batch of water at a cold temperature would instigate*

thermal shock (grains loathe abrupt temperature changes).

Visible confirmation that the grain is responding to its wake up call is the appearance of a 'chit', a small white root tip at one end of the grain. Diastase also begins to form, and continues to develop during germination (this combination of enzymes subsequently starts to break down proteins and starch in the barley, making them soluble, which is essential for the conversion of starch into sugar during mashing).

Barley can be germinated either spread evenly across stone or concrete malting floors, or in germination vessels such as drums. On a malting floor this may take five days in summer, seven in winter, reflecting the ambient temperature. The barley is aerated by 'turning' (redistributing) it every few hours using a 'malt shiel' (spade), which helps control the temperature and rate of germination. Alternative options are a 'plough' (a three-pronged rake) or a type of rotivator, supplemented by another basic form of temperature control, either opening or closing windows.

The germination drums at Port Ellen Maltings are not only the UK's largest, but also have the ultimate pedigree of being manufactured by the firm of Robert Boby. Each of seven steel drums holds the contents of two steeps (i.e. 50 tons of barley at original weight, 65 tonnes after steeping).

Loading the grain into drums inevitably results in two separate piles of grain. As this would foster uneven growth rates in different sections of each pile, the drum is rotated twice. This procedure is assisted by angled fins bearing a corkscrew pattern set within the drum ensuring the grain spreads evenly across the floor.

A perforated steel floor enables carefully controlled volumes of air, generated by large fans, to be blown through the grain. This maintains the appropriate temperature, and as the air is humidified with fresh water it also promotes the right humidity for growth (ordinary air would simply dry the barley too soon).

The air flow, humidity and temperature are adjustable in order to control the growth rate, with the temperature not exceeding 25 to 26°C. Too high a temperature entails a risk of the embryo dying and damaging the enzymes. Another factor promoting consistent growth rates is that the circulating air also removes heat and carbon dioxide from the drum (exiting through vents). Continued growth sees the grain beginning to break down the cell walls and protein lining to access the starch. Meanwhile, developing rootlets also consume protein, which is another advantage. Protein must be carefully managed in order to avoid problems at subsequent stages in the production process. Higher levels *of protein diminish the effect of hot water on the starch during mashing, for example, which compromises the rate of conversion into sugar. Protein can also burn onto the surface of the wash still, contributing undesirable caramelised flavours to the new make spirit.*

However, if rootlets were left alone to do what comes naturally, they would intertwine and create a dreadful tangle. This is countered by rotating the germination drums every eight hours, a leisurely turn lasting five minutes at Port Ellen Maltings, with the fins gently teasing the roots apart.

After about five days the grain reaches an optimum stage of growth when most of the protein has been utilised for root growth, and the cell walls have been broken down, providing direct access to the starch. The acrospire (shoot) also extends under the skin (husk), along around three-quarters of the grain's spine. Any longer would indicate excessive growth. Any shorter, and it's not quite ready.

A traditional method of checking growth was for the Maltman to inscribe his initials on a spade using a grain. If legible, the malt was ready. Another low-tech option is the 'rub test'. By splitting a grain open with a fingernail, a small amount of the endosperm can be rubbed between the thumb and forefinger. If this leaves a fine white powder mark, it confirms that the starch (in the form of barley flour) is ready for kilning. A lack of white powder indicates the starch is still enclosed by cell walls and protein.

The aim of kilning is to arrest growth by drying the malt as quickly and uniformly as possible, with the moisture level typically 40 to 50 per cent at the beginning of the process. Taking care not to damage the heat-sensitive enzymes, the initial temperature is around 40 to 50°C. Once the grain reaches the 'break point', when the surface moisture has been driven off, the temperature is gradually increased to around 75°C.

For malt that is being peated, an important factor is that moisture promotes the absorption of smoke, essentially by the husk. As the surface begins to dry, it becomes harder for the grain to absorb smoke, until reaching the 'break point'.

Once the peating has been concluded, kilning dries the malt further (essentially the interior of the grains) to a moisture level of about 4.5 to 5 per cent. This can take from 25 to 40 hours, using either hot air or firing the kiln with gas or fuel oil. In addition to peaty, smoky flavours created by peating, kilning also develops the malt's flavour profile with a range of sweeter, biscuity notes.

After the rootlets have been removed, malt is subsequently rested in sealed bins

> *for several weeks. As the heat of kilning concentrates residual moisture in the centre of the grain, the resting period allows this moisture gradually to extend back and be evenly distributed throughout the grain. This ensures milling is more even, promoting fermentability and consistency.*
>
> *The rootlets aren't wasted either, serving farmers rather than distillers. Mixed with dust from incoming barley to form 'malt residuals,' then dampened with water and shaped into pellets, this is used as cattle feed. Islay cows are used to the peaty flavour that their local 'take-away' serves up, whereas mainland cows are not. However, Port Ellen Maltings also caters for them by adding a small amount of molasses to the recipe, which sweetens the flavour.*

How much peated malt to use ? Jack writes ...

> *if you get the same malt that I do (from Hugh Baird malting company), it comes in 3 strengths of peat: low (5ppm), medium(10ppm), and high(15ppm). This means that you CANNOT make a heavily peated malt like Ardbeg, Lagavulin, or Laphroaig- they are in the 40 to 50ppm phenol content range. You can come close to Bowmore (20ppm). And Aberlour, Glenfarclas and Cragganmore are easy to do - they have peat/phenol content of 2ppm. Deanston and Glengoyne have no peat at all.*
>
> *To make a Scotch, just make an all grain batch of beer using peated barley, either straight (most homebrew shops, like mine, only have the heavily peated malt in stock), or mixed in with some domestic 2-row to cut the peat levels. I'm an Irish lover, mostly- so I make mine unpeated, and I use the corn whiskey books' tips on "making the cut" to make the smoothest stuff you could ever find on the planet. I've made Scotch by mixing 2-row and peated barley in a 50/50 mix and double potstilling it. It was great when aged on sherry wood- but I gave it to a family member who likes Scotch more than I do.... (by the way, mixing unpeated malt whiskey with corn whiskey (80%malt/20%corn) and aging on old bourbon chips with a dash of sherry makes a great copy of Bushmill's Black Bush Irish blend- my favorite.)*

More from Jack ...

> *After re-reading some of my books, I found some numbers that might help those looking to copy Glenmorangie Scotch. On your commercial stills photo page, Laphroig is listed as a 10 in peat, Glenmorangie is listed as either a 2 or 3. From another book, I found out that the ppm of phenols (from peat) in Laphroig whiskey are in the 40 to 50ppm range (the*

heaviest)- but I couldn't find anything on Glenmorangie. After comparing the numbers, I ran the estimates as given Laphroig= 40 to 50ppm which equals a rating of 10, and Glenmorangie is a rating 3 to 4, which gives X for the peat levels. Going from the highest to the lowest- I found these possible peat levels (in ppm of phenol) for Glenmorangie= 8,10,12,15ppm are all possible levels. Another published ppm level states that Bowmore is about 20ppm- medium peat- far too heavy for the likes of Glenmorangie, ruling out the 15ppm rating by tasting. I then found a Scotch retailer online listing his products- he has Glenmorangie listed as a "North Highland" type of Scotch- other retailers list it the same. The same book that lists the ppm of Laphroig and Bowmore states that The north highland style sits between the lightly-peated Speysides (like Aberlour and Glenfarclas at 2ppm) and the medium-peated Bowmore.

The average of 2ppm and 20ppm is 11ppm- right between the mid-range numbers I calculated above for Glenmorangie "possibles". This, added to the fact that on Glenmorangie's OWN WEBSITE, they state that they take a middle cut of only one-fifth of the second run, to get a delicate, light Scotch. Comparing these cutoff points to the corn whiskey book, which takes a full 57.1% of the available alcohol as a middle cut, makes Glenmorangie an even tighter cut than the already smooth-as-water corn whiskey type of cut. Hugh-baird malting company sells three levels of peat malt: low (4-6ppm) which is of no use here. Medium (7-12ppm), which could be used as-is. and high (13-20ppm) which should be cut by about one-third with unpeated 2-row, in order to get about the same levels of peat as Glenmorangie, That is, enough to provide a complexity to the malt flavor, but not enough to make the whiskey taste like dirt.

To sum up- find out what peat you can get from a brewshop, cut it with 2-row if you need to. Mash it, sparge it, cool it, then ferment it. Keep in mind that the water in the Glenmorangie distillery is considered "hard", but not as much as Burton water- I would leave it alone if I have good luck with all-grain beer already. After the ferment, Distill the stuff in a "beer stripping run" to collect about 1/3 of the original mash volume until you get enough to fill your spirit still (using a stovetop potstill in the 5gal range, with a one-gallon ice-water-wok evaporative still works very well in giving a light spirit on the second run). Put your "low wines" into the smaller still, and collect out only about the middle 20% of the run to save as drinking spirit. For example, mix 5 pounds of 2-row with 10 pounds of

> *heavily peated brew-shop malt, mash and ferment as for allgrain beer with hard water. Distill out of this mash about 1.5 gallons (6L), run this into a small potstill, then collect out about 50ml of foreshots, 300 to 400ml as heads, approximately 500ml as your "keeping spirit", then save the rest as feints to be redistilled. Aging on ex-Bourbon wood, with a bit of finishing on ex-sherry wood completes the drink. This is not a cheap drink to replicate, but it is very good, and cheaper than $50US a bottle Glenmorangie.*
>
> *References:*
> *Spirits & Cocktails by Dave Broom (Carlton books, 1998)*
> *Making Pure Corn Whiskey by Ian Smiley (self-published, 1999)*
> *Classic Beer Style Series #8 Scotch Ale by Greg J. Noonan (Brewers' publication, 1993)*
> *Classic Beer Style Series #18 Smoked Beers by Ray Daniels and Geoffrey Larson (Brewers' publication, 2000)*
> *Malt Advocate Magazine, Volume 9, number 2, 2nd quarter, 2000 issue, Glenmorangie advertisement, pg3*
> *www.Glenmorangie.com- online distillery tour.*
> *www.homedistiller.org - Commercial distilleries photos and links page.*

Ian Wisniewski (whisky and spirits writer, and author of Classic Malt Whisky (Prion Books)) wrote about peat at Whisky World (big thanks to Whisky World for letting me copy these extracts !)

> *In addition to the level of peating, another consideration is the origin of the peat. As coastal and inland peat has differing characteristics, this yields a varying range of phenolic compounds – though exactly how influential this terroir is in the resulting dram depends on who you ask (particularly as the production process has a significant effect on the phenolic level). Peat cut from inland moors features a higher level of forestation and bracken, with Speyside peat for example comprising plenty of Scotch pine, roots, heather and spagnum moss (which has a great ability to retain water). The closer to the coast, the higher the level of sand, which means a looser texture, with coastal peat bogs, particularly on the west coast, also characterised by seaweed.*
>
> *Islay peat is a prime example, comprising pine trees, grasses, bog myrtle, heather and mosses, alongside a significant level of seaweed and sea spray influences, while sand contributes additional saltiness (being historic 'ocean sand'). These components combine to give a lightly oily peat with iodine, medicinal, salty and even tarry notes (which can be readily identified in Islay malts).*

Extracting peat is obviously eco-minded, only cutting the amount required for that year, with the surface layer of turf reserved and placed over a previously cut trench, ensuring regeneration. The peat cutting season, typically April to September, reflects entirely practical considerations as peat bogs must 'dry' to the point when they can be walked on (or take tractors, which have been known to disappear in peat bogs). Having worked a short shift on Islay, I know I would never be hired in that capacity. It's skilled and exacting work. The hours are awful too, a 4 to 6am start, finishing around 9 or 10 pm, as favourable weather means cutting as much as possible.

Hand-cut peat is typically extracted from a trench in two stages, using a peat cutter (or peat spade) to cut a piece around 60cm long and 15cm wide. After cutting an initial surface layer, another cut is taken directly below, with each piece laid on adjacent turf to begin drying. Mechanised cutting entails pulling a machine behind a tractor, fitted with either a 'circular' or 'chain saw.' This cuts a line several centimetres wide, which can be adjusted to various depths, cutting between 0.5 and two meters (so it can be a shallower extraction than hand cutting).

Different machines have individual methods of extruding peat, which can be compressed in a chamber, prior to evenly spaced bricks of peat around 10cm square being deposited in the machine's wake. Ready to dry where they fall, the pieces are collected a month or so later. Alternatively, peat can be continually squeezed out (like toothpaste) for the full length of the trench being worked. With a diameter of around 15cm, a skin forms on the surface within three or four hours as the peat begins to dry, preventing absorption of any rainfall. Continual shrinking, as the peat dries over the next couple of weeks, also breaks it up into manageable lengths, around 10 to 40cm long, with a diameter of five to 10cm.

Hand-cut peat typically takes longer to dry, while also requiring an additional step. It takes about two weeks for a skin to form, enabling the peat to be handled and carefully stacked with several other pieces to form either a small tower or wigwam. The wet side (the one that lay on the turf) is placed outward to ensure even drying over the next four weeks or so. Judging the moisture level is down to the experience of the peat cutter, though it's obviously not an exact science. Consequently, peat arrives at the distillery with moisture levels that can vary from 10 to 45%, and balancing this range is part of the skill of peating.

The aim of adding peat to a fire, which may even be started using redundant pieces of whisky casks, is to create a consistent level of smoke, not flames. As phenols are flammable, they can be destroyed by a flame breaking through onto *the surface of the peat. Controlling the fire and peat reek entails various parameters. The more fibrous top layer of peat provides more smoke, but is more reluctant to burn than darker, underlying layers which produce more heat. Very dry peat gives plenty of heat but not enough smoke, and so not much of that distinctive flavour. Adding smaller blocks of drier peat and crumbly debris – known as 'caff' or 'peat fines' – can help impede air flow and so produce more smoke. This type of peat can also be hosed (being very dry it holds water well) and used in its rehydrated form to help cool the fire down (being careful of course not to extinguish it) and promote smoke. To maximise the influence of the smoke, which at a traditional floor malting ascends through a wire mesh floor on which the malt is spread out, mechanical turners and fans are used to help draw the smoke through more evenly. Historically malt was turned manually on the wire floor by distillery employees. As one of the distillery's least popular jobs, it was at usually rewarded by a dram.*

Peating times vary from around 16 to 24 hours. This reflects the moisture level of the malt, typically 40 to 50% at the beginning of the process, with moisture promoting the absorption of smoke, essentially by the husk. As the surface of the malt begins to dry, it becomes harder to absorb smoke, until reaching the break point when the surface moisture has been driven off. Once peating is concluded, the malt (essentially the interior of the grains) needs further drying to a moisture level of around 4.5 to 5%. This entails kilning, with the kiln fired by various types of fuel, such as coke, or by using hot air, with kilning taking around 25 to 40 hours.

Malt is subsequently rested in sealed bins for several weeks, which is an important procedure. As the heat of kilning pushes remaining moisture to the edges of the grain, the resting period allows this moisture to gradually extend back, and be evenly distributed throughout the grains. This ensures that milling is more even, promoting fermentability and consistency. Peating levels are measured as phenolic parts per million, with a lightly peated malt around one to 10 ppm, a medium level around 10 to 30 ppm, and 30 to 50 ppm for a heavily peated malt. Commercial maltsters, which can do the job at a far more competitive price than in-house floor maltings, originated in the 19th century, but really took off in the late 1950s to early 1960s. That's when many distilleries increased their production capacity, but without extending malting floors. This meant maltings could not keep up with new production levels and numerous distilleries closed their malting floors. The minority retaining them include distinctive drams Bowmore, The Balvenie, Highland Park, Laphroaig and Springbank.

Whoever peats the malt a similar degree of accuracy applies, with peating levels generally between three to five ppm either way of a distiller's specifications, a

> *range which is not significant enough to cause any concern over consistency of the new make spirit (distillers inevitably prefer the peating level slightly over rather than under). Specific peating levels can also be attained by combining peated with unpeated (or lightly peated) malt, a practise known as blending.*
>
> *The peating level within the malt decreases during the production process. Although this varies among distilleries, a typical reduction of 10 to 40% could apply to the new make spirit. The largest degree of loss is typically attributed to distillation, with feints, pot ale and spent lees carrying a significant level of phenols.*
>
> *During maturation the peating level can also affect the influence of the cask. This is usually said to account for up to 60 or 70% of a malt's resulting flavour, though it's more like 40 or 50% with heavily peated malts, as phenols mask the oak influence.*
>
> *The type of cask is another consideration. Bourbon barrels promote phenols and distillery character more readily than the richer flavour profile and sweetness of a sherry barrel, where phenols are either masked or more integrated, depending on your perspective.*
>
> *Peating levels do not seem to be affected during the first 20 years or so of maturation. The level can actually rise during this period, due to similar compounds, polyphenols, released by the barrel's toasted / charred layer. While the visible longevity of phenols varies among malts, one theory is phenols begin fading after 20 years. Another opinion is that the phenol level remains constant, and as other flavours derived from the oak become more pronounced, phenols are masked. My current opinion is that I need to do a lot more tasting, then I'll see how I feel …*

Note that "live" malt is NOT the same as just "liquid malt" commonly bought in a can from your homebrew shop. If you are using it with grains, you need a malt that still has the enzymes present & active in it. They will not be present if it has been heated up over 70 ish degrees. Harry explains ...

> *There are two broad types of malt extract. Brewers (non-diastatic) and Bakers (high-diastatic). I've been a baker since 1969 and we always used malt in the old days to convert some of the starch for yeast food. I guess what I'm saying is that if you used bakers malt instead of brewers malt, you would achieve a result, and probably cheaper too.*
>
> *Have a look at this site in U.S. http://www.maltproducts.com/*

This extract from their products page...

> *Malt, the Natural Flavor, Sweetener, and Coloring Agent is available in many forms.*
>
> *Liquid, Dry, Diastatic, Non-Diastatic, Dark, Light, Extracts, Syrups and Powders with Cereal Adjuncts.*
>
> *Diastatic Malts (with the natural barley enzymes still active). are used primarily by bakers to supplement the amylase in the wheat flour to provide sugar for fermentation, improve pan flow, improve crumb color and break and shred in bread type products.*
>
> *Nondiastatic Malts (without active enzymes), are used as flavoring agents, for color sweetness and humectancy. The nutritive materials present promote vigorous yeast activity, accelerate dough conditioning and add flavor and aroma to finished baked products.*

So... if you are trying to convert other grains, make sure that the malt you use is "diastatic", or else you will need another source of the enzymes. If you simply want a malt for use on its own (ie as a quick and simple whisky base), then the "non diastatic" is ok.

Gristing

Gristing is cracking/crushing the grain to expose its center (the starch). You can use rolling pins (tip: put grains in a zip-lock bag - no mess), coffee grinders, mills, etc. Again, home-brewers get quite detailed (fanatical ?) over exactly how this should be done. Just get it broken into 3-5 pieces, but don't turn it to dust or flour. If you're using a mash tun etc, you want the gristing to pretty much keep the outer hull of the grain intact, so that it can form a filter bed during sparging. Generally mills are used to do this - they sorta "pop" the grain out of its skin, without breaking stuff up too much.

Mashing

This step converts the remaining starches to sugars. Heat the grain (and malt or amalyse) to 62-63 &degC for 45 min to 1 hour (stir occasionally), using 4.5L water per kg grain, then strain out the grains (use a kitchen sieve), keep the liquid (the wort/mash). Some methods involve bringing it to temperature, then holding it there for 2 hours in a big pot etc in the oven. When straining out the grains, rinse them several times with a small portion of the wort to fully wash them clean. Take care when heating the wort - it will easily boil over, quickly getting you banished from the kitchen. Watch it carefully, and enjoy the aroma.

When due to separate the grains from the liquid (lautering), raise the temperature to 75-77 &degC. At this "mash-off" temperature the wort viscosity is favourable for quick & complete separation, enzymes are mainly inactive, and bacterial action is precluded.

It can be a differcult exercise to rinse the grains - getting them to soak through a collander or using a brewers "false bottomed" pail. John V writes ..

> *Herewith a tip for those stuck with draining mash. The ideal item for this is the nylon paint straining bags sold at paint supplies stores. It comes in two sizes, the larger ones fits over an average-sized kitchenpan. I now use them for straining mash; my wife 'borrow' them for straining berry juice for jams and jellies. They clean very easily, just hold under running water.*

To which Tony adds ...

> *The nylon paint straining bags work well for me as well. I prefer using them over the top of large food grade plastic pails (available free at restaurants or deli's). The deep pail gives lots of capacity for strained liquid and leaving it drain overnight recovers prety much all of the available liquid from the fruit or mash. When the mash is too heavy the strainer elastic can't hold the weight, in this case use a stainless hose clamp (band clamp)to secure the strainer to the top of the pail. If you can't find a large enough clamp to fit around the bucket two smaller clamps can be easily assembled end to end and they are less expensive than one large one. I paid $1.70 Cdn. for a pair of small clamps a few days ago.*

There are two enzymes which convert the starches to sugars & dextrins. Beta-amaylase "chops" the long starch molecules in half into shorter chains, whereas Alpha-amaylase "breaks off" the branches in the starch structure. Working together they do a great job, and convert 60-80% of the available starch to fermentable sugars.

Of the malted barleys, their enzyme potency is (in decreasing activity) 6 Row by a country mile, then 2 Row, Pilsner malts, Lager malts, Ale malts then Viennas and then Munichs.

From http://realbeer.com/jjpalmer/ch14.html

> ***Starch Conversion / Saccharification Rest***
> *In this stage the diastatic enzymes start acting on the starches, breaking them up into sugars (hence the term saccharification). One group, the amylases, are enzymes that work on the more complex starches and sugars. The two main amylases are Alpha and Beta. Alpha works by breaking up long, branched starch chains at the branch points, leaving behind a variety of straight chain starches and dextrin-type sugars. The reduction of these large branched chains reduces the viscosity and "liquifies" the mash. Beta amylase works by separating these straight chains into fermentable maltose sugar units.*

From http://www.howtobrew.com/

> *Beta amylase works by hydrolyzing the straight chain bonds, but it can only work on "twig" ends of the chain, not the "root" end. It can only remove one (maltose) sugar unit at a time, so on amylose, it works sequentially. (A maltose unit is composed of two glucose units, by the way.) On an amylopectin, there are many ends available, and it can remove a lot of maltose very efficaciously (like a hedge trimmer). However, probably due to its size/structure, beta cannot get close to the branch joints. It will stop working about 3 glucoses away from a branch joint, leaving behind a "beta amylase limit dextrin."*
>
> *Alpha amylase also works by hydrolyzing the straight chain bonds, but it can attack them randomly, much as you can with a pair of clippers. Alpha amylase is instrumental in breaking up large amylopectins into smaller amylopectins and amyloses, creating more ends for beta amylase to work on. Alpha is able to get within one glucose unit of a amylopectin branch and it leaves behind an "alpha amylase limit dextrin."*

Alpha-amylase works best between 65-67 &degC, and dies within 2 hours at 67 &degC.
Beta-amylase works best between 52-62 &degC, deactivating within 40min at 65 &degC.

(To understand how enzymes work, see Enzymes, a useful email from Stephen Alexander to the Homebrew Digest about enzymes, explaining how they affect

the rate of a reaction, and how they work in the conversion of starch to glucose.)
You really need a mixture of the amalyses. Baker explains ...

> *If you have a purified Alpha you're going to want to add a gluco with that, or you'll end up with a low DE syrup. Even if your amylase contains a Beta you won't get full conversion. Beta can't get past the branch points, and the mash will end up full of beta limit dextrins.*
>
> *An alpha beta combo will only give you a theoretical 42DE, if you add a pullulanase (a de-branching enzyme) it goes up to 50DE, and Alpha/gluco combo has a theoretical DE of 95.*
>
> *By the was DE stands for dextrose equivalent, it is a measure of the percentage of glucose bonds that have been hydrolyzed. Pure dextrose has a DE of 100.*
>
> *I'm pretty sure that Beano is a 1,4-alpha-D-glucan glucohydrolase (a type of gluco-amylase)*
>
> *One of the things to keep in mind when you are thinking about what enzymes you want to put in your mash is what enzymes are commercially available. There are probably thousands of starch degrading enzymes out there, but only a handfull are produced industrially.*
>
> *Let me back up a bit, there are two types of starch, amylose, and amylopectin. Amylose is a straight chain of glucose molecules, linked at the alpha 1,4. Amylopectin is a highly branched chain starch molecule, the straight part is linked at alpha 1,4 the branch points are alpha 1,6 linkages.*
>
> *Wheat starch is about 24% amylose and 76% amylopectin.*
>
> *Alpha amylase randomly breaks alpha 1,4 linkages*
>
> *Beta amylase starts at the non-reducing end and breaks off two glucose molecules at a time(maltose). Beta only breaks alpha 1,4 linkages and so can chomp right through an amylose molecule, but will get stuck at the branch point (1,6 link) on amylopectin leaving large "beta limit dextrins".*

> *Pullulanase is known as a "de-branching enzyme" it cleaves alpha 1,6 linkages leaving nothing but straight chains for the beta amylase to chew through. However you'll still be left with a wort full of maltose.*
>
> *A gluco-amylase, sometimes called amyloglucosidase, will break both alpha 1,4 linkages and alpha 1,6 linkages leaving glucose (dextrose) molecules in its wake.*
>
> *Since what you want to do is break down the starch and create dextrose as quickly and efficiently as possible my recommendation is to add alpha amylase and gluco-amylase together. I personally use a high heat stable alpha amylase to thin the mash and a gluco-amylase when the temp drops, I often add more gluco when I pitch my yeast just as a precaution. what the hell it can't hurt right?*
>
> *Is the Pullulanase enzyme also in the malted wheat? No, but you don't need it if you're adding a gluco-amylase*

Zoran adds ...

> *Termoamylase break down starch at high temperature, above 100deg C to short polysaccharide chains. The starch glue became liquid. These chains are attacked by glucoamylase not galactosidase,to give glucose as a final product. These 2 enzymes gave 95% yield glucose. The rest are not important for convesion, but can split to glucose with pullulanase, not pectinase. It is important to have appropriate pH check. Information,usage and prices for these enzymes you can find on net*

The higher mash temperatures (65-70C) will produce dextrinous (heavy bodied beers, lots of "mouth feel") in a shorter period, whereas lower mash temperatures (62-63C) will produce more fermenatble (more alcoholic) beer over a longer time period. So go for 62-63C.

If you don't want to use malted grains, you can use amylase from a packet. Ted advises ...

> *boil the unmalted grains then cool them down to 148 to 155 degree F (64 &degC to 68 &degC), then add the amylase and let it sit for 60 min. Test the liquid with iodine for starch conversion (if there is starch present it*

> *will turn purple) Let it sit until it has converted. Don't seperate the wort from the grains untill after this process has finished.*

You can use Iodine to test for starch - add a couple of drops to a spoonful of wort; if it turns blue starch is still present, and it needs more mashing. It has no reaction / colour change if there is no starch present. Iodine is poisonous, so toss away the sample you tested.

Jack warns ...

> *few of the books on brewing/distilling say that weak sulfuric acid can be used to drop the Ph of grain mashes. According to the e-chapters you sent me, and the Seagram's distilling textbook I have:THE PRESENCE OF SULFURIC ACID DIRECTLY RESULTS IN THE FORMATION OF ETHYL CARBONATE IN THE FINAL SPIRIT!!!- THIS CHEMICAL IS A KNOWN CARCINOGEN AND IT'S PRESENCE IS RESTRICTED BY ALL GOVERNMENTS IN SPIRITS CONSUMED BY HUMANS!! I've always used lactic acid (or backset) for adjusting Ph in my beers ,etc.- I'm glad I've never used sulfuric acid.*

The reaction taking place during mashing is one of hydrolysis and all the components of the grain particle are subject to varying degrees of changes. While the conversion of starch results mainly in fermentable sugars, the degradation products of the proteins and other components will ferment into fusel oils, aldehydes, esters and acids, which are grouped under the generic title of "cogeners". The composition and concentration of these cogeners determine the quality and characteristics of a whiskey. Thus corn, with its high starch content, provides the source of alcohol, while rye, with its high protein content, provides the "flavour". The variation of the respective proportions of corn and rye leads to different mash bills which exhibit different levels of flavour. The malt, with its unique function (to provide the amalyse to break down the starch), always occurs at a constant predetermined percentage, typically 10-12% of the grain bill.

Reese answers some common questions ...

> Q1) I have thought about using a different corn - but would the chopped or cracked corn not behave in the same way as flaked corn? Would it not absorb the water in the same way, after all it is still corn starch?

> *It absorbs water, yes, but it only swells and remains relatively intact. Flaked corn, on the other hand, is corn that has been ground, rolled and then cut into flakes. When it absorbs water, it reverts back to its finely-ground state, hence your porridge problem. Chopped or cracked corn, while it absorbs water, will do so slowly, so you need to cook it longer and at a higher temperature. I kept my water at boiling through out the whole cooking process.*
>
> Q2) Also, I take it that you suspend the boiled cracked corn inside a feed bag during fermentation?
>
> *Yes. I have a large brewers bag that fits over the opening of my fermentation bucket, reaching to its bottom. After filling the fermentation bucket with sugar water, I line the bucket with the bag, cook the corn/malt and then simply pour it (and the excess water in which it was cooked) in. Then I tie the bag off with a loose overhand knot and put the lid on the bucket while it cools. It remains in the bucket and tied during the whole fermentation process. Afterwards, the bag will be emptied and washed for use in my next go.*
>
> Q3) How do you get the wort off the fermented corn - squeezing with your hands? Some sort of press? A lauter vat/set-up?
>
> *It should be possible to just simply rinse the bag with warm water, capturing what drains through. A good squeezing might help, but what you would get off wouldn't match the quantities of wort already suspended in the remainder of your now-brewer-bag-free fermentation bucket. The excess water that was available after cooking the corn/malt mix (and the corn's action on the wort while in the bucket) should have already contained enough starchy goodness to flavor the sugar-water wort base well enough.*

Scott writes ...

> *I'm no expert, but I do know from reading and personal experience that it's best to boil corn for 30 or 40 minutes to soften it up and gelatinize the starches (unless it's flaked corn, which has already been gelatinized). Make sure you use a stockpot that won't scorch the corn (e.g. thick stainless with a copper or aluminum bottom -- expensive! Or, like me, a*

> *non-stick aluminum pot -- less expensive). If you scorch the corn, your hooch will have a nasty stink (personal experience). If you don't free up the corn starches with a boil, your yield will be significantly lower. 1.040 is actually pretty good condsidering your mashing method, the amount of grain and the volume of water you used. You should be able to get closer to 1.060 if you add something like the enzyme gluco-amylase to the mash or wash.*
>
> *Why don't you get as much as with a sugar wash? Grain is about 50% starch, and you're never going to convert 100% of that to fermentable sugars. If you convert 75%, you're doing well.*
>
> *As for the iodine test still showing starch, there could be several reasons. Did you mix the malt throughout the mash (i.e. did all of the corn have a chance to get exposed to the enzymes)? Was your mash evenly heated throughout? Mixing/stirring to evenly distribute the heat is a good idea. You don't want hot spots destroying enzymes.*

Should you ferment on the grain, or sparge the grains ? Ian Smiley suggests..

> *If you're doing an all-grain mash of corn, rye, and or wheat, just ferment it all on the grain and strain it out later. It'll strain much more easily and efficiently after the fermentation. In fact, this is exactly what the commercial whiskey distilleries do.*
>
> *If you're making an all-barley-malt malt mash, you should sparge the grains out after mashing. Again, this is the way the commercial malt whiskey distilleries do it. However, keep in mind that malt mash does not undergo a kettle-boil the way an all-grain beer mash does, so you must limit the amount of sparge water you use or you'll over dilute the mash.*

Brainsolenoid cautions ...

> *I must admit humbley that I get a bit skiddish when I hear folks talk about fermenting on grains. There are a few items surrounding the mystery of fermenting / boiling grains, and in the Brewing community, these are some of the more basic items:*
>
> *1.) Grains were boiled in the late 1,700's up through modern times by Belgian Monks and German Brewers. They were performing what was referred to as a "decoction" mash, which was used to guarantee a*

cotrolled mash temperature in the times prior to thermometers. Part of the mash (and a little liquid) was pulled off the tun and sent to the kettle, where it was brought to boil, and then added back into the mash. This doesn't kill the enzymes as they survive in the liquid part of the mash. It makes a great Bock or other fuller bodied lager.

2.) Brewer's boil their wort for numerous reasons, but mainly for reducing wort volume (and increasing sugar content), breaking proteins out of the wort for clearer beer, and for another extremely important reason......sterility. I get nervous when folks walk away with a snippit of info and fail with it. Yes, you can make a wash without boiling, but you are running some risks, sterilization wise, and will require an good size pitch of fast yeast to get things moving quickly. Even after boiling, I answer a lot of questions by Homebrewers who's wort has gone to mold even after boiling and pitching yeast. Long lag times produce off-flavors and and infections, and boiling helps at least to minimize what's carried over from the bacteria on the grains.

3.) Now, I will preface this by saying I'm no chemist, but it is our belief that you have to boil for quite a while......say 90 minutes at least and it's still a function of wort gravity.....to get even close to the type of flavors found in extracts. Extracts, so we believe, gets that band-aid type background from overworked melanoidens. These produce the type of extreme maltiness you feel in Dopplebocks and higher gravity beers. Extracts are just worked to hard to get them in extract form and in contest tastings I can taste them right off.

4.) Brewer's don't ferment on grains because it produces off-flavors as well as clarity nightmares. It's been written in brewing circles as well that fermenting on the pulp material produces methanol, though I have read to the contrary in (2) distillers resources that only pectins produce methanol. Since it is considered a "wood alcohol", we have always considered it as a byproduct of pulp fermentations. Though the "pectin" story seems to be spread throughout messages on this site (their source being the same (2) I've seen, no doubt), the Brewer / Engineer in me will stick with the logic that if fermenting on cellulose is a good thing, then we'ld all be cutting our trees down for hooch.

It may be true that some Distillers are boiling their washes and are

> *fermenting on grains, I'm sure you'll find some that aren't. The use almost laboratory standards that we don't have access to. Further, their pitching rates / oxygen contents are much higher than the amatuer distiller.*

To which Ian Smiley replies:

> *The information that BS gives is very accurate and completely consistent with the regimen I've learned and have been using for many years as an all-grain beer brewer, and achieving excellent results. I've done triple decoctions and cold lager fermentations to make continental pilsner, and I've done heavy English ales with dark specialty malts using other methods that BS mentions.*
>
> *I'm also aware that to ferment a beer on its grains would not only impart all kinds of off-flavours and undesirable bitterness from the husks, but it would engender yeast autolysis later in the fermentation cycle. And, for beer mashes, one definitely has to boil for about 90 minutes. This is not only important to achieve the hot break and to stabilize the flavour, but it's the only workable way to perform and control the hop extraction: bitterness, flavour, and aroma.*
>
> *Having said all that, I must point out that in my last contribution I was referring to whiskey mash, and not beer mash. There's a significant difference in the two processes. Whiskey mashes that are fermented on the grains are high-adjunct mashes (typically 80+% corn, rye, or other cereal grains) and mashed to optimize fermentability. The mashing temperatures of around 65C (149F) for 60 to 90 minutes are more than enough to sterilize (i.e. Pasteurize) the mash.*
>
> *Whiskey mashes are fermented from 60 to 84 hours, then they are strained and distilled. Given that the substrate is reasonably free of bacterial contamination (as it would be after 90 minutes at 65C) and that a copious and clean yeast starter is added, there's insufficient time for an infection to establish itself before the mash is brought to boil in the still. This is very different from a beer mash that has to undergo primary, secondary, and tertiary fermentation over numerous weeks, which would afford amply time for bacteria to thoroughly establish itself.*

> *Whiskey made from mostly cereal grains are not only fermented on their grains, but in some pot-still bourbon operations that use steam pipes to heat their still boilers, the grain is even placed in the still. Now, a flame fired still could never do this without burning the suspended grist on the bottom of the still pot.*
>
> *Malt-whiskey mashes are sparged the way beer mashes are, and are not fermented on the grains. But, they are usually not boiled, they go straight to the fermenter, are oxygenated, and are fermented for 60 to 84 hours, then distilled.*
>
> *I hope this helps to clarify my prior contribution re fermenting on grains and not boiling.*

Raoul suggests that root ginger is a source of amalayse, decreasing fermentation times down from 15 to 3-4 days ...

> *Try 1/8 tsp of fresh ginger root and 1/2 tablet of Beano with every gallon of whole corn and 8-10 pounds of sugar you use. I then dilute to 1.090sg (about 4 1/2 USGallons) and chuck in 1 oz of Fleischmanns ActiveDry, RapidRise or breadmachine yeast. After 3-4 days it is at 0.992sg and it has stayed above 95 degF. The ginger is a really cheap source of alpha-amylase and the Beano seems to act as a catalyst. No need to boil the wash either.*
>
> *A reliable source of a-amylase enzymes is ginger and I believe the inside white part of a banana skin. Also it is present in saliva but I don't like the idea of spitting into my wash. It replaces the function of 6-row barley or malting the corn. To prepare the ginger, add 1 cup of cold water (40deg F) and the ginger root into a blender and get it as fine as possible.*
>
> *You can also use the mash 2-3 times or so I have been told. Some old timers in the woods here report up to 5-6 times. This suggests that they do not have an efficient starch conversion but they didn't use ginger either.*
>
> *Use a paint strainer (or a stocking leg) as a bag to hold your grain. This solves the straining issue.*

Stanford writes:

> *I have produced a very favorable distillation by using* Aspergillum oryzae *during the fermentation process. One must first make a loose or watery, fully cooked porridge of grain mixture, cool to below 95 F, then sprinkle the inoculants over the porridge. No malting is needed! When the porridge has reduced to a more watery consistency, yeast without vitamins is added. Kept at blood temperature for a week or more will COMPLETELY exhaust the grain!*
>
> *The A. oryzae is much more effective in breaking down the starch to sugar than malt. This is how the Japanese make Sake from rice. I believe the results are superior, the AO produces more pleasurable aldehydes than malt, and retains more of the corn flavor.*
>
> *Additionally, as with sour mash, a little of the reserved ferment beer added to a new batch, alleviates the need for additional yeast or inoculants. Near continuous process! However, others have indicated that as batches progress, mutations can occur that will deviate from the original strains of both yeast and inoculants. Let your tongue be your guide!*

Fermentation

The best yeast to use with a grain mash is a basic beer yeast. Scott recommends

> *I would use an ale yeast that supposedly gives a complex and balanced flavor profile. Maybe something like White Lab's Edinburgh Ale Yeast (#WLP028). I just finished using this yeast to ferment an all-grain mash (I fermented on the grain). I ended up with about 8% alcohol and the final gravity after 72 hours was around 0. I used it at the slightly higher than recommended temperature range of 75F-80F. The whiskey tastes pretty good. It won't put Lagavulin or Laphroaig out of business, but what the hell it's a lot cheaper.*

Jacks "No Cooking Needed" Mashing Technique

If you've read Enzymes, you'l know how how they affect the rate of a reaction, and how they work in the conversion of starch to glucose. The normal temperatures recommened are those at which the alpha and beta amylase work fastest. If you're prepared to wait a little longer, and not get quite the same conversion, you can mash without cooking. Jack reports ...

> *I just finished my experiments with this method (after reading about how old-time moonshiners would make their whiskey by just boiling some*

> *cornmeal, letting it cool, and adding yeast).*
>
> *Using flaked corn from my homebrew shop, I tried this: Mix 2 pounds of flaked corn (and 70 grams of high enzyme, six-row barley malt- crushed) into one gallon of cool tap water. Add one tablet (or 5 drops) of the medicine called Beano per gallon of this mash (I use the liquid, because I know it dissolves better) and your yeast- I use a dry ale yeast. This mix- without cooking, heating or stirring- will ferment out into about 5-7%abv!!*
>
> *I know it sounds hard to believe, but it's true- it comes out to 10 pounds of flaked corn , and 2 pounds of six row malt per five gallons of water.*
>
> *For those who want to make corn whiskey or bourbon, but have no all-grain brewing experience, don't worry- just mix the grain, and add yeast and Beano. Beano is an enzyme that will break down starches in the stomach so they don't down break down in the intestines and ferment (the cause of gas)- and, since it works in the body, it works at room temperature. I have made 2, five gallon batches in this way (using a wine yeast- lavlin k1v-1116- makes for a better, more delicate, corn whiskey. The competative factor also prevents infection).*
>
> *Just distill this in a steam jacketed potstill, or an ice water bath still. This system uses about 20% more grain than is needed using normal mashing methods, but, if you have no time for holding grain at 155F for 90 minutes (or if you just aren't familiar with all-grain brewing) this system works great.*

Basic Whiskey Recipe

So a "no frills" whiskey recipe might go as ...

> Heat 4 kg cracked or crushed malt with 18 L of water to 63-65 &degC, and hold there for 1-1.5 hours. Heat to 73-75 &degC, then strain off and keep liquid, using 250 mL of hot water to rinse the grains. Cool to below 32 &degC (should have an initial specific gravity of 1.050). Add hydrated yeast & leave to ferment (maintain at 26 &degC) until airlock stops bubbling and final SG of around 1.010. Let settle for a day, then syphon carefully into still.

Jack recommends (highly) ..

Bring about five gallons of water to a good boil, then add 12 pounds of (unhopped!!!) pale malt syrup and dissolve it, then boil it for a good 15 minutes, then cool (I use a wort chiller, it takes me 20 minutes to get this much water down to a pitching temp)- pitch with either 60 grams of dry bread yeast, or any ale or lager yeast that (This is important) has a reputation for producing low to no amounts of esters (these are nasty in whiskey). after about 3 to 4 days distill it and make the cut according to the corn whiskey book. I put mine in a bottle with some toasted American oak chips, diluted down to 50%abv - The best malt whiskey I have had in a long time! YOU HAVE GOT TO TRY THIS !!! (yeah, I know, three exlamation points- the sign of a true madman-trust me anyway). The next experiment is to steep 50 to 100 grams of peated malt (grains) in the 5 gals of water (at 155F for 45minutes) before bringing to a boil and adding the malt syrup- You guessed it- SCOTCH!!! and IRISH WHISKY from a store bought still (a eurostill) and maybe an hour or two of stove work- no mashing temps, no worrying about water hardness or Ph or iron content- simple, easy- you gotta love it.

Update ! ... Just tried out something new- if you add 3 tablets (dissolved in a little water) of Beano- (it's found in the pharmacy- it's an enzyme that breaks down long chain starches into short chain sugars to help with gas problems) to the malt whisky mash recipe - it'll increase alcohol yields a little (like 2-3%) as well as make the stuff less likely to foam in the still- also, if you have a twin element still, let it heat up on the lower setting to slow down the heat up time and prevent foaming even more (I even add a half teaspoon of mineral oil to break up the foaming - it's a lot of work to keep malt syrup mashes from foaming in a still) A variable power setting would also be helpfull.

Rob advises ..

for corn mash, I just use the cracked corn as is. I do grind up the malted barley but just cracking it is fine. I use about 2 lbs barley and 8 lbs corn. Get the water to boiling, about 6 gallons depending on the size of your pot. Add the craked corn and let it simmer at around 180 degrees (82 &degC) or so for about 1\2 hour.. This softens it nicely. Temperature for this is not critical. Turn heat off and let temp drop to about 145 F (63 &degC) and add the malted barley. Keep temp at 143 or so for about 2 hrs.. This results in dextrous for a high alcohol mash. Then what I do is take my primary fermenter and cover it with some filter cloth and hold

> *the cloth in place with a bungie cord. The cloth I use is the kind with holes that is used to make soccer jersies. I dump the mixture about 2 quarts at a time and sprinkle hot water(160 F (71 &degC) or so) over it. This washes the sugars out of the grain. Once each 2 quarts is finished, I scoop out the spent grain and repeat the process. The resulting wash is fermented for 5 days or until it slows. Then I siphon it into a secondary fermenter and let it finish working and so it will clear.*

CornFed writes ...

> *for those that want to use corn or a all grain base mash... First of all when using corn meal various problems can occure, so proper lautering and filtration is needed to seperate the wort from the meal. This can be problematic in itself. The use of micron bags and or screens are needed. I get around some of this mess by using cracked,crushed or whole corn, though whole corn needs to be worked a little longer so that total starch conversion can take place. Steeping for 40 to 50 hours in a mixture of hot water (110F.) potassum metabisulfite which releases sulphur dioxide and lactic bacteria (Lactobacilus) to aid in softening the corn. After the corn has soften and swelled in size, I then add more water and raise the temp up to 140F. Now I add a Enzyme cocktail this is very important as corn has very little if any enzymes in it that can convert the starches over to usable sugars. I keep the mash at this temp. for 3 to 4 hours then raise it to 155F. for 30mins during this time you must keep the whole thing stirred. I use a turning gear motor and a paddle to get the job done. Now for the time being lets talk about These Enzymes as they are very important. I use a Enzyme cocktail of more than one or two enzymes Mainly because I'm striving to convert the corn down as much as I can to usable sugars. I don't have a constant recipe as of yet that I use, because there is so many types of Enzymes and all have different actions. Finding the right ones require the study of these actions and how each Enzyme works to help other Enzymes in breaking down cellwalls, protein, glutens and starches. Cellulase is a enzyme that breaks down Plant fibers and cellwalls, Proteinase breaks down protein. Glucanase breaks down gluten, Amylase of which there are two types Alpha and beta breaks down starches both are found in malted barley. The list of Enzymes goes on and on, Amyloglucosidase, Ferulic acid easerase, Xylanase, Alpha-acetolatate decaboxylase are just some of these. You can obtain some of these Enzymes under different names some of which are Cellulase 13L, Combizyme 108L, Depol 112L, 670L, 740L,Maltamyl, San*

> *Super, Ceremix. Ok now that you are totaly confused lets get back to the mash , after conversion has taken place add more water and lauter then filter the wort, this will remove any unwanted particles.*

Jack describes his new recipe ...

> *I found an AMAZING way to make malt whiskey Brew an all-barley malt (2-row) batch like normal; mash/rest/sparge. Rather than just cooling the sparged wort- boil it (a good strong rolling boil) for 90 minutes, then cool it with a wort chiller or a bathtub (it should be at 70 to 80F in 45 minutes).*
>
> *Here is the new twist- Pour the mash into a sanitized glass carboy, sit it in the bathtub and surround it with cold water. Let it sit until ALL of the trub (the white, brain like sludge that settles out to the bottom) has finally settled out. Once the trub has ALL settled out (it must be perfect- the wort must be sparkling clear)- this can take about 4 hours, THEN siphon off the PERECTLY CLEAR wort into another fermenter (I use the stainless steel pot I boiled it in), and add your yeast and Beano.*
>
> *Once fermented and cleared (about two weeks), freeze concentrate, then potstill it using the "making the cut" numbers from the corn whiskey book.*
>
> *This is the BEST whiskey I have EVER HAD (my wife's family goes to Scotland to get their stuff- this is better!). Not only is it smooth from the tight middle cut, but the long boil and PERFECT trub separation (I boiled 5 gallons, I only fermented about 3- I didn't let ANY trub carry over into the fermenter. Like I said it must be perfect separation) will give you a whiseky malt flavor that is so clean and clear, the spirit's finish actually tastes like you are chewing on a grain of 2-row- It is the most amazing, soft, grainy finish (without being harsh) that you will ever try. The long boil, and the perfect separation from the sediment is what does it. Give it a try- you will never go back to malt syrup whiskey again.*

Rev. Cunninghams Family Recipe American Whiskey

- *2 pounds Corn (off of the ear, can, or thawed from frozen)*
- *1 pound of raisins (if you can, use light raisins)*

> - *3 Oranges*
> - *15 Peppercorns*
> - *1 Gallon of water*
> - *3 pounds Sugar (the recipe calls for regular table sugar, but I like brown sugar)*
> - *3 teaspoons of acid blend*
> - *1/2 teaspoon of nutrient*
> - *10 grams of champagne yeast*
>
> *Place the corn into a blender and process it until it is pulp-like. Pour the corn pulp, zest of the 3 oranges, and peppercorns into a nylon straining bag (tie the top) and place into the primary fermenter. Boil the one gallon of water and put it into the fermenter with all of the other ingredients EXCEPT THE YEAST. Stir, cover, and let sit for 24 hours. After the 24 hour wait, stir in the yeast. Stir daily for 3 days. After 2 weeks, strain the juice from the bag and rack the wine into a secondary fermenter. After about 4 weeks (making sure the wine has fermented out all of the sugar and cleared) distill.When distilling, be careful that you have fermented out all of the sugar, because if too much sugar is left, it may caramelize while distilling.*

Carolina Shiner writes ..

> *I have used the cornflake recipe 2 times a week for a month,dont ask why. It has been taste tested by several old timers who could not tell it was not the original corn moonshine recipe. Here is the whole thing,*
>
> - *19 ltr of well or spring water or water with NO Chlorine,*
> - *10 lb white sugar mixed in the 19 ltr water. Blend well to put sugar into solution*
> - *add 1 lb of cheap or even out of date corn flakes ground into almost powder*
> - *for more corn flavor just add more flakes*
>
> *What you are doing is making neutral wash and adding flavor. For exact instructions on neutral wash visit Sugar Washes.*

For quite a large scale operation, The "Household Cyclopedia" recommends to make Malt Spirit by ...

> *Mix 60 quarters of barley grist, ground low, and 20 quarters of coarse ground pale malt, with 250 barrels of water, at about 170°. Take out 30 barrels of the wort, and add to this 10 stone of fresh porter yeast, and when the remaining wort is cooled down to 55°, add 10 quarters more*

> *malt, previously mixed with 30 barrels of warm water; stir the whole well together, and put it to ferment, along with the reserved yeasted wort; this wash will be found to weigh, by the saccharometer, from 28 to 32 lbs. per barrel, more than water. In the course of 12 or 14 days, the yeast head will fall quite flat, and the wash will have a vinous smell and taste, and not weigh more than from 2 to 4 lbs. per barrel more than water. Some now put 20 lbs. of common salt, and 30 lbs. of flour, and in 3 or 4 days put it inside the still, previously stirring it well together. Every 6 galls. of this wash will produce 1 gall. of spirit, at from 1 to 10 over-proof: or 18 galls. of spirit from each quarter of grain.*
>
> Note that 1 quarter = 2 stone = 12.7 kg, and 1 barrel = 42 gallon = 160 L, along with the usual 1 lb = 0.45 kg.

Another helpful post from Jack offers ...

> *Most extract- beer brewers (as well as home whiskey makers) tend to have some trouble with grain based whiskey mashes- I've found a method that makes it much easier:*
>
> *Grind all of the grain in whatever mill you have (most homebrew shops have these on site) and get 2 quarts of water per pound of grain ready by adding 2 teaspoons of gypsum per 5 gallons and then adjusting the ph with citric acid to about 5.8 (for the best results, measure out all the water you need 2 days ahead of time and bring it to a rolling boil for 25 minutes, let it cool with the lid of the pot on. This will drive off any chlorine, as well as produce a white powdery precipitate on the bottom of the kettle- this is the remains of temporary "carbonate" hardness in the water and is not good-pour off the water and leave this stuff behind. after it's cool treat it as above). The cheap pH strips at the homebrew shop will tell you when you've reached the right pH.*
>
> *Heat the water about 165 to 170F, then slowly (with stirring) add in the grain. The grain should cool the water down to about 152F. Using either an insulated picnic cooler, or your stovetop, try and hold this temp for 90 minutes. NEVER let it go above 160F or you'll kill off the enzymes.*
>
> *After 90minutes is up, most brewers involve themselves in the frustrating idiocy that is called "sparging"- this is where you slowly sprinkle water over the grain (now in a container with a screen covered*

> *outlet at the bottom) to rinse the sugar off of the grain- It normally takes a good hour to do this right, and those using a lot of corn or rye, it won't work- these grains stick together and won't allow the water through. Instead, after the 90 minutes is up, since you haven't stirred it, the mash will have separated into a top clear layer, and the grain will be on the bottom. Using a measuring cup, scoop out the clear liquid into another kettle (don't disturb the sediment), until there is no more clear layer to scoop off. Measure how much water was taken out- take some more water (treated as above) and bring it to 160F or so and add that back to the grain bed.*
>
> *Let it settle for about 30 minutes, and scoop off the clear layer again. Add more preheated (and ph adjusted) water to repplace what you took off, and let it sit for another half hour. This time, when you scoop off the clear layer, gather up the grain in a fine mesh bag, and squeeze out all the water you can.*
>
> *Taste the grain after doing this, if it is still sweet, you may want to soak it in more water.*
>
> *Combine the batches of clear mash and boil them (to sterilize them) for about 15 minutes.*
>
> *This is known as "no-sparge" brewing and is said to make the best malt flavored beers. For those of you with a spigot on a bucket (or kettle), just open it up and let whatever water that will run off by itself do so. As long as no husk material is in the "Freerun wort" there is no need to recirculate it. I found this method listed in an 1800's distilling book, and have found it usefull because when making grain mashes with lots of flaked grains (or alot of wheat), my sparging runoff always got stopped up. Because you can't boil a mash with a lot of grain in it (the husk causes off flavors), just mashing the grain and cooling it to ferment it would always give me a contaminated batch with some really nasty flavors.*

Blueflame uses his cousins corn whisky recipe, which ...

> *for a 25 gallon wash use*
>
> - *1/2 cup of dried yeast*
> - *50#'s cracked corn*
> - *50#'s sugar*

- *25 gals water*
- *2 gals.honey*

> *Let it work for 7 to 9 days, strain off then distill until to 60 - 70 proof then he stops (he uses a pot still and catches everything.) Then puts it to age in charred kegs and uses burnt apricots in the kegs (6 apricots to 10 gal of whisky). He then lets it sit for 6 to 8 months then dispenses it to the family members at out annual gatherings. Its really smooth and taste like Crown Royal*

later, Blueflame mentions ...

> *It usually distills off about 90%*
> *We dilute down to 45%alc then keg with about 300 of 3/4 by 3/4 charred oak blocks per 16 gals*
> *We use 12#s of honey and about 2 dozen black peppercorns also*
> *Let sit-- or charcoal filter--- really smooth.*

Yet more recipes from Jack ...

> *.. using 12# of pale malt syrup and "making the cut" according to the corn whiskey book (I went by taste, when there was no bite at all- that's when I collected) and aging on a small amount of heavily charred american oak (1/2 teaspoon per 750ml bottle at 55%abv) makes something that can give any irish malt a run for the money.*
>
> *I've also been working on a "cheap scotch" method. In 2.5 gallons of water, steep five pounds of peated malt (homebrew shop) for an hour at 155F. Once done, filter out the grain (rinse the grain with another gallon of water at the same temp), and bring the water to a boil- add ten pounds of sugar, ferment with an ale yeast, then either double distill it in a potstill and mix with some polished sugar spirit, or make the cut in a reflux still like with corn whiskey (I haven't tried the reflux still method but the blended potstill batch was declared "a fine batch of peatreek" by a visiting Scot- appearantly, peatreek is another word for "moonshine").Give it a try.*

Yet more from Jack (an all-in-one summary) ...

> *Making decent Scotch whisky is very easy to do at home (provided you know anything about all grain beer brewing). Even if you don't all grain brew- peated malt and malt syrup can be made into very nice Scotch*

(I've never tried the synthetic flavoring route- and I never will). Mash preparation will be first, then distillation:

***Allgrain method** - (I'll assume you can brew your own all grain batches)- start with a mix of 10 to 15 pounds of common 2-row malted barley, and mix in anywhere from 0 to 5 pounds of peated malt (both commonly found in homebrew stores) into the 2-row. grind the grain in a mill, then mash the grain at about 150F for 90 minutes, using 2 quarts of water per pound of grain. After 90 minutes is up, draw off some clear liquid, and add a drop of iodine tincture, if it turns purple, there is still starch in the mix- mash another hour at 150F. If there is no change, sparge (rinse) the grain slowly (maybe 30 minutes) with water heated to 170F. Continue until 6 gallons has been collected. Bring this to a boil for 5 minutes, then cool it by using either a wort chiller or a bath of ice water (don't add ice to the mash). Once cool, add your yeast (a dry ale yeast works best)- this should come out to about 7 to 11%abv once it's finished fermenting. Adding some Beano (an anti-gas enzyme sold in the US) is also a good idea- it will break up more complex starches and turn them into fermentable sugars- jaust add it with the yeast.*

***The easy way** of making Scotch is to go to the homebrew shop and buy 3.75 pounds of peated malt and Steep it for a half an hour in 3.75 gallons of water at 155F. After steeping (nylon stockings work well as a giant "tea bag" for the grain), remove the grain, pour another gallon of hot water over it (no hotter than 170F) to rinse out any more flavor. Bring the 4.75 gallons of water to a boil, take it off the heat source (this is done to prevent scorching the extract), and dissolve 12 pounds of pale malt extract (UNHOPPED!!) in the water. After the malt syrup is dissolved, cool the mash. After it's cool add your yeast (and Beano).* I asked about why the rinsing water had to be at exactly the right temperature, and Jack replied .. *You never allow the water to go above 170F because it will leach tannins out of the grain husk (it'll end up so astringent that it tastes like straw). In this "steeping" procedure, your not really converting any starches, just leaching out flavors from the grains, but you must stay below 170 or you leach out some really nasty flavors. 155F is the perfect temp. This is the same technique used to add "specialty grains" to homebrewed beer made with malt extract. I just found it worked well to put the smoky flavor into malt whisky as well.*

> *Once the mash is fermented, load it into a potstill (making a heavier Scotch from the start is best- if it's too strong you can blend in some polished neutral spirit later on). If you have done a 5- gallon batch, distill the mash until you collect 1.6 gallons of "low wines" (it will be anywhere from 17 to 30%abv). After the batch has been "reduced" it can be stored with no danger (not flamable- can't spoil, etc)- but it must not be ingested (it will likely be cloudy- this is the heavy alcohols we'll get rid of them next). Take the 1.6 gallons of "low wines" and put it back in your potstill, distill until you collect 0.4 gallons of Scotch. On this second run- discard the first 100 ml of spirit that comes out as "heads"- throw them out. The 0.4 gallons you collect is to be checked to see what strength (about 70%abv) it is, water it down to about 60% and age it on some toasted American oak (heavy toast- used if you can find it) age it in the bottle at about 1/2 to 1 teaspoon of oak per 750ml of spirit. Every month, add a little water as it ages. one month at 60%, one at 50%, and the final at 40%, will extract both vanillins and sugars from the wood, and be very smooth for it's age. This is a wastefull, low yield method- but it produces the smoothest spirit (close to Glenmorangie). A splash of port or sherry (1.5ml per bottle) is also a nice touch. The potstill should be on a burner- it should not be an element- run still. Too much of a chance of scorching the whisky. If you have an element run reflux still, procede as above, then freeze the fermented mash in plasic jugs, then let the spirit thaw and drip into a collection container- collecting 1/2 of the 5 gallons (leaving the rest as ice in the plastic jug). Put this "freeze concetrated" mash in your reflux still, add an equal amount of water, and distill it. The freezing concentrates the alcohol/flavor, and the watering of the mash prevents foaming and burning on the heating element of the still. This makes a lighter, but just as good spirit- collect the 100ml of heads, then run as per a normal reflux still, and age the spirit as above.*

Jack also writes about Japanese (Scotch) whisky production ...

> *I went to a Scottish games festival here last week and picked up an unusual book. It's titled Japanese Whiskey, Scotch Blend by Olive Checkland (Scottish Cultural Press, 1998). It's a look at the life of the man responsible for bringing Scotch-style whiskey making to Japan: Masataka Taketsuru- who was sent to Scotland to learn the trade of whiskey- he stayed for three years, and returned to Japan, setting up a distillery for Suntory (they financed his trip), then a few years later, he established his own distillery: Nikka. Most of the book deals with the*

problems his Scottish wife had to go through living in Japan during WW2- but the appendices has about 3 pages of notes recopied from the notes Masataka wrote down while he was learning. Appearantly, in 1919, the Scots were not overprotrective of "trade secrets" as they are now. After reading the book, and the notes, I did some math to reduce them down to a "homedistillers" level. A lot of the notes were concerned with prices for malt, peat, and taxes- but there were a few gems in it:

- *The yeast was obtained from a brewery in Dublin -it was tan/brown in color. (in 1919 this means the leftover yeast from a batch of stout).*
- *Four runnings were taken from each mash- the first two were fermented and distilled, the third and the fourth were used to start the next mash. (this means you mash the grains with water, wait, then drain all the water off, add an equal amount of water to that which was drained off, wait again, then drain that off, and repeat twice more- saving the first two mashes for the ferment).*
- *The mash temperature was 144F (62C) and was held for 90 minutes on each of the four mashes.*
- *The grain to water ratio was 2 to 3 pounds of malt per gallon of water.*
- *The ferment was held at a temperature of 78 to 97F (25-36C) and was complete in two days.*
- *The specific gravity of the first mash was in the 1.067 to 1.080 range.*
  The second runnings were at a gravity of about 1.037 to 1.025
  The third runnings were at a gravity of 1.009 to 1.007
  The fourth runnings were at a gravity of about 1.004
- *The mash was considered "ready to distill" when it fermented out to a gravity of 1.002*
- *According to the Hazelburn distillery, a 5 gallon (20 liter) batch of mash should get you 75.47fl.oz. (2264ml) to 60.37fl.oz (1811.1ml) of "proof spirit"- this is based on their use of 42,400 gallons of mash to get between 4,000 and 5,000 proof gallons of spirit each week. (they used 6,000gallon fermenters).*
- *Drinkable spirit is identified by adding water till it's 45.5%abv, and checking for clarity. (if it's cloudy- it's tossed in the feints receiver)*

This is the historical info:

- *Before WW1, one gallon of whiskey was 3 shillings (15p), after WW1 it went to 10 shillings (50p)*

> - *A plain oak cask costs between 2pounds and 10 shillings- sherry casks cost as much as 4 pounds.*
> - *The non-sherry casks are made of Canadian oak. 4.8 bushels of barley (one bushel=54 pounds) costs 71 shillings (pre WW1 it was 30 shillings)*
> - *A distillery worker's wages was 4 pounds a week - they worked 10 to 12 hour days.*
> - *Peat (post WW1) cost 7 shillings per cubic yard (pre WW1 it was 3 shillings, sixpence)*
> - *In one week the distillery uses 40 tons of coal (2 shillings per ton pre-WW1, post WW1 cost 2pounds per ton.*
>
> *In other news/advice, I have been playing about with more dry yeast- the dry yeast made by Muntons and Fisons is PERFECT for distillers of grain whiskey (malt especially), three, 5 gram packets of this yeast will drop the gravities listed above in the time stated above (2 days to go from1.080 to 1.002!). If you want to make authentic Scotch- this info would be of use. To make it more authentic use the Muntons and Fisons yeast in a stout recipe first, then recollect and re-pitch into the whiskey mash. For those who have access to it, Hugh Baird malting company sells peated malt that, cut 50-50 with plain two-row malt will give the 17ppm phenols that the heavier whiskeys use (the lighter brands drop down to 2 to4 ppm phenol). Hope this is usefull to someone- I've found it helpfull in my malt whiskey experiments.*

Bob offers ...

> *I have found that trying to ferment only grain is a loosing proposition. I use the grain as a flavor additive and a nutrient source for the yeast. It can be done, but the yield is low. This is a receipe that I have developed over a number of years that gives very good results. Here it is: This is for a 15 gal. mash batch:*
>
> - *Add 25 lbs. (11kg) of sugar to about 10 gal. (38L) of warm filtered water. I use water at about 100 degrees F (38C).*
> - *Stir with vigorous agitation until sugar is completely dissolved. I have a home made stirrer that chucks into a drill that I use. While stirring, raise the paddles so that air is whipped into the sugar water solution.*
> - *On a stove or hotplate, stir 2 pounds (1 kg) of unhopped dark malt extract into 3 gallons (11L) of boiling water.*
> - *After the malt is dissolved, add 5 pounds (2.25 kg) of corn chops (a grind that is not as fine as corn meal so that it will stay in a grainbag). Stir, while boiling for 1 hour.*

- *For the first 15 minutes or so, you need to stir almost constantly, as the corn will stick to the bottom of the cooking vessel.*
- *Let malt/corn cool until you can pour corn into a grain bag. The liquid is added to the sugar/water solution.*
- *Tie the grain bag with the cooked corn and add to mash.*
- *After mash has cooled to 75-80 degrees F (24C) add 1 tablespoon yeast that has been dissolved in a cup of warm mash. I use distillers yeast.*
- *Let fermentation go as long as possible to get highest yield.*
- *Distill, pressure filter through block charcoal, cut to desired proof and enjoy.*

> *For added variety add 2 drops of double strength vanilla extract to a liter. A vanilla bean should work great also. Another good drink: Add 4-5 mint leafs/liter. Shades of mint juleps*

Paul describes his recipe ...

> *All these are in U.S. measurements. I'm also look for the easiest way that takes the least amount of time. I start with 10 lbs steam flaked corn purchased from a feed dealer. Every dealer varies in the quality of his or her product. I guess I lucked out because mine is pretty much all corn no other garbage. 7$ a 50 lbs bag. Some times I'll substitute 2 lbs of flaked wheat, rye or both. Those get a little pricey @1$ lbs.*
>
> *Along with being short on time I'm cheap. I boil 4 gal of tap water. Mine is well water so it is acidy and has calcium in it already. When the water is boiling I put it into a 6 gal. bucket that is insulated. I then pour in the 10 lb mix of grain. I stir it with a portable drill with a 5 gal paint stirrer attached. I keep a cap on the bucket to keep the heat in. Every 10 min or so I stir the heck out of it. Helps break up the corn and gelatinize it also aerates the oxygen free boiled water. When the temp hits 150 I throw in 2 lbs of cracked malted barley. I stir this with the drill, keep it covered and insulated and stir every 10 min or so. Hopefully the temp doesn't go down more then a few degrees. If it does I throw what I can into a pot (4+ gals) and bring the temp up to and hold it at 149 give or take for the remaining time. I then throw it all back into the 6 gal bucket take the insulation off and top off with ice- cold back slop. When temp hits 118 I check the SG. (12 to 14) There is usually 2-3 inches of clear yellow liquid on top.*
>
> *I take 2 cups of liquid put into a bowl add some water and pitch 1/3 cup*

> *of bakers yeast. Let it foam up good then toss it in and stir. I have made 2 side by side batches one with bakers and one with distiller yeast and you can not tell the difference IMO. With insulation back on bucket ferment for 3 day or less. (When airlock bubbling slows down.)*
>
> *I have a 2 bucket system I use to separate the grain from liquid. A 6 gal bucket with a tap on the bottom and a 5 gal bucket that fits into the other. I cut 2/3 of the bottom out of the 5 gal and have a fine mesh nylon bag that fits over the top. I tie wrap the bag around the lip of the bucket so the bag doesn't slip with the weight of the grain. I let the whole thing drain over night. (I collect almost 4 gals of liquid not bad) By this time any yeast sediment has settled to bottom of the 6 gal bucket. I open the tap and slowly drain off the liquid so I don't disturb any sediment. I liquid is see-thru clear.*
>
> *I then throw into a pot still distill 2x and add distill water to taste. Oak it with toasted oak or if I want it quicker JD chips and a dried apricot (2 weeks) in a mason jar. I think that's everything. Cost about 5 bucks for 6 quart of fine bourbon.*

Tarvus describes his recipe ...

> *All grain brewing for distillation is much simpler than all grain beer brewing. You can eliminate the hassles of lautering altogether and ferment "on the grain". You can even distill "on the grain" if using propane, but I think you might have scorching problems trying that with electric elements. You can also eliminate all the hassles of protein rests and mashout since you won't be worrying about "mouth feel" or lautering. And you don't have the hassle of doing a boil and hop additions either. You won't have to worry about some of the things that can spoil a beer - like hot side aeration and grain astringency since they don't affect the distilled product. Grain mashes seem to naturally create the ideal ph for fermentation and the grains themselves contain all the nutrients necessary for a good ferment. Finally, the need for post-fermentation sanitization is not as high as for beer. After all, you are going to be boiling the stuff right away in your still rather than bottling and storing it for weeks or months like you would beer. Unlike beer, the risk of infection bacterial infection of the final product is nil.*
>
> *I have brewed nearly 100 all grain beer batches and 4 all grain batches*

for distillation so I have a bit of experience with both. If you plan on an all barley malt brew, it's very simple. If using a high percentage of adjuncts like corn, it gets just a bit more complicated, but still easier than beer brewing.

Most of the equipment you will need, you probably already have - except, perhaps, for a copper immersion chiller and a sturdy wooden paddle for stirring a thick mash.

Here is my recipe and procedure for all-grain bourbon:

Grain Bill *(Scale down as necessary for your equipment)*
25 pounds cracked corn
5 pounds rye flour
17 pounds crushed 6-row malted barley

Equipment
32-gallon Rubbermaid trash barrel (fermenter)
20-gallon stockpot mash tun (doubles as my boiler)
8-gallon stockpot
Outdoor propane cooker
2-quart pitcher
Oak paddle

Mash Procedure
For the mash-in I use all the corn, all the rye and 8 of the 17 pounds of barley malt for a total of 38 pounds of grain. You want about 1.25 quarts of water per pound of grain in the mash-in, so that rounds off to about 12 gallons of water

Pre-heat 12 gallons of water to 162F. This is a little over 1.25 quarts per gallon. You can expect roughly a 13 degree F drop in temp when the grain is added to the water. It is better to undershoot than to overshoot since it is easier to heat up than to cool down the mash. The target mash-in temp is 149F. You can slowly add heat if you undershoot. If you overshoot by a degree or two, don't worry about it. If you overshoot by a lot, you will quickly have to add more cold water to drop the temp before the amylase enzymes become denatured from the heat. (We are shooting for high fermentability in our mash)

Be sure to stir the mash thoroughly with the paddle. 38 pounds of grain in 12 gallons is THICK, so the sturdy paddle is a necessity! You want to make sure all the grain is moist, that there are no pockets or clumps of flour and that the temperature gradient is the same top to bottom of your mash tun and center to edge as well. Eventually we are going to boil this mash to gelatinize all the cracked corn, but if we don't do at least a partial starch conversion first, it will set up so think and gummy it will be impossible to stir! (Trust me on this - it happened to me!) I like to let the mash sit about an hour at this point. With the thermal mass of this size mash, the temp drop is only about 5 degrees in that period of time and most of the readily available starch converts. If you scale down the recipe, you may need to occasionally add heat to maintain the temp in the 148-149F range. We want full fermentation in order to maximize the amount of alcohol produced so we want to hold 148-149F as much as possible. Going higher than this will cause un- fermentable dextrines in the mash. This is good for beer, but bad for bourbon!

After an hour, light the burner and slowly raise the temp while stirring constantly. Grain scorching is not a problem unless you forget to stir every few minutes. We want to bring the mash slowly to a full rolling boil. The water loss due to steam is about a gallon an hour. Boil the mash for about 30 minutes to an hour to gelatinize the corn and release additional starch into the mash. Don't forget to stir constantly! The mash will start to get real gooey! Use the blade of the paddle to continually scrape the bottom to keep the grain from sticking! At the end of that time, add cold water to make up the volume lost to steam, (one quart per 15 minutes of boil time) and add an additional 12 quarts of water for the 9 pounds of malted 6-row barley to be used shortly.

Monitor the temp closely. At this point, you will want to rapidly lower the temperature of the mash to 152F. Do this by using the immersion chiller. Keep stirring as you chill to assure an even temp gradient.

Once 152 F is achieved, remove the chiller and add the remaining 9 pounds of 6-row malted barley. Once again, stir thoroughly! The temp should fall to the 148-149F range when you add the barley malt. If it drops below 148F, then slowly bump up the temp by adding heat and stirring. I usually let the mash rest at this temp for at least 90 minutes.

The previous boil will have released a lot of additional starch into the mash and you want to achieve as much starch conversion as possible. Only occasional stirring is necessary at this point. In between stirs, you will start to notice clear syrupy wort forming on the top of the mash.

After 90 minutes, you will have achieved about as much starch conversion as you are going to get. Don't worry if you don't have full conversion. Starch haze is a defect in beer, but no starch haze will come over in your distillate. You are never going to achieve 100% conversion of all available starch. I feel like if I can get 28- 30 points per pound per gallon in my mash that I'm doing pretty well. Milling the cracked corn even further before the mash would probably release more starch, but that's an additional step, requires a mill set up for milling corn, and is something not worth hassling with - particularly since corn is like $6.00 per 50 pound sack! Grain is cheap, time is expensive!

After the 90 minute conversion rest, again use the immersion chiller and chill the mash down to yeast pitching temp. I use a 2 quart pitcher to ladle the mash into my 8 gallon stock pot and empty the stock pot into my fermenter 4 gallons at a time (I ain't into lifting anything heavier than 4 gallons!) Be sure to splash and aerate the mash thoroughly as you dump it into the fermenter! After all the mash has been transferred, I usually top off with a bit more water to bring the gravity of the wort down a bit. I feel like wort in the 1.050 range seems to bring more of the grain flavor across into the distillate than higher gravity wort, but that may just be my imagination. It's up to you whether or not to do the dilution.

The wort chiller is made from 50 feet of 5/8" OD soft copper tubing. This is the same OD as 1/2" rigid copper pipe so the same fittings will work on both. I've used chillers made from smaller tubing, but between the greater surface area and the increased throughput volume, this chiller is far more efficient.

My chiller was formed by winding and gently bending the tubing around around a co2 tank. It comes coiled up already from the hardware store so really the only thing required is to tighten the coils a tad and provide verticle elevation to each sucessive coil. There are 15 coils on my chiller and each coil is about 12 inches in diameter. The completed chiller stands about 12 inches high. Stainless hoseclamps hold clear vinyl tubing to both *ends of the chiller. The input end has a hose fitting so a standard garden hose can screw into it. The output is just a plain vinyl tube which I use to feed the hot water coming out into my swimming pool. That saves water and helps warm the pool at the same. time. Since the surface of the mash is the hottest part of the mash, the chiller works most efficiently by feeding the cold water into the top coil since the greatest delta T and hence greatest cooling happens there. The output end comes up from the bottom of the coil (inside the loops) and exits out the top.*

It's a really simple, quick and dirty gadjet to build and it's well worth the effort if you contemplate all-grain brewing. I even use it to chill a sugar wash down to pitching temps - so it's useful even without doing all-grain worts.

My mash tun/boiler is wide enough that I can use my little paddle to stir both inside and outside the coils of the chiller. Stirring really speeds the chilling process. Back in the days when I was brewing lager beers, I would use my RIMS pump to recirculate a 10 gallon GOTT cooler full of ice water through the chiller. I could take 10 gallons of wort from mashout temps of 170F down to 55F in about 15 minutes.

Fermentation

I don't mess with an air lock; I just put the lid on the garbage can fermenter. It outgases so much co2 that the chance of anything getting in is nil. Besides, the fermentation is so rapid that the wild yeasts and bacteria never get a foothold. If the average ambient temp over 24 hours is going to be less than 70F, I use an aquarium heater immersed in the fermenter to maintain 70F minimum. Within 24 hours, there will be a cap of grain husks covering the top of the liquid in the fermenter. Within a week, (sooner if you've use a turbo yeast) the cap will drop back into the wash. The wash will taste dry and a bit bitter at this point. It will be a neat looking light golden color. It's ready to run.

Distillation

I use a stillmaker type fractionating still for my run. I don't do anything like removing packing to de-tune the still, but I run it HARD to minimize reflux for this type of run and I seem to achieve pot still type results. By running hard, I'm talking about running nearly 5 quarts an hour - about like I would do a stripping run.

I discard about the first 100 ml of heads, then start collecting. I collect in half-quart increments and label them with a marker as they come off. I use taste, smell and visual inspection of a sample of each collection jar mixed with water to determine when I have started collecting tails. Tails get added to the wash for the next run in the series.

I should note that typically, I wind up with about 30 gallons of wash after topping up my fermenter which I run in 3 ten gallon increments. 10 gallons half fills my boiler which is critical since I distill "on the grains" meaning that a good deal of grain remnants are scooped up in the process of charging my boiler. There is a real risk of a clogged column when distilling on grains and I had a narrow escape from disaster once when this happened to me! Since then, I never fill my boiler more than half full when distilling on grains to allow sufficient headspace so as to avoid clogging the column with spent grains.

I usually time my distillation day to coincide with mash day. I can get two separate mashes out of a 50 pound sack of corn using my recipe, so I repeat the mash process the day I do the run-off of the previous mash. Accordingly, I leave a goodly quantity of spent grains in my fermenter and add the new mash on top of them. Doing this, I avoid having to pitch new yeast and maintain good flavor continuity from batch to batch.

Another trick to flavor continuity is called "slopping back", and I use this as well. After my last run, I save 5 or 6 gallons of the spent liquor remaining in the boiler and use this as a portion of my initial mash-in water for the next mash. This assures ideal ph for the new mash, provides good flavor continuity, and eliminates what would otherwise be a disposal issue.

Aging

Once I have determined which of the jars collected are going into my final mix, I blend them together and take a spirit hydrometer reading. Usually I find that my taste, smell, visual examination of the distillate assures that my final mix will be in the 62-63% alcohol range - which is ideal for aging. If it is higher than this, I add bottled spring water to dilute it down to 125 proof for aging.

> *It takes at least 4 runs to accumulate enough 125 proof bourbon to fill a 5 gallon oak barrel. Consequently, while waiting to accumulate enough to use in my 5 gallon aging barrel, I have been keeping the hooch in a 5 gallon stainless soda keg. I have a lot of white oak lumber available and after heavily charring some chunks and slivers with a torch, I add the scrap oak to the soda keg to give it a head start on aging. The bourbon develops a nice golden color and begins to pick up a nice oaky taste after just a few weeks. I sneak a soup ladle full on occasion, water it down to 80 proof and enjoy a mighty fine tasting bourbon that continues to improve with age. The only problem is, at this rate it's gonna take me more than 4 batches to accumulate enough reserve to fill my barrel and have enough on hand to top off the angel's share when necessary.*

See more on Grain Based Washes - Page 2

Poitin

Also see the recipes on the Fruit based washes page

Jack writes ...

> *This is an 1842 recipe for poitin (pronounced Pah-cheen) - I have modified it for modern "ease-of-use"*
>
> - *boil 5 gallons of water and pour it over a mix of ten pounds of rolled oats (unflavored oatmeal) that has had a pound of 6 row barley (ground) and mixed in to it.*
> - *Allow this to sit until it is cool enough to add yeast, then add a dry ale yeast and 15 drops of liquid beano (or three of the pills). When you add the yeast/Beano enzyme to the cooled mash the stuff may be thick - like stiff oatmeal- don't worry. The yeast breaks it down with the beano as it is fermenting. Within a day it will be a liquid with grain floating in it.*
> - *ferment until dry*
> - *double distill in a potstill.*
> - *Don't age drink it white.*
>
> *From what I have read, oat whiskey is the ONLY spirit to have totally died off.. The last commercial distillery was in Ireland- and it shut down*

> *in 1975. Oats are a relatively expensive grain, as well as being very sticky, so distillers don't like it very much. If it is filtered well, and run on a water-bath still (or an ice water/wok still) there should be no problem*

Akvavit

Teemu writes about Akvavit ...

> *Here is a recipe for the most popular flavoured vodka in Scandinavia.*
>
> ***Akvavit** -The Scandinavian flavored vodka.*
>
> *The most famous flavored vodka from Scandinavia is probably Akvavit (or Aquavit if you ask from any Dane.) Akvavit is not actually vodka, it is just specially made grain based spirit flavoured with caraway seeds and sometimes aged with oak. Most fanciest type of Aquavit, the Norwegian "Linie Aquavit" even travels in oak barrels on a ship from Australia and back, just for getting the special flavor... Other well-known brands are the Danish "Aalborg" and the "Aalborgs Jubilæums Aquavit".*
>
> *Akvavit has quite long roots, the oldest recipe that I found is dated back to year 1642, this is a Finnish recipe is from year 1802, and this is how it goes (converted for home distilling purposes):*
>
> - *1 kg of barley flour*
> - *1 kg of oat flour*
> - *2 kg of rye flour*
> - *5 kg of cooked and smashed potatoes*
> - *5 kg of gristed rye malt*
> - *about 30 L of water*
> - *15L of sour mash (from previous batch) or 20g of citric acid and 10l of water*
> - *couple of juniper branches*
> - *½ L of beer sediment*
>
> - *Clean linen cloth and some rope*
> - *50 - 70L bucket*
>
> - *100 g of coarsely chopped caraway seeds*
> - *500 g of powdered charcoal (made from birch if available)*
> - *20 g of coriander seeds*
> - *10 g of dill*
> - *Couple handfuls of washed sand*
> - *Cotton bag, big enough to hold all these*

- *Copper or silver coin*

- *Large bottle (and optionally some oak (and sandalwood) chips)*

Put the grains and potatoes in the bucket and soak in the sour mash for couple of hours. Boil the juniper branches in 30litres of water; remove the branches and pour the boiling water on the grains and potatoes and stir well. Leave there over night, and in the morning check the temperature (must be 20 - 27 degrees Celsius) and add beer sediment (or about 50g of ale/porter yeast). Stir. Cover the bucket with the linen cloth and secure tight with rope. (You'll see why in a day or two). Let ferment until there is about 10cm (4") deep layer of clear liquid on the top (this should take about two weeks or so). Distill in a water/steam bath pot still (with the tails from previous batch) three times (just like you were making Irish-type whiskey).

Fill the still with the middle run from third distillation and put the coin in the still. Fill the cotton bag in the following order: first put sand in the bag, enough to cover the bottom of the bag. Then put the spices (caraway seeds, coriander and dill) in the bag. Mix the charcoal and the remaining sand and put in the top of the bag. Hang the bag below the stills outlet tube, so that the distillate can drop through the bag to the receiving container. Distill slowly; the heat input to the still is correct when the coin rattles about once in a second (col... col... col...). Collect until the tails show up. Cut the distillate down to 50vol.% with spring water (use bottled water if you can't obtain fresh spring water) and age in the glass bottle at least for two months. (Add couple of oak (and sandalwood) chips if available).

Simplified recipe (of my own invention)

- *4 L of 40 vol.% vodka (or well made Moonshine...)*
- *30 g of caraway seeds*
- *5 g of coriander seeds*
- *5 g of dryed dill*
- *Some oak chips*
- *Splash of Irish whiskey*

Combine all in a large jar and macerate for a week. Filter trough a coffee filter and ad a teaspoonful of glucose (dextrose), age for a month or so.

> *Akvavit is mainly used for aperitif, and it is commonly served ice cold from 4cl shot glass. Traditionally there is some salted Baltic herring or smoked salmon served as "sakuski" with it. Another traditional way of serving any type of vodka is that you put a silver coin in bottom of a large cup and pour coffee on it until you can't see it anymore, then pour enough vodka in the cup so that you can see the coin again; drink the whole cupful with one swig...(Warms well in the winter). And, of cause, the real smorgasbord is never complete without an ice-cold bottle of Aquavit...*

Wal writes about Poitin...

> *Quite possibly poitin distillers in the west of Ireland do not have computers so cannot post their recipes to us! Based on background information, together with parallel developments with U.S. moonshine (by Scotch-Irish immigrants) and Russian samogon, here are some possible recipes for Irish poitin.*
>
> *1) **Single Malt Poitin***
> *(This would be the original raw 'uisce beatha' before cognac aging techniques were adapted. Prior to this cognac method, dried fruits were used to provide flavor)*
>
> - *20 litres water (5 U.S. gal)*
> - *5 kg (10 lb) crushed malted barley grain*
> - *Yeast (preferably beer yeast)*
>
> *Barley is malted by soaking and spreading out in a 25 mm (1 in) layer to sprout. Wait until sprouts ('acrospires') are 5 mm long. You can then use this 'green malt' immediately by crushin lightly and adding to water at 65C (149F) for a 90 minute conversion rest. Leave to cool to fermentation temperature of 24C. Add yeast. (It is possible to harvest yeast from the sediment in bottle conditioned Australian or Belgian beer.)*
>
> *2) **Grain Poitin***
> *You only need about 10% malted barley grain to provide the enzymes to convert starch to fermentable sugars. According to the literature rye, oats and wheat were used. About 1-1.5 kg (2-3 lb)/4 l (5 US gal) is used.*
>
> *a) **Single Grain***
>
> - *20 l water (5 US gal)*

- *4 kg (9 lb) crushed and cooked grain (barley, rye, oats, wheat)*
- *500 g (1 lb) crushed malted barley grain*
- *Yeast*

b) ***Mixed Grain*** *(from)*

- *20 l water (5 US gal)*
- *2 kg (4 and 1/2 lb) crushed malted barley grain*
- *1.5 kg (3 lb)crushed barley grain (cooked)*
- *250 g (1/2 lb) crushed oats (cooked)*
- *250 g (1/2 lb) crushed rye grain (cooked)*
- *250 g (1/2 lb) crushed wheat grain (cooked)*
- *Yeast*

3) ***Sugar and Treacle***

This recipe came from County Fermanagh and is from 'In Praise of Poteen'

- *20 l water (5 US gal)*
- *3 kg (61/2 lb) brown sugar*
- *250 g (1/2 lb) treacle (molasses)*
- *65 g (2 oz) hops*
- *450 g (1 lb) bakers yeast*

Steep ingredients in 2 l (1 qt) of lukewarm water. Add additional cold water and yeast.

4) ***Grain and Sugar***

- *20 l water (5 US gal)*
- *4 kg (9 lb) crushed barley (cooked)*
- *500 g (1lb) crushed malted barley grain*
- *2 kg (4 and 1/2 lb) sugar*
- *Yeast*

1 kg of grain is equivalent to about 600 g of sugar. Beer yeast would ferment out about a maximum of 5 kg(10 lb) sugar/20 l (5 US gal) of water, so you can juggle the proportions to suit.

P.S. Do not forget to throw out the first 50 ml to "the fairies"

I have formed the opinion that early poitin was raw single (barley) malt whiskey. Peat was the heat source. Later to cut costs (possibly in line with Scottish practice) malted barley and other grains (wheat, oats, rye)were used. The use of treacle (molasses) is mentioned, as is raw (brown) sugar, (one source says sugar was used after 1880). Currently barley and sugar, or even sugarbeet pulp is mentioned. I would imagine if potatoes were not suitable for eating, that they would be used too. Potatoes, were once an essential staple in the Irish diet (in 1845, consumption was 5 kg/day), and even now 140 kg/head/year are consumed. 1 acre could feed a family for a year. Larger farms grew grain that was used as a cash crop. It is all a matter of convenience and economics. I doubt whether potatoes were used before the 1900's the time they became the principal source for vodka in Estonia. A similar story is seen with U.S. moonshine and Russian samogon. The Irish pot still and the Scottish pot still are similar and have basically simplified the geometry of the alchemist's alembic still. A similar shape is often seen in the U.S.probably brought over by Celtic immigrants.

Found one sugar based recipe for Poteen -'Poteen from Ireland' http://www.harvestfestivals.net/poteen.htmScaled down to 20 litres or 5 US gal -

Poteen

- *20 l water*
- *450 g bakers yeast*
- *3 kg brown sugar*
- *250 g treacle (molasses)*
- *65 g hops Steep ingredients in 2 litres of lukewarm water. Add additional cold water and then add the yeast and ferment for several weeks. Transfer to still.*

  See also: 'Poteen - making on Tory' http://www.tirchonaill.local.ie/content/44773.shtml ".....ingredients, including barley, oats and rye...."

  'Illicit stills....Poteen....' ~http://indigo.ie/~kfinlay/lefanu70/lefanuXVIII.htm "It is a curious fact that in parts of Donegal they grow a crop of oats and barley mixed; they call it 'pracas' (which is the Irish for a mixture), and use it for no other purpose but illicit distilling."

'History of Potcheen' 'Bunratty Potcheen' (a legal poitin)
http://homepage.tinet.ie/~bunrattywinery/historypotcheen.htm

It is often said that the 'exise free' Irish poitin (poteen) is made from potatoes. Home distillation is still a word-of-mouth tradition in Ireland and I have not been able to find actual recipes for poitin, but I picked up some interesting clues.

Potatoes were actually introduced by Sir Walter Raleigh onto his plantation in Cork in 1589, and quickly became a staple in the Irish diet. But was it fermented and distilled? In Poland, until the 18th century, vodka was produced chiefly from rye, wheat, barley and oats. Johann Joachim Becher developed a method of producing spirits from potatoes in 1669, but it was not until 1798 that the first instructions for "a practical way of distilling vodka from potatoes" was published. Distillers did not begin to use potatoes on a large scale until 1820. The potato is a relatively expensive source for alcohol. Potatoes contain 15-18% fermentable material while grains contain 50-67%. 10 kg of potatoes produce 1 litre of alcohol while 10 kg of grain produces 4 litres. Because of the 1845-1849 Famine in Ireland, some 1 million people died and some 1 million people emigrated. The immigrants to the U.S.A. brought their distilling knowledge with them but they did not use the potato, preferring the native maize. This suggest that a poitin made from potatoes is a late innovation and it is more than likely this began after 1900.

Here are some quotes from 'Google groups' on the subject of poitin:

- *'Beercommie' "Poteen is Irish moonshine, it is pronounced 'pocheen', and is usually made from grain, barley, wheat, or rye. I'm not ruling out potato, but its safe to say that potato is not the fermentable of choice."*
- *'Fintan Swanton' "Poitin (literally 'little pot', meaning the still in which the drink is made) is an illicit spirit made from just about anything which comes to hand - grain, potatoes, or probably commonest these days, just yeast and sugar."*
- *'Ross McKay' "I recently saw a documentary on Poteen, and IIRC, you start off by brewing an ale from barley and oats (maybe about 20:1 ratio?),then double distilling it."*

An interesting article on poitin appeared in the Malt Advocate: 'The Poteen Game' by Cormac MacConnell "The beer is created by fermenting barley, yeast and sugar for about three weeks in

> *wooden barrels. though sometimes in Connemara, the moonshiners use sugar beet pulp purchased from Irish sugar plants in the South." "....about 100 gallons of 'baor' produce 12 gallons of poteen,...."*

Tennesse Whiskey

Here is one recipe for Tennessee-Style whiskey. With practice, you will be able to produce a high quality product comparable to the better Tennessee-style whiskeys on the market, such as George Dickel.

Jack advises ...

> *I just found the "mash bill" that is made of. It consists of 80% corn, 12% rye, 8% malt (a high enzyme 6-row variety will be needed). It is distilled once in a pot still with a thumper, then filtered through a 10 foot layer of maple charcoal (this takes about 4 days). It then is placed in new, charred American oak barrels where it ages for 5 years, 6 months before it is bottled.*

Another iteration of the same process...

> *aged in the same way, with the same grain bill, but it is filtered through maple charcoal again after aging. By the way, it was 1941 when the American government gave Tennessee whiskey it's own classification.*

regarding a homemade version, Jack adds ...

> *I have tasted this recipe when home made and it was better than the original, using this mash bill. The distillery uses 80% corn, 12% rye, 8% malt (6-row). They ferment with 25% backset from a previous distillation run- homemakers should do the same. They use a 64inch diameter copper beer still with a doubler- but a homemade potstill with two runs (collect one-third of the mash volume out of the still as low wines, then re-run it, collecting from 75%abv to 55%) works just as well. The resulting spirit is then aged on charred American oak, and sweetened with a dash of REAL maple syrup (the kind that has a slight smokey flavor)- this will taste JUST like the store bought spirit- but will be a LOT smoother. The spirit should be aged at less than 65%abv, to prevent vanillins from clouding up the smokey sweetness from the maple syrup.*

Bushmills Black Bush Recipe

> *The recipe for Bushmill's Black Bush whiskey: Mash a grain mix of equal parts (by weight) of malted and unmalted barley. Shoot for an alcohol level of 8%. Triple distillation in a pot still is the method they use but anything you can do to get it to 80% should work. Dilute down to 63% and age in Oloroso sherry casks for about ten years (keep in mind the Irish climate is a cool, mild one), then mix it with aged corn whiskey of the same strength then reduce to 40% and bottle. (20% corn whiskey, 80% of the malt whiskey). The strain of barley they use is Golden Promise. An ale yeast should be used for the ferment.*

Moonshine

A "genuine" moonshine recipe, as still being used by Deb Brewer is ...

- *5 gallon bucket all grain horse feed (we use MannaPro Hi Grain sweet feed)*
- *one package of yeast (using bread yeast now--others will increase quality and ferment time)*
- *5 pounds sugar*
- *water*

> *Put enough feed to cover bottom of 5 gallon bucket a good 4 inches deep Add 5 pounds of sugar. Fill 1/2 full with warm water--warm enough to melt sugar but not so hot as to kill yeast. Mix until sugar is dissolved. Add yeast and mix some more finish filling with warm water--again not so hot to kill the yeast. Cover with lid--our lid has a little cap that screws on, leave it loose to breathe.*
>
> *4-5 days later it's ready to run! This is an old-timer recipe and works quite well. Our liquor is always 170-190 proof. You can substitute corn meal for the grain (horse feed) but I don't recommend this for pot stills cuz you can't filter it well enough. The meal will settle and burn in the bottom of your still. The old-fashion way of making corn liquor--with real corn--just is not feasible time wise.*

Diamond writes from Kentucky ...

> *the only way I can tell you is by the barrel full. We used 55 gal. barrels or 53 gal. oak whiskey barrels. Take 100 lb. of cracked yellow corn (this corn needs to be air dried, not dried by gas, gas dried takes the goodies*

out of it) Put the meal in the barrel, put about 40 gal. of good water in your cooker and heat the water to about 100 degrees, drain the water by the bucket full and stir your sugar in so it dissolves good, we used 50 lbs. sometimes 60 lbs. of sugar on the first barrel.

Here's probley whats different, we DID NOT add any YEAST of any kind to this. If the weather is in the mid 90's this would work off in 5 to 7 days, about day 2 or 3 it sounded like Rice Crispie's that just had milk poured over them, agin no yeast was added. We did take a wood paddle and maybe stir it once or twice a day. In those days all there was available was baker's yeast, and adding baker's yeast caused an off taste, hic-ups, indigestion or heartburn so thats why it was left out. In cold weather sometimes yeast was used to get the first barrel going.

When the mash got "dog heads" on it, that's when the large single bubbles come about 20-30 seconds apart it was ready to cook off, its better to cook a day early than a day late. The mash also had a sour taste to it. On a 50 or so gal. cooker with two propane burners, shine would start running in about an hour. The cooling barrel was also about 55 gal. with a 5/8 inch by 40 foot copper worm, had cold water running in the top and discharging water coming out mid ways or most time at the bottom of the barrel. This first run would usually start at about 120-125 proof and let it run down to about 80 proof, this was strained through a heavy white felt hat, sometimes a double hand full of hickory charcoal was used in the hat also. You put this 80-125 proof to side to keep, but kept running from the 80 proof on down to about 45-50 proof, this would be about a gal.and we called it singles. The 80-125 proof would be about 4 gal.

You cut your cooker off when you got to the 45-50 proof and let the beer cool down to about 100 degrees. You took about 3, 3lb. coffee cans of your meal out of the barrel and put the same amount of fresh back in (this makes a difference in your next yield and proof) mix another 60 lbs of sugar to your warm beer and put back in your mash barrel and stir up, let it work off agin.

On your 2nd run, put your beer in the cooker and also the gal. of singles you saved out. This run here should start out about 135 proof, have seen it go to 140, after a gal or so it may be 120 and stay 120 for an hour or

> *better before it drops lower in proof, this run usally last about 2 1/2-3 hours and makes about 9 gal. agin quit saving it when it gets to 80 proof but keep running till down to the 45-50 proof for your singles, it will make about 2 gal or so this run, repeat the whole process 2 more times or more, don't forget to take some old meal out and put same amount of fresh back in each time and also pour the singles back in the cooker. I don't think I've ever seen the proof get above 140, but have seen 11 gal. yields.*
>
> *On your very last cooking, pour all your previous runs of the 80-140 in a barrel and run your last cooking, keep adding your makings to the barrel stirring and checking till you get the proof you want, most times we done 97-100 proof. But this could be drinked as is or if you wanted it much better, you put all of this finished shine back in the cooker and cooked it agin, this time it comes out at 170 proof and let it run to about 150. Take this and put in a barrel and mix well or spring water with it to get the proof down, it still makes about the same amount, 3 runs always made 22-23 gals. REMEMBER NO YEAST WAS ADDED!!!!!!!!!*

MooNShiNeR reckons ...

> *I've always gone with my tried and true, except for brandies and split-brandies. LOVE making split-brandies!! Large batches of mash ferment the best! Like in 55 gal wooden or plastic (new of course) barrels.*
>
> - *Wheat Bran ~~~~> a five gal. bucketfull and then another half bucket.*
> - *Sugar ~~~~~~~~~> 50 lbs. (Sam's club is the deal!)*
> - *Fleishman's (Bakers)Yeast ~~~~> 3 packs*
> - *Filler up with water.*
>
> *That'll make anywhere from 6-8 gallons of fine liquor, uuhhh Fuel, yeah fuel...*
>
> *First batch in will ferment 5-7 days and then form a cap. If you "slop-back" that mash it will work off in 3 days after the yeast is growing up to around 6-7 times. Then it's time to start a fresh mash. When the cap falls, and the beers getting a bitter taste to it, she's ready to run. If it has any sweet taste at all it is too "green" and will not produce as much*

and will kick and buck and act wild in the still with a posibility of blowing the cap. Not a happy experience. It can ruin yor hole day. Never knew I could run so damn fast... I know a few good common sense tricks on what to do when as far as the mash goes. If is it not workin good or too good for that matter. You make all the alcohol in the barrel. If you don't do it right there, the prettiest still in the world won't do you any good at all. Still just separates the juice from the water. Hell, you all know all that by now, I'm sure of that.

Wheat bran: when U go to the feed store where they mill 'th grain, specify unsalted wheat bran. If the feller looks at you twice or reaaal hard, mumble kinda under yor breath, "damn horse is so constipated..." Sugar: Go 't Sam's Club or anywhere thet they would sell you sum 50 pound saks 'O sugar and load a couple up on yor cart. Take 'em to 'th check out counter. Whistle a tune, soft and slow like. Don't forget to whistle... And if the checkout countr gurl looks at you funny like or says sumthin smart, you jess say, "Yep, the church is havin a bake sale t'morrow and they all put me in charge of buyin 'th sugars." This'll covr you fer buyin all them packs of Fleishman's Bakers yeast too.
Werks for me...

My notes on sloppin back, ya'll folks've caLLed it yeast recyclin. That's just fine (must be city folk) Ya'll alright. I luv ya jess 'th same.

*Ok, see... What I'm tryin to say hear see, is... After yor first run 'O mash, save about half 'O that slop thar in thet cooker 'O yors and put thet rite back in thet there barrel. OK, bucket for you short runnrs. Add half agin as much new fresh grain to hit. DON'T put n'more yeast inner. She's got enuff rite thar whare shes at. OK, put the usual amounts of sugar rite in thar as well. Watchr work up a STORM and make sum goooood likker my frens. Specially on the thrice batch like I toldja b'fore. Now do this up to 6-7 times. Toldja thet one too. Man, ya'll gonna make sum goood sh*t, I tell ya.*

When I'm through witchall, ya gwon 't make sum two shot stuff. Two shotz and you'll be bouncing off 'th walls to find jore bed at night.

See the Moonshine Stills Photos page for photos of his still (75 gallon & shotgun condensor) and construction details.

Brandon makes a corn whisky :

> *try 25 pounds cracked corn, 25 pounds sugar, 12.5 gals water. First wash your cracked corn really good to get most of the trash particles out-- put in in a large vessel-- (we use a food grade plastic drum with a snap on lid)--in a seperate container collect 6.25 gals hot water--add sugar to this and stir unitl it is all disolved--pour into the drum with the corn-- then add another 6.25 gals. cold water -- stir mixture till u get a thermometer reading of 78F to 80F deg (25C). then add 1.5 pkgs turbo yeast(if u use it) or 4 to 6 ozs. bakers yeast-- stir for a couple of minutes and let it sit -- it will begin to ferment in a couple of hours it the temp is around 80 to 90 deg.--when the wash has quit bubbling and the liquid is clear -siphon off and distill*

Wal summarises a few moonshine recipes ...

> *If you want to make your own recipe, keep in mind grain contains about 60% fermentable material. About 1 to 1.5 kg of grain is normally used / 4 L (1 US gal) as the mash is quite thick, the rest can be sugar. 1 kg grain/4 L water would be equivalent to 600 g sugar/4 L, so you could add an additional 200 g sugar/4 L to give a 10% alcohol yield which beer yeasts should handle. The crushed grain needs 10% crushed malted grain for malting. e.g. a generic moonshine mash for 20 l could be 5 kg crushed grain, 500 g crushed malted grain, and 1 kg sugar. Other combinations are possible.*
>
> ***Kentucky Sweet Mash***
> *20 L water (5 gal)*
> *2 kg (4 and 1/2 lb) corn meal*
> *500 g (1 lb)*
> *50 g malted grain*
>
> ***'Alcohol Fuel Manual' grain mash***
> *20 L water (5 gal)*
> *4 kg (9 lb) crushed grain*
> *400 g (1 lb) crushed malted grain*
>
> ***Ian Smiley's Corn Whisky***
> *20 L water (5 gal)*
> *3.5 kg (8 lb) flaked maize*
> *750 g (1 and 1/2 lb) crushed malted grain*

Moonshine : 'Old John Barley'
20 L water (5 gal)
2 kg (4 and 1/2 lb) crushed corn
700 g (1 and 1/2 lb) crushed barley
300 g (3/4 lb) malt syrup
1 kg (2 and 1/2 lb) molasses

Moonshine
20 L water (5 gal)
3 kg (7 lb)crushed grain
4.5 kg (10 lb) sugar

Moonshine
20 L water (5 gal)
2 kg (4 and 1/2 lb) corn meal
300 g (1 lb) malted corn
2.5 kg (5 and 1/2) lb sugar

Moonshine
20 L water (5 gal)
6 kg corn meal (uncooked)
0.6 L malted corn

The Fine Art of Moonshining
Fermenter - barrel (55 gals or 220 l)
1/2 bushel (30 lb or 14 kg) Corn Meal
a)
3 & 1/2 lbs (1.5 kg) malted corn
2 handfuls raw rye to form cap on fermenting mash
Optional - sugar, 40 lbs (20 kg) in 2 lots - 10 lb (5 kg) then 30 lb (15 kg)
Yeast not mentioned.
b)
1 bushel (60 kg) corn meal
1 & 1/2 gal (6 l) malted corn
Yield -
Pure Corn 1.5 gal (4-6 l)/bushel (28 lb or 13 kg)
Corn & Sugar 6 gal (24 l)/bushel (28 lb or 13 kg)

Shawn is learning corn whisky from an elder neighbour...

> *He has learned this through trial and error but he is willing to try and teach me. For example there is not allot of exact science that he uses. Its mostly by site, smell, tasting and touching.*
>
> *Please remember allot of hard work goes into making the mash if you do not use sugar. The problem that I have now is that there is not a local mill here in C that will grind the malt without asking questions.*
>
> *He does not use a hydrometer but he reads the bead. Here is how he does it. He takes a quart mason jar half full of the distillate with a lid on it. He holds the top of the jar in his right hand and hits the inside of his left hand with the bottom of the jar three times. This causes the distillate to bubble inside the jar and before the bubbles settle he turns the jar onto its side and it will break into three consistent pools. Thus he said is 103 proof. He was right because I checked it with a hydrometer and its between 100 and 104 every time. Nothing replaces experience*
>
> *The still ...He has had several different sizes over the past several years but all of them were made of copper. Typically they were pot stills that had thumpers attached to them. He primed the thumpers with what he refers to as backings. Which I have interpreted as (what was at the end of the previous run.) The actual boiler was surrounded with a type of clay and rock mixture and was heated with propane burners. The boiler did not sit on top of the heat source. It was heated indirectly. The large still that he used for corn whiskey had a tank that set beside the still with tubing that ran from the cap of the still through the container. This was filled with mash and was preheated by the current alcohol of the mash being distilled. When he had gotten to the end of the first run the old mash was discarded through a valve at the bottom of the still and the new preheated mash was drained into the still from a valve at the top therefore eliminating the slow heat up of the new mash. Just in a few minutes there would be distillate running. The cooling was done by a 1inch worm in a 55 gallon barrel with cold water being piped up from the creek.*

Things have changed quite a bit since the "real old" moonshine recipes ... Jeff wrote of

SOUR MASH MOON SHINE

- *1 bushel of hard (seed) white corn*
- *bury corn in horse manure*
- *pour 5 gallon of water over the corn*
- *corn sprouts in about two days*
- *remove corn and wash*
- *roll the corn to crack it*
- *put corn in a 55 gallon barrel*
- *add 1/2 bushel of corn meal*
- *add 5 pound of sugar*
- *fill barrel with water*
- *in 21 days a red skim will form and it is time to cook it put a hose with a stopper in the end and push it to the bottom. Blow out the stopper and siphon off the mixture until about 4 inches is left in the barrel*
- *strain remaining liquid, put in cooker, cook it till it boils, then simmer.*
- *yields 1.5 gallons of 105 proof moon shine!!!*

SWEET MASH MOON SHINE

- *1/2 bushel of corn meal in 55 gallon barrel*
- *5 pounds of sugar*
- *1/2 pounds of "Red Star" yeast*
- *Scald the mixture with 5_10 gallons of boiling water*
- *fill barrel with water till five or six inches from the top.*
- *cover barrel with cloth and wait till it quits working (about 2-3 days)*
- *cook mixture until it boils*
- *put a hose with a stopper in the end and push it to the bottom. Blow out the stopper and siphon off the mixture until about 4 inches is left in the barrel*
- *strain remaining liquid, put in cooker, cook it till it boils, then simmer.*
- *yields 4 gallons of 90 proof moon shine!!!*

Dave replied to these with ...

> *Your recipes are interesting conversation, but I don't think you would want to drink the whiskey made from either. Whiskey made from corn exposed to horse shit will have a flavor dissagreable to most. The amount of whiskey produced by the second recipe is way off base. A good rule of thumb is that there is one US gallon of 100 proof whiskey in a bushel of*

corn. Also, one gallon in 25 pounds of sugar. Here is how my late grandfather made

ALABAMA CORN WHISKEY:

- *Take one bushel of untreated seed corn.*
- *Put it in two croaker sacks (burlap bags to any Yankees reading this).*
- *Put each sack in a #2 washtub of water at about body temperature.*
- *Weight each sack down with a concrete block.*
- *Soak the corn for 12 hours,*
- *Bury the sacks about 4 inches deep in the compost pile.*
- *He had a special compost pile for this. It was composed entirely from oak leaves.*
- *When the sprouted corn root is about half the lenght of the corn grain you are ready.*
- *Wash the corn in clear water. Grind the corn very course. He used a Corona mill.*
- *Put the ground corn in a 50 gallon wooden barrell. Finish filling the barrell with water.*
- *Add 12 packs Fleishmans yeast. Let ferment until complete.*
- *Siphon off the liquor, leaving behind any dead snakes, rats, birds or other varmits.*
- *Put it in the still. Fire it off slowly.*
- *If anything came out in under an hour, you are too fast.*
- *Run it through the still 3 times. Catch the first pint of each run. Save it for your Coleman lamp. It ain't fit to drink. That is where your headaches are.*
- *Yield should be about 1 US gallon of pure 100 proff, triple distilled whiskey.*
- *Don't empty the spent grains outa the fermenting pot just yet. You can use it to make seconds or " backins" as the old timers called it. To make 'good stuff' add another bushel of sprouted corn (no more yeast) . Let it work and repeat the above procedure.*
- *To make rot gut for your brother-in-law add 20 pounds of sugar and proceed as above*
- *Keep in mind: Never, ever under any circumstances whatsoever let anything touch your whiskey except wood, stainless steel, copper or glass. Age your whiskey in charred oak barrels for at least a year. Or for small amounts, tale a wide mouth gallon jug. Add lump hardwood charcoal (NEVER use briquettes, only REAL charcoal). Fill with whiskey. Age at least a year. Filter through a coffee filter & drink it.*

> *Nearly 40 years ago, as a young scientist, I took a sample of grandpaw's whiskey and several storebought whiskeys to the lab & ran 'em through the gas cromatagraph. Grampa's was much more pure !!*

Mark found an old recipe ...

> *"It is many years ago that this Norwegian recipe was used and I put it down here just for a matter of record. It would be a blessing if modern distillers would adopt this old pure old formula.*
>
> *Take one bushel of corn meal and one-fourth bushel of malted barley meal. Place them in a large kettle and cover with enough good well water to cover the meal at least four or five inches. Slowly bring to a low boil and simmer for at least one hour, preferably two hours, and keep adding water to keep up the water level as the meal absorbs the water. Stir to keep from burning. This cooking or mashing gives the malted barley enzymes a chance to change the starch in the corn to maltose which is an easily fermented sugar. Yeast cannot change cornstarch or any other starch to sugar. Remove the pot from the heat. Let cool and strain the liquid from the cooked meal into a fifty gallon oak barrel. Add well water to the cooked meal mass. This is called "sparging" it and stir and again squeeze out the liquid. Repeat until all of the liquids possible are washed out of the cooked meal. Add about one hundred pounds of corn sugar or invert sugar or cane sugar, if you do not have the others, and stir in well. Fill the barrel about three- fourths full by adding good well water. Take a saccharometer and test the solution. By adding sugar or water, adjust the solution so that it will produce sixteen percent alcohol. Add a gallon of top fermenting yeast "starter" or about five pounds of yeast skimmed off from a previous mash or bakers' yeast if you have no top fermenting yeast. Put a cover on the barrel as yeast produces alcohol much faster if it does not have too much of a supply of air. Never set a mash where it is windy or drafty as then the yeast will turn the sugar into carbon dioxide and water, not carbon dioxide and alcohol. Let ferment at not colder than 75 degrees. Test the wort or liquid every day with a saccharometer. Let the saccharometer go between 996 and 998.*
>
> *Then siphon and run the wort through a pot still, not a patent still, in not less than three hours time producing not more than ten to twelve gallons of whiskey running about 90 proof. Strain the whiskey through a three-foot-thick layer of hard maple charcoal. Add one quart of dry sherry wine and the juice from a level tablespoon of nutmeg boiled in a half cup*

> *of water to the whiskey. Store in oak barrels or in glass jugs with a few oak chips in the bottom. The oak barrels or the oak chips will give the whiskey color. No modern maker has ever equalled this whiskey and will admit it if asked. It is so smooth that you can drink it down like water, needs no mixing with anything. Any Scandinavian worth of the name was highly insulted if you ever tried to diulte this drink of the gods." Bull Cook and Authentic Historical Recipes -- G.L. Herter, circa 1969*

Sour Mash

One style that is sometimes used for whiskey is that of a "sour mash".

Jack explains ...

> *The reason sour mashing is done is to lower the pH of the fermenting mash in order to help prevent bacterial infections. It is used in both rum and bourbon making because both grain and sugar cane/molasses have a large amount of naturally occuring yeast and bacteria growing on them because of the high sugar and starch content these products tend to have. It is much easier (on an industrial scale) to reuse the liquid left in the still after the run is finished to adjust the pH of the next batch, rather than using higher cost food grade acids. It will also help to create a more consistant product from batch to batch.*

Jack on how to do a bourbon/sourmash ...

> *All the grains you listed (*I'd used rye flakes, corn grits & barley flakes but got into trouble*) look like a de-husked, pre-processed variety (that will prevent any husk flavors - wheat is (I think) the only grain you can leave in the ferment without worrying about off (tannic) flavors developing. The husk on any other grain will make a drink that tastes like hay horse bedding). It also looks like a bourbon recipe, so, keeping with the industry standard, you ferment on the grain (only malt whiskey is sparged, anything with corn or rye in it is fermented on the grain).*
>
> *Here is how I do it.*
>
> - *Mix your grain bill together and weigh it out. For every 3 pounds of grain (1344 grams) you will need one gallon (4 liters) of water.*
> - *Put the grain-I use 15 pounds (6.75 Kilos) per 5 gallon (20L) batch-into your fermentor (sanitized, 20+liter buckets are best), pour in 10 liters of room temperature water, and mix it with the grain. Make sure there are no lumps or clumps, and that all the grain has*

> *been wetted down (no dry spots are allowed). The first water mixed with the grain MUST NOT BE HEATED!! If it is, the grain will clump together, leaving dry spots in the middle of the clumps, leading to an infection.*
>
> - *Take the next 10 Liters of water and bring it to a boil in a pot on the stove. Once it's boiling, pour it into the bucket with the pre-wetted grain, and stir it up to prevent any clumping. This will liquify the starch, and sanitize the batch (the precooling effects of the grain/water in the bucket will prevent the bucket from warping/melting).*
> - *Leave the hot water/grain filled bucket overnight. When cool, add your yeast and your enzyme, and let it ferment. Depending on the grain, when you add the yeast, the mash may be as thick as oatmeal- don't add any more water, it will thin out in a day or so, during the ferment.*
> - *Wait until all foaming and bubbling has stopped, and all the grain settles to the bottom (3 days to 2 weeks, depending on temperature), filter this through a layer or two of cheesecloth, and distill it.*
>
> *This is how bourbon is made commercially in the US. It's also how I've been doing it for the last year.*
>
> *If you want a true sourmash bourbon, after the distilling of this whiskey, save 4liters of slop from the still (it will be sour after it's been stripped of it's alcohol) and add it to the grain, along with 6 liters of room temp water, instead of just adding 10 liters of cool water. The idea is to get a mix of water/still slop that is 25% still slop (this is the minimum amount required by law to call the stuff sourmash bourbon in the US). The sour slop will lower the pH dramatically, helping to prevent bacteria, and helping to promote enzyme activity. There you go- no extra equipment needed, and you can fill your fermentor up to just about the top.*
>
> *Mashing (holding the temps, etc) is a waste of time for whiskey- the enzymes work in about 90 minutes at mashing temperatures- at room temp, they take about 2 or 3 days (you know, about the same amount of time for a seed to sprout- this is a natural proccess, after all). Because the yeast is in the mix all ready, no time is really lost. As soon as starch converts, it's fermented.*

Ted Palmer advises

> *In distilling 'sour mash' is the process of using up to 1/3 of the stillage* (ie the grains left after in the wash after fermentation & distilling) *in the next batch of mash. The pH is low and it helps save water in the distillery.*
>
> *(This is different from 'sour-mash' as done by beer brewers, where sour mash is made by allowing lacto baccilus bacteria to lower the pH of the mash before or during ferment. No distiller would ever add lacto or any other bacteria to his mash, for the reason that the bacteria lower the yield of ethanol. If you want to try making a lacto culture take barley malt and soak/cover it with water and let it set for a day or two. You should smell a vinegar aroma, if not, toss it out and try again. Lacto bacillus live on grain)*

Brad also adds ...

> *I have never done it but it is used occasionally in brewing. Some like a sour tang in stouts and Belgian wheat ales. The procedure is very simple. Bring a few handfuls of cracked pale malt in a small mini-mash up to a warm temperature, around 50 &degC or so. Hold for a few hours and leave for a couple of days covered with aluminium foil. Some people put it inside a thermos flask to keep the temperature up. The naturally occurring lactobacillus on the grains will multiply and acidify (lactic acid) and sour the malt. It is then added to the main mash. I don't know the theory or practice behind sour mash whisky nor why it is done.*

Jeff writes about the "backset" coming from still residue...

> *The most explicit is Waymark & Harris _The Book of Classic American Whiskeys_ (although they contain some other inaccuracies) (p. 59 - 60): "Meeting the fresh mash in the fermenting tub is some of the leftover 'distiller's beer' from the lasts distillation. Called by many names - - thin slop, backset, setback, yeast back - the proportion of this 'yeast back' tends to be around 25 per cent of the total volume of the new mash. The high temperature of the distilling column has taken out the alcohol and killed the yeast, but the leftover spent beer is mildly acidic as a result of the fermentation process. Added to the new mash, the boost in acidity provided by the spent beer inhibits undesired bacteria and yeasts, making the mash - technically, but rarely by distillers, called 'wort' at this stage - safe for the desired distiller's yeast. it also provides a certain continuity in character between batches. It is from this step*

that we get the term, 'sour mash.' Because of the limestone character of the water, a sweet mash, that is, a mash not using any of the acidic 'yeast back,' would be pH neutral or even a bit alkaline, and hence at high risk of spoilage through undesired microbiological growth."

BTW, backset is also added to the mash, not just the fermenter (from Murray's _Classic Bourbon, Tennessee and Rye Whiskey_): It is also at this stage [the mash] ,that the sour mash process is introduced (adding an amount of the backset, that is the spent grains from the previous distillation, the thin stillage, to the mash). This succeeds in controlling the acidity of the mash and helps prevent bacterial infection."

Regan & Regan define backset in their _Bourbon Companion_ (p. 173): "Liquid strained from the mash after its primary distillation. Sometimes referred to as sour mash, stillage, spent beer or setback."

So here we have it described as both spent grains and as liquid. It would appear that since the writers are neither distillers of even brewers that they are not writing from a position of first hand familiarity with the processes.

Regan & Regan write in their _Book of Bourbon_ (p 211): All sour-mash whiskeys use a measure of backset to bring continuity of style to subsequent batches of fermentable mash. _Every_ straight bourbon, rye and Tennessee whiskey made at present is made by the sour-mash method. [I don't know if they are including Anchor's Old Potrero - JSR] Regulations used to require a minimum of 25 percent of the total mash be made of of backset in order for a whiskey to use the words "sour mash" on the label. Although that rule no longer applies, most distilleries still use upwards of 20 percent."

Regan & Regan list the percentage of sour mash used by different distillers in their _Bourbon Companion_ (although I think this should be taken with a grain of salt - for one thing, Murray says that Beam declined to provide details of their processes and recipes but the Regans give details). They range from 20 - 25% at many distilleries to 32% at Maker's Mark to an astounding 41% reported for Jim Beam!

As an example of how backset is used in both the mash and the

> *fermentation, Murray reports (p. 50) that Bernheim uses 12.5% in each, for a total of 25%.*
>
> *I have seen some authors (but can't find it right now) compare sour mash to sourdough in that it provides a continuity of process, but as a baker who knows sourdough, this is not an entirely apt comparison. Sourdough, after all, contains live organisms.*

Ian Smiley explains how the sour mash recipe is a variation on the "no-cook" technique :

> *The reason that modern mashing methods use specifically optimized temperature, pH, water chemistry, etc is to maximize the efficiency of the operation. And, some distillers over the years have argued that such practices over-process the mash and produce a much less natural or desirable flavour.*
>
> *No-cook recipes have been around for centuries and there are people even today that swear by them. However, a no-cook recipe is very slow and extremely inefficient, and that is why the old-time sour-mash methods were developed, probably about 200 years ago.*
>
> *The sour-mash method involves the mixing of corn pone (i.e. meal), and other grains such as rye or wheat, with water, and sometimes barley malt, at ambient temperature. Almost all no-cook recipes nowadays involves the addition of sugar as well. A large charge of whiskey yeast is added and a very slow and inefficient fermentation takes place. When the fermentation is complete, the spent grains that float to the top are skimmed off and discarded. The liquid is strained from the mash and distilled into whiskey.*
>
> *A mixture of about 50% backset (i.e. the left-over liquid in the still after the distillation is finished) and 50% water is added to the remaining grain in the fermenter, and some additional grain is added to make up for what was skimmed off and discarded. There's ample yeast left in the grain sediment in the fermenter so no additional yeast is required. And, a second batch is fermented. When the fermentation is complete, the process is repeated, and so on.*
>
> *This no-cook sour-mash method is very inefficient by commercial*

> *standards, but in the end almost nothing is lost. The same grain and the same liquid (backset) is recycled again and again, with only the spent grains removed. Even the residual alcohol and non-fermentable sugars in the backset is cycled back for another enzyme exposure and fermentation.*
>
> *It was by this sour-mash method that distilleries were achieving very high grain-to-alcohol conversion efficiencies 200 hundred years ago with very little scientific understanding of the process.*

Regarding **Old Prorero** Jack offers ...

> *Rye mash is fermented on the grain- it is not sparged, or boiled.*
>
> *Old Protrero recipe:*
>
> - *Mash 100% rye malt at 110F for 30minutes, then 145 (30minutes), then 155 (30minutes) to get the best conversion, then cool with a wort chiller to 80F and add your yeast. (if you wonder about water chemistry, use the kind for "California common" styles of beer)*
> - *The 110F rest is called a "beta-glucan" rest- it is done to break up the gums in malted and unmalted grain, and in beer brewing can increase sugar yields by as much as 15%.*
> - *Double distilling in a potstill (collect the run in separate lots, say 100ml, and blend them together by taste) is what is done for Old Protrero (they use an old fashioned alembic style still- it looks like a onion-topped Cognac still).*
> - *It is aged for just about one year in UNCHARRED American oak barrels- he did this to allow the peppery/honey quality of the rye to come through more strongly than the vanillins from charred oak, plus, he admits to trying to replicate an early 1800's whiskey, and charred barrels were not required in America until 1933- he ("he" being Fritz Maytag- the founder of the distillery, and founder/owner of the Anchor Steam brewery) is also experimenting with some new charred oak for his later runs- but I don't think any has been released*

Scotch

Jacks recipe for "liquid golden heaven" ...

> *Try this-*
>
> - *Soak 50 grams of peated malt in a gallon of water at 155F for 45 minutes- remove the grain, add another gallon and a half of water*

> *and bring to a boil- stir in 12 pounds pale malt extract-top up to 5 gallons and cool. Ferment with a dry ale yeast.*
>
> - *Then put this five gallons into 10, half full gallon milk jugs and freeze them SOLID in your freezer. Invert the jars over some one quart canning jars and allow the liquid to drip out (no external heat) until the quart jar is full- the result will be about 2.5 gallons of malt wine at about 17%abv.*
> - *Use the "brewing schnapps without a still" type of still (the ice water bath still) to turn this liquid into a 55% abv spirit.*
> - *Then blend this unaged spirit 50/50 with some sugar spirit (double distilled and carbon polished- diluted down to 45%abv then aged for one week on virgin-new, uncharred, American oak- 1cup of oak per gallon of spirit) then add one tablespoon of honey per quart bottle (dissolved and boiled until clear in some water- just use equal parts water/honey)*
>
> *TA DA!!! liquid golden heaven. For a slight fruitiness to this, toss in a raisin or two (per bottle), and let them soak for a week. Having alot of pure sugar spirit around thats really clean tasting is a good thing for anyone (including traditional potstillers') to have laying about! Without blending, pure malt (made with extract) costs about $10US a litre- this makes it more economical, but just as tasty!!*

For a wheat whisky, Jack writes ...

> *This is the grain bill for **Maker's Mark** "red wax seal" whisky (the founder of the distillery insisted on the Scottish spelling, instead of the Irish "whiskey):*
>
> - *70% corn*
> - *14% wheat*
> - *16% 6-row barley malt.*
>
> *Mash in the 150 to 155F range for 90 minutes, then ferment on the grain, strain out the solids, then distill to about 70 to 80%abv. If you have any soured mash (from previous whiskey runs) or "backset" use a mix of backset (33%) and water (67%) for your mashing water- this is how the distillery does it. If you want a more neutral flavor, Stoli vodka is wheat based, just distill an all-wheat mashbill (ferment on the grain again) then distill to a higher proof- around 90%abv.*

Beer Schnapps

Jack offers ...

Beer schnaps are a somewhat unheard of spirit. for the most part, it is made privately among brewers in Germany, and shared among other brewers. Of the beers turned into schnaps, the pilsener style tends to produce the most complex distillate. With a complex malt profile and a powerfull hop bitterness/aroma they make a great spirit to show off to any commercial brewers you happen to know. One of the best pilseners I've turned into schnapps was a clone of a Czech pilsener: Pilsener Urquell. Here is the beer/mash recipe.

Steep in a half gallon of water at 150F for 20 minutes:

- *1/2 pound 2.5 lovibond German light crystal malt*
- *2 oz German Munich malt*
  Strain the water into your brewpot, rinse the grains with 1/2gallon of 150F water.
- *Add water to the pot to bring the volume up to 1.5 gallons, bring to a boil and add:*
- *6 pounds extra-light dry malt extract*
- *3.5 oz of Czech Saaz hops @3% alpha acid*
  Add water to bring volume up to 2.5 gallons, bring to a boil and boil for 45 minutes, then add:
- *1oz Czech Saaz hops*
- *1 tsp Irish moss*
  Boil for 15 minutes, then add:
- *1oz Czech Saaz hops*
  Boil for 3 minutes, remove the pot from the burner, put the lid on the pot, and cool with an ice water bath or a wort chiller. Top up with cool water to 5 gallons, put into a sanitized fermentor and add your yeast. The best yeast is Wyeast's 2278 Czech pilsener lager yeast. If you don't want to go to the trouble of fermenting it at 45F for 3 weeks, you can use two packets of EDME dry yeast. Just make sure you add the yeast when the beer is at 70F - NO HIGHER!! OFF FLAVORS WILL DEVELOP AT HIGH TEMPERATURES!!
  After 7 days soak 1/2 oz Czech Saaz hops in a quarter cup of vodka, and add to the beer (the vodka sanitizes the hops and acts as a carrier for the aromatic oils).

14 days later, run it into a potstill, collecting the first 75ml as heads, then go by taste. Keep a teaspoon by the collection jar and taste it as the run progresses- it will end sooner than you think due to the lower alcohol. Don't try to adjust the recipe to get more alcohol in it- it will ruin the

> *balance of the malt and hops. Some like to end the run at higher strenths, making the hops more dominant, some like to let the run progress a little farther, so the malt can come through a little more (my preference).*
> *You should make an attempt to ferment with a good liquid lager yeast at lager temps. A five gallon carboy fits into a 5-gallon bucket, which can then be filled with water. Ice can be added to the bucket when you leave for work, and when you come home, to maintain lager temperature. This gives the beer/spirit a better aftertaste/finish. If you decide not to distill it, just bottle the five gallons with either 3/4cup of corn sugar or 1.25cups of light dry malt extract, boiled in water. You now have something German brew masters talk quietly among themselves about.*

Russian Vodka (Samogon)

Volodia reports ...

> *I was under the impression that vodka was made from unmalted grain until I came across a Russian language site: http://www.stopka.ru/drink/samogon/samogon00.shtml. The site gives instructions for making a simple pot still and a Chinese still (using a central wok-like condenser), and samogon recipes. For the social and economic background to samogon production (in English) see http://www.exile.ru/feature/feature93.html. See also ..*
>
> - http://www.stopka.ru/drink/samogon/samogon00.shtml
> - http://samogon.by.ru/index.htm
> - http://homepages.irk.ru/quant/samog/samogon.html
>
> *Measurements are given in buckets, the size of which is not given, but the old Russian bucket measure was 12litres. When yeast is not available, a sourdough starter of 3l of boiled hops and 1.5l of stillage(back slop) is recommended. A fully malted grain based mash recipe from malted rice, wheat, barley, millet, maize or peas is suggested. The consistency of the mash is to be a watery gruel (kissel). 500g of yeast is recommended for 12 buckets of mash.*
>
> *Recipes from Samogon site:*
>
> - *Wheat grain malt. 10kg malted wheat, 30l water, 500g yeast.*

- *Potatoes and malted grain. 5 buckets potatoes, 2 buckets malted grain.*
- *Bread and malted grain (1). 20 loaves of bread, 2 buckets malted grain.*
- *Bread and malted grain (2). 12 loaves of bread, 1/2 bucket malt grain, 15l water, 750g yeast.*
- *Sugar mash. 6kg sugar, 30l water, 200g yeast, bunch currants or morello cherries or dill for flavor.*
- *Sugar-beet. 30l of shredded and cooked sugar-beets, 200g yeast.*
- *Sugar-beet and sugar. 15l shreded and cooked sugar-beets, 6kg sugar, 10l water, 500g yeast.*
- *Sugar-beet molasses. 1 bucket molasses, 25l water, 250g yeast.*
- *Starch. 2 buckets water, 10kg starch, 2kg sugar, 500g yeast.*
- *Medovukha. 3kg honey, 3l sugar syrup, 27l water, 300g yeast.*
- *Mixed mash. 20 glasses wheat grain, 1kg sugar 21litres water.*

> *Other recipes are for fresh apples, pears, plums and dried apples and pears (in winter I gather).*

Bread

Wal writes ...

> *Bread is already a baked (cooked) milled grain i.e flour, and seems like an great waste product to ferment. At least 50% starch apparently.*
>
> *I collected over a period 7kg of left-over bread. Dried it to make sure it did not go mouldy, and just treated it like a milled and cooked grain. You have the option of adding 10% malt to convert the starch to sugars or using amylase enzymes. Yield is apparently about 60% sugar from the starch in the bread. I used 1 kg bread/5 litres of water. (1 lb - 2 lb/gal seems the norm)*
>
> *Method:*

- *Crush bread (gelatines easier)*
- *Raise temperature of water to 75C (I used a 60 litre HDPE open-top plastic drum with 2/1500W jug elements screwed in)*
- *Add crushed bread*
- *Wait for temperature to drop to 65C*
- *Add malt or amylase enzymes (I used enzymes)*
- *Hold at 65C for at least 1 hour.*
- *Cool to 24C (overnight)*
- *Add yeast (You could first strain off the sugar rich liquid for a clean wash)*

Left over bread can also be used as a supplement with a sugar wash to provide nutrients for the yeast.

'Bouza' which has been known in Egypt since the days of the Pharaohs. See http://www.fao.org/docrep/x2184e/x2184e07.htm Here is a redacted version.

***Bouza** (Egyptian beer):*
To get a 5% abv beer you would use

- *4 kg coarsely ground wheat*
- *1 kg wheat grain*
- *30 litres water*

Knead 4 kg coarse flour with a quantiity of water into a dough.
Cut dough into thick loaves and bake lightly.
Moisten with water the 1 kg of wheat grain and allow to germinate (3-5 days).
Sun dry grains, crush and mix with the bread loaves which are soaked in water in a fermenter.
Add active slurry from previous mash. Ferment. Bread is also still fermented to make a 'bread kvas' by the Eastern Slavs (Ukrainians, Belarusians, Russians) and the word 'kvas' is mentioned in 10th century Kievan chronicles. 'Kvas' is a generic word covering weakly fermented drinks from malted grain, bread, fruits and tree saps (maple & birch). Red beets were also fermented to make a sour 'beet kvas' for borshch before the introduction of tomatoes which provided sourness. 'Bread kvas' which is allowed to go sour, is also used as a natural vinegar for borshch. Sometimes one comes across the word 'kvas' and for comparison purposes here are several redacted recipes.

***Green malt and rye bread kvas**:*

- *1 kg green rye malt (barley & oats were also malted)*
- *1 kg sliced dried dark rye bread*
- *20 litres water*

For a reddish color, roast a small quantity of the malted grain) Crush malt lightly. Add green malt and bread to water (65C). Allow to stand for several hours. Add sour dough starter (or 30 g yeast) and allow to

> *ferment for several days. Strain. Keep in cool place. Drink when still effervescent or bottle as for beer.*
>
> ***Rye bread kvas:***
>
> - *1 kg sliced dried rye bread (lightly toasted in oven)*
> - *1 kg honey, molasses (or sugar)*
> - *20 litres water*
>
> *Pour boiling water over bread, honey/molasses. Allow to cool (24C). Add sour dough starter (or 30 g yeast) and allow to ferment for several days. Strain. Keep in cool place. Drink when still effervescent or bottle as for beer.*
>
> ***Crabapple and wild pear kvas:***
>
> - *7.5 kg apples (cores removed)*
> - *7.5 kg pears (cores removed)*
> - *20 litres water*
>
> *Pour water over apples and pears. Cover and allow to ferment (traditionally by wild yeasts). Strain. Keep in cool place. Drink when still effervescent or bottle as for beer.*
>
> *Kvas is a folk beverage, and there are many variations depending on available material and personal taste. I have seen recipes using mint or horseradish root for flavoring.*

Rice

Jack experiments again ...

> *A friend of mine wanted me to try and make for him a traditional Korean spirit. I'm not sure how traditional this is, but, judging by the info on ancient Chinese distillation techniques, this stuff would be considered a high quality drink.*
>
> - *Go to an asian food store and look in the fridge section for something called Koji (it's a mold culture used to make soy paste, sake, etc), it typically comes in a plastic, 20oz container (round, taller rather than wider- I used Cold Mountain brand rice koji).*
> - *Soak an equal VOLUME of short grain rice in enough water to cover it overnight (just dump the koji into a bowl and use the container to get an equal volume of rice/koji), then, steam the rice*

for 45minutes. After steaming, add 20fl.oz. of cold water and 1.25teaspoons of Morton Salt Substitute (no other brand is allowed- this is the only stuff with the right chemical composition)

> *(The salt substitute is a mix of potassium chloride, fumaric acid, tri- and mono- calcium phosphate. It's not essential to the brewing proccess (I've made 2 batches, one with one without- I couldn't tell the difference) as far as I can see, but the book on sake brewing I have reccomends it. If you can't find it- don't worry, for this recipe it's not critical. It's more of a requirement for plain sake brewing, though. I guess it acts like a micronutrient source for the yeast and the koji. The sake book also adds a little winemaker's yeast nutrient, but I ran out while trying out the recipe- it didn't harm it any.)*

- *Stir the rice/water until there are no clumps of grain, then add the koji.*
- *Cover and let it sit for 2 days, then add a wine yeast (I used lalvin k1v-1116).*
- *Allow to ferment at LAGER temperature (50F) until the rice settles down to the bottom of the fermentor.*
- *Distill this sour smelling sake twice in a potstill- that's it- a traditional korean folk liquor.*

If you use sorghum instead of rice, you get a drink highly prized in China called Mao-Tai. I personally hate sake (I thought tequila hangovers were bad!),but this distilled product is pretty good- It has a buttery, grainy smell/flavor that is really quite good (the sorghum version has the same taste but with an underlying soy flavor- my personal favorite). Forget all the sake you have tried- this stuff has none of the sourness of the mash. It is, in fact, not sweet, but almost malty in texture (like a thick beer- despite being out of a still), and is definitely the strangest batch that you can bring to any homebrew tasting. Something grand from those who brought you Kimchi!!

Wal writes ...

Japanese rice wine or 'Sake' is distilled to make the spirit 'Shochu' ('Soju' in Korean). Koji mold (Aspergilus ssp.) is traditionally used to make the mash, but enzymes (amylase) and citric acid are also being used currently to make shochu. This could be copied by homedistillers. See: 'Sake World' http://www.sake-world.com Click on 'How Sake is Made'

'Ingredients of Japanese Sake' http://www.media-akita.or.jp/akita-sake/materialE.html
'The Chemistry of Sake Brewing'
http://brewery.org/library/sake/techpa15.htm *Click on 'Top' to go to the Index*
'Production of Shochu Spirit from Crushed Rice by Non-Cooking Fermentation' http://ss.jircas.affrc.go.jp/engpage/jarq/33-1/nishimura/nishimura.html

A Japanese experiment by Kenryo Nishimura and others proved that it is not necessary to cook (to gelatinize) or convert (malting) milled grain prior to fermentation. Milling, soaking, adding enzymes and citric acid is sufficient - "....the product obtained by the non-cooking fermentation method was superior to that obtained by the cooking fermentation method in terms of both aroma and flavor components." The product referred to is 'shochu', a Japanese distilled spirit from rice. The non-cooking fermentation did take only one day longer than the cooking method due to the initial concentration of glucose in the cooking method. The method eliminates the messy cooking part of using grain and should encourage more to try grain-based washes. Here is a suggested quick moonshine mash for 5 US gals or 20 litres:

Quick Moonshine
5 kg (10 lb) crushed grain (grits)
2 and 1/2 kg (5 lb) sugar
20 L (5 US gals) water
2 tbsp acid (2 g acid/litre)- a pH 4-5 is required.
2 tsp amylase enzymes (alpha-, beta-, gluco-) or 750 g (1 and 1/2 lb) crushed malted barley grain (15% by weight)
Suitable ale yeast
Yeast nutrient (D.A.P.)
This should produce about 10-12%abv.
No pre-soaking of the crushed grain is required as there is sufficient sugars for the yeast to begin the fermentation process while the grain soaks.

Steve explains about Koji ...

Kojiis a type of mould similar to that which turns bread green and furry. Scientific name: Aspergillus oryzae. It breaks down starch with an

> *enzyme called amylase, the same one as in saliva and malted grains (the very same enzymes we activate when we mash malted barley, wheat etc to produce wort.)*
>
> *Koji comes in two forms. First is koji kin, in other words, seed koji. This is generally in the form of rice grains on which the mould has been allowed to run rampant and go to spore and then dried. This is now the inoculum.*
>
> *The second form is what is more commonly referred to as simply koji, but to distinguish it from koji kin is referred to as kome koji (kome means rice in Japanese--it is pronounced as two syllables, the "o" should be as in of, and the "e" as in egg.) So this koji is steamed and cooled rice that has been inocculated with some koji kin and then incubated at 30 to 35 degrees for a few days. The mould hyphae grow right through the rice. You need to stir it every 6 to 12 hours and stop it by bunging it in the fridge if it starts to go yellowy green--that means it is trying to form spore. In Japan, it is possible to pop down to the local supermarket and buy koji in this form fromm the cool-goods section as it is used for making miso paste and a few other food-related things.*
>
> *In sake making, it is this kome koji that is mixed together with a larger quantity of steamed rice, some water and yeast to get the fermentation underway. At coolish temperatures (10-15 deg) the koji chugs away making amylase, the amylase converts the rice starch to sugar, and the yeast does what yeast does best. And yadda yadda yadda, eventually you get sake.*

Whisky

Steve writes to the dbd ...

> *Scotch is made from traditionally manufactured 2-row malt (no bromates of giberellic acid to speed the process). Takes about 15 days. The malt is similar to a lager malt (less modified than a PA malt) and some or all is smoked above peat fires for flavor. Green malt contains hexanal related chemicals which impart a grassy flavor. Distillers malts are low kilned like lager malt, since they want to preserve beta-amylase. There is no crystal malt used in whisk[e]y making since the Maillard flavors are left behind in the still. Scotch starts with a ~65C mash. That wort is run-off into a fermenter, then more water is added to the spent grist for a second*

mash around 74C. After that is runoff there is a third mash at around 80C. The three runoffs are combined in a wort around SG=1.050. I think the first mash is thinner than the second and third, but I don't recall the figures. The total mash time is around 8 hours if I recall correctly. The wort is never boiled and the enzymes are still active in the open fermenters. The wort is allowed to undergo some small amount of lactic fermentation before yeast is added - a 12 hour delay before pitching I think. The yeast is conventional brewing yeast from local breweries - random stuff. The fermentation is brief - like 4-5 days before distillation begins. They don't wait for the full completion of fermentation since there is a loss of about 5% of the ethanol to the yeast, which convert it to acetolactate and use it for energy, if they wait. It's distilled in intentionally low efficiency pot stills either 2 or 3 times. The ~5% ABV 'beer' first becomes ~ 15-20% "low wines" then 55-60% barrel strength whisky. The scotch is stored in used oak barrels (bourbon or sherry use) for a number of years - typically a minimum of 10 to 12. It is then diluted with water (various sources) to bottle strength - 43-50%ABV.

There are several US whiskey making variant, but basically they perform a cereal mash with a large portion of grain - majority is corn typically with some rye (spicy flavored) and wheat (dull flavored). They will then perform a single infusion mash of the result. This thin mash - grist included - is cooled and pitched. US mfgrs are quite picky and secretive about their yeasts. The open fermentation proceeds and the active enzymes continue to produce fermentables during the fermentation. The fermented mash - grist and all - are distilled in a column (coffey, continuous) still. The result cannot be more that 80% pure alcohol in order to retain the name whiskey (US law). The alcohol must be stored in new charred oak barrels at no more than 125 proof for 4 (3?) years before it can be labeled whiskey.

During distillation the early runnings (foreshots) are removed. This contains a high concentration of acetic acid, esters and any methanol. This only occurs in the first distillation for double or triple distilled pot stills. Late runnings containing fusel alcohols are also removed by stopping the distillation process as the vapor temps rise. When pot distilling Scotch the liquid remaining from the 2nd distillation is added back to the 'green beer' for redistillation.

> *Pot stills are basically a pot with a gooseneck lid - alembic stills. Continuous stills are a tall column with several condensation "plates" inside. You can think of the pot still as sort of a broad or crude filter since it doesn't control the vapor temp very accurately. The column still's plates cause a very tight temp control of the vapor at the top. For whatever reason it appears that the pot still does a better job of preserving the flavor components at a given ethanol concentration IMO.*
>
> *Properly speaking, sour mash is a US whiskey making term for mash after yeast+lactobacilli have decreased the pH making it acid. US distillers pitch a fraction of sour mash (backset) into the upcoming batch. It adds an active yeast (and lactic) cultures to the new batch and also decreases the pH which makes fermentation easier for the yeast and harder for their competition.*
>
> Jeff adds .."I don't think it contains active yeast and bacteria even though it's often written that it does. Backset is the low pH solid leftovers from the still as I understand it that is added to the mash. A great deal is used in some distilleries, (a quick look at Regan & Regan's "Bourbon Companion" shows 20% (Old Forester) to 41% (Jim Beam)). This was a method that was developed by Jim Crow, a Scottish physician who was an early distiller in Kentucky in the min-19th century and essentially developed modern bourbon."
>
> *HBers sometimes speak of an extended bacterial acidification rest (lactobacilli rest really) as a sour mash, but it's not quite the same thing.*
>
> *The book I mentioned "Whisky Flavour:..." by Piggott has a lot of great detail on Scotch mfgr.*

Jeff gives me more details on producing a whisky ...

> *For a Scotch-style malt whisky, I'd use all malt (duh!), of the palest, lowest protein variety available. I'd mash with water that gives an appropriate pH (just like beer), and aim for a high gravity (1.070 or so, I think). No need to boil as for beer, but the second runnings will dilute. Scotch distilleries do three runnings and use the third running to mash in the next mash. You probably aren't going to have successive mashes.*
>
> *For a bourbon I'd use 70 crushed maize, 15% crushed rye and 15%*

> *crushed barley malt (highest diastase possible, such as pilsner malt if you can't get distillers malt). Aim for a gravity of 1.070 or so. Add a little malt to the maize and hold at 65C, then raise to a boil for 30-40 minutes, then let cool and/or add cold water to bring to 75C, add rye, hold 30 minutes to gelatinize, then add malt, aiming for 65C. Hold until conversion is complete as indicated by an iodine test. No need to run off the wort - just ferment the entire mash.*
>
> *For bourbon's first cousin, rye whiskey, you could use 60% rye, 15% barley malt and 25% maize, or all malted rye (my preference), or other combinations of malted and raw rye.*
>
> *To do a sour mash (traditional), first sour some grain by doing a small mash as above, then throwing in some crush barley malt into the cooled mash and hold at warm temperatures for several days. Then add this to main mash with the yeast.*
>
> *Cool to 25C and pitch lots of highly attenuating yeast. Dry yeast should work fine. Maybe Danstar Nottingham, perhaps followed by champagne yeast, which is less characterful but more attenuating.*
>
> *Keep the temperature between 20-25C if possible.*
>
> *Scotch is made from wort that is fermented into beer. With traditional North American whiskeys, the whole mash is fermented and distilled. I would think you'd have to worry about scorching the grains on the bottom of the still.*
>
> *Charred oak barrels and warmer year round temperatures contribute to the faster maturation of bourbon (4 - 8 years) as compared to Scotch (10-15 years). Bourbon and rye are greatly influenced by the charred oak barrels. I'd like to make a 100% malted rye and age in uncharred and/or old barrels, much as Anchor Distillery is doing.*

Alex H writes :

> *you can make very good malt whisky from malt extract and grain mash. I find that it is best to use a blend of two row pale malt extract and pale malt powder. The liquid malt extract has been boiled heavily and adds a nice rich, deep chocolate flavour to your wort and the powdered malt*

gives it that round fresh malt flavour.

I use a blend of cracked maize and the above malts in my wort and find that this gives a balance of flavour that is a lot like an Irish Whisky. Due to using malt extracts instead of malted grain I never cook my wort as this would caramelise the malt and give a nasty flavour to the distillate. I used to always use malted grains and cook my wort and go through the whole process but I have found that using malt extract is just as good and so much easier. A lot of emphasis is placed upon SG, enzyme conversion of starches into fermentable sugars and many other esoteric factors but the truth is that these factors are more important in the making of beer or if you are not using added sugar and are relying upon the sugars from the grain starches.

I use a 120 lt pot still and run to a high wine of 30%, empty the still and then re-distill the high wine to 60%. After distillation, I run the entire run through activated charcoal to remove any impurities. To age my whisky I use a 225 litre American oak barrel that I have heavily charred inside, this is the only way to age whisky as wood chips do not simulate the many chemical reactions that go on inside the barrel over time. You can get smaller barrels but they must be American oak and they must be charred (you can do this yourself.) I use used red wine barrels from Margaret River and rinse them out well with a few litres of white lightning to get the excess red wine out before I char the inside. A famous distillery in Scotland who I will not name has just released a premium scotch whisky aged in used French red wine barrels, selling for over 250 pounds per bottle (my idea first!!) The red wine remnants in the oak give a beautiful, round flavour to the whisky.

My recipe is as follows;
10 kg cracked maize
2 kg liquid malt extract
2 kg pale malt powder
22 kg sugar
1 pouch Alcotec turbo yeast
Water to make 100 lt (inclusive of above ingredients)

Method;
Fill fermenter with 50 lt hot water.

Add sugar, malt extract, malt powder and maize. Stir until sugar dissolved.
Add cool water to fill up to 100 lt mark (will be less than 50 more lt as dry ingredients displace water)
When mash is approx body temp cast your yeast over the top and stir well.
Mash will be rich brown colour.
Seal the fermenter (I never use an airlock. Trust me, you do not need one as the fermentation and escape of co2 is so rapid that nothing will get in)
Wait approx 10 – 14 days depending on ambient temp.
Mash is ready when it has gone a lighter colour, has no sweet taste and is non reactive (no foaming response) to added sugar.
Strain grain out and run through still.
Age and enjoy!

Obviously you will have to adjust this recipe to suit your still and fermenter size. This is a great recipe and will produce sublime whisky!!

Preparing a Fruit or Vegetable Based Mash

Summary
Fruits that are high in sugar can be used too. Fruit pips etc don't contain arsenic, but may have very small amounts of cyanide present naturally, though not enough to poison you.

If you have plenty of excess fruit or vegetables available, give them a crack too ..

Jack suggests ...

> *go to farmer's markets, farmer-run co-op stores, and roadside fruitstands- offer to haul away all the bruised/overripe fruit, and promise a gallon or two of wine/brandy to the owners in return for the favor (make sure to deliver on that promise so you can go back next year)- this is the easiest way to get raw fruit at NO cost.*

Source	**Yield**
Sugar	100 %
Sugar Cane	9-14 %, more if tropical
Sugar Beet	12-18%
Molasses	50%
Honey	80%
Grape	16-30 % (usually 20%)
Artichokes	17 %
Bananas	20-25 %
Barley & Malt	68 %

Carob beans	40%
Cassava	25 %
Corn	70 %
Potatoes	20 %
Raisins	60 %
Apples	24 %

Keep the ratio of available sugar to water as for the sugar based wash, eg 0.20 - 0.25 kg/L, so as to keep the yeast happy. For example, Wal writes that .. "sugar Cane juice has a 9-14% sugar content so is fermented without dilution. Raw sugar from juice would require dilution. Molasses has a 50% sugar content and requires dilution. Palm tree juice is similar. You can get get palm sugar (or jaggery) and use it as a sugar based wash to produce toddy which can be distilled to arak."

Fermented Fruit and Vegetables - A Global Perspective lists the steps taken to make grape wine, banana beer, cashew wine, tepache, colonche, date wine, jackfruit wine, palm wine, toddy, pulque, ulanzi, basi and muratina.

Wal ...

> *A press for fruit and grapes is useful for those making alcohol from a fruit mash - e.g. brandy, grappa, calvados (apple jack), slivovica. Here are some useful sites:*
>
> - *"Instructions to build a fruit press" http://freespace.virgin.net/roger.simmonds/press.htm*
> - *"Making a press" http://ourworld.compuserve.com/homepages/andrew_lea/press.htm*
> - *"Homemade wine press"http://members.iinet.net.au/~kookie/*
> - *"Paul's winemaking press" http://www.geocities.com/NapaValley/Vineyard/1762/pressplans.html*
>
>   *For more links on wine-making, see*
> - *http://home.att.net/~lumeisenman/*

- *http://winemaking.jackkeller.net*

Scott writes

> *The recipe that I use is one that has been in my family dating back close to 200 yrs. (of course there have been slight modifications over the years...we now use boughten yeasts instead of wild yeasts and we buy tomato paste instead of making it). This recipe is for a 5 gallon mash.*

- *I take 20lbs. of the biggest stickiest grapes we can pick, and I freeze them.(it is easier to de-stem them when they are frozen).*
- *Then I pull them off of thier stems and put them in a 3 gallon stockpot and add enough water to cover the grapes a few inches.*
- *Then I bring them to a boil and mash them with a potato masher untill ALL the grapes are mashed pretty good.*
- *Then I add 5 lbs. of white granulated sugar and a 6oz can of tomato paste and stir until it is disolved.*
- *Next, I pour it all into a 6 or 7 gallon bucket and fill it to 5 gallons with cold water, squeeze the juice of 1/2 lemon and cover it.*
- *When the temp is down to about 78-80 degrees F is when I get my yeast started. I have used baker's yeast and it works fine, but lately I have been using Red Star's champagne yeast.(very similar to ec-1118).*
- *I take 3-5, 5gram packets and put them in a pitcher that is 1/2 full of the mash from the bucket. I stir it well, and leave it sit over night.*
- *The next morning, I skim off whatever is floating off the top of the bucket and discard it.*
- *Then I SLOWLY pour the yeast pitcher into the mash stirring it gently.*
- *Then I cover it with a couple layers of plastic wrap and a rubber band (I poke some holes in the plastic with a pin).*
- *Every morning, I skim whatever is floating off the top and stir vigorously, and stir again 3-5 times a day.*
- *After about 3 days of this, I slowly pour the contents into a new bucket. The grape seeds will be on the bottom of the bucket (I save them and plant them later) you can discard them. Top the bucket with water to 5 gallons, cover it again.*
- *I will stir it vigorously 3-5 times a day until it stops fermenting. (usually about 2 weeks) when it is done fermenting, it is still a thick juice that contains alcohol, and does not resemble wine at all.*

> *NOW it is ready to run. We have always run in a pot-still.*

- *1st run. FAST, collect everything until the distilate comming out is about 20-25%abv.*
- *2nd run. SLOW, discard the first 150ml.*
- *we collect in 250ml increments, and add them together to taste.*
- *we stop collecting at about 30%abv.*

The finished product has a little bit of a grape aroma and after flavor. We usually age it in natural uncharred oak, and sometimes we add about a half cup of raisins to age it with.

This is how we have made ALL of our fruit spirits for as long as anyone can remember. Although, when we make our heritage slivovitz, we use wild yeast only, and NO sugar, and we also use a bit more fruit. This is the traditional Croatian method of making Slivovitz that my family and others have used for around 200 years.

Tater writes

Tater's fruit recipe*;* Take

- *1 bushel[40 - 50 lb] of any fruit/ berry.*
- *20 lbs sugar*
- *1/4 cup lemon juice*
- *1 pack E 1118 and 1/2 oz distillers yeast:*

If apples or pears grind and or cook em. Peaches nectarines plums cherry's blueberry. I pour boiling water with dissolved sugar on it and lemon juice. I blend it with a drill powered thin set mortar mixer. That's blades I had sharpened. Adding water as I blend till I have a 13 gallon total wash.That's a thin gravy or thick soup texture. I pour mine through a rat wire sieve I made to remove seeds and any fruit that wasn't blended.Stir hell outta wash to get air back in wash and take a gallon of cooled wash and add 1 pack of Ec1118 yeast and 1/2 oz of distillers yeast stirring both in let set till morning and add back stir in well and cover and vapor lock. Remember to leave space in fermenter for pulp to rise or you'll have a mess and stir pulp gently back in wash every day. Will make 3 gallons of around 120 proof fruit likker. If doing a no sugar added wash add more fruit to get wash to texture and use this chart to figure fruit sugar content. http://www.nutritiondata.com/facts-001-02s01ja.html

Freeze 50 to 70 lbs peaches and thaw. Should look like this after thawing

Then add a little water and stir. I use a sharpened mortar mixer.

Then pour through sive to get seeds and large pieces of pulp and skin out. Save this to add a bit of water back to and stir again

Use hands to rub fruit through sieve. Seeds help with this. After all fruit is poured through and seeds and skin are tossed wash should look like this

Take a pot, add 20 lbs sugar 1/4 cup lemon juice water and heat until clear.

Add sugar water to wash and add enough water to make 14 gallon total. Stir well and put gallon of wash in bucket and add yeast. This was 1/2 oz ec 1118 and about same distillers

Next morning it looked like this

So I added it back to wash well stirred in like this.

By end of day wash had formed a cap.

Fermented out in 18 days. Kept cap stirred back in wash to stop from drying or molding.

Then when cap fell i ran wash and got 3 gallons of 110 proof. The end

Arsenic or Cyanide ?

Seeds of fruits like apples, cherries, apricots, etc., do not contain any arsenic. Arsenic is a heavy metal that is too difficult for a plant's metabolism to process, any amount of it would likely kill of the plant. The only time arsenic is likely to be present is if it had been used as a form of fungicide/herbicide spray during the culivation of the fruit (very unlikely these days - I think its mostly outlawed), and hadn't been properly washed off.

Plants do however have the ability to work with vast amounts of carbon and nitrogen, this results in most hard seeds containing cyanide (the cyanide radical is CN-). Not really enough to injure anyone, infact commercially made Kirsch (cherry brandy) uses ground up seeds to give a nut like flavor (cyanide tastes kind of like an intense bitter almond flavor). In some recipes grinding up the seeds of delicate tasting fruits should be avoided but with something more robust (like apple), it should be of no concern.

Wal elaborates ...

> *The kernels of prunus species (plums, cherries, apricots, apples) contain HCN - hydrocyanic acid, formerly known as prussic acid. 0.05g is a lethal dose for an adult. It has been recorded that a person died from eating a whole cup of apple pips as a treat on his birthday! Normally, when macerating these fruits in alcohol, the stones should be removed, although small amounts are used for flavoring purposes (e.g. Maraschino).*
>
> *Fruit mashes (i.e. with stones included) should not be a problem for the distiller, as HCN is susceptible to hydrolysis at high temperatures.*

Zoran writes that it is possible to remove any cyanide present, using copper sulphate:

> *in Serbia the national drink is a plum brandy called slivovitz. If someone tries to speed up fermentation by crushing plums with some mechanical devices, natural glycosides come in contact with the enzymes present. After hydrolysis, a bitter taste and smell is a consequence of the cyanide present. After distillation farmers do not throw away such brandy. Simply they put 20 g of $CuSO_4.5H_2O$ on each 10 L of 80 proof (40%) brandy. Chemically Cu(CN)2 is very hard do dissolve, even at high temperature. After distillation they got good drink. Big companies remove cyanide in the same way.*

Esters and especially organic acids arise from misfermentations of leafs/twigs or rotten parts of fruit, so try to avoid having them in the brew.

Using Fruits

If tempted to try some of the European use of fruits, the following is somewhat of a guide. Apple brandy is usually 60% apple, 30% pear, and 10% your choice.

- Run the fruit through a juice extractor or similar, no pips unless you enjoy cyanide,and no pith if possible. Put the skins through the food processor/juice extractor as that's where the enzymes are that the yeast require.
- Achieve a specific gravity of about 1.050, dilute with water if necessary.
- Pitch a rehydrated yeast at a temp. of 25/30 C. It is very important to then hold the fermentation at that temperature. It will achieve that pretty much itself ,but just be prepared to help it keep that way. Any dry white wine ,champagne or sherry yeast is good. An excellent French brand is Lallemand (Uvaferm bc or Lalvin ec-1118), but you will also need to use a yeast nutrient (eg Fermaid, or try your local home brew shop).
- Fermentation will take no more than 8 days (the reason the traditional fermentation takes so long is they use wild yeasts).
- Don't add sugar if you want this to be "kosher "and a fair dinkum brew. Sugar will raise the ethanol production but at the expense of taste/quality etc.
- Don't do any additions after fermentation has started - it can stop a brew in it's tracks.

Jack adds ...

> *the majority of flavor compounds in whiskey come from the yeast that is used. The aldehydes that the yeast contributes turn into esters on long*

> *aging. These halp to provide a better flavor for the whisky. In a fruit brandy (like plums)- this would mar the flavor of the fruit- It may make it more complex if it were aged on oak for a while- but for those attempting to make a clear slivovitz/schnaps type of spirit- the yeast would give flavors that prevent the pure plum flavor from coming through. I guess another rule for fruit brandy/schnaps has got to be: Let the wine clarify fully before distilling- no distilling on the lees !.*

A less traditional approach would be..

> 2 kg Granny Smith apples or Nashi pears
> 1 Campden tablet (for basic sterilisation)
> 6 tsp yeast nutrient
> 5 kg sugar/glucose
>
> Peel & grate fruit, add to fermenter with Campden tablets , and 3L water. Cover and leave for 24-36 hours. Dissolve sugar & nutrient in some hot water, then add to fermentor. Top up with cold water to 24L. Add yeast when below 24C. SG should drop from 1.03 to 0.99 over 12-14 days.
>
> Don't overdo the Campden tablets. They are sodium metabisulphite, and can kill they yeast if not fully dissipated by the time the yeast is added.
>
> The best fruit to use is windfall fruit (the stuff brown & lying on the ground), as these are higher in sugar. Sometimes when trying to make schnapps, you can reserve a little of the fermented stock, and add this back to the distilled liquor, to enhance the flavour.

For schnapps, Jack explains ...

> *Schnapps may be made by fermenting 4.5 pounds of fruit in a gallon of water, in addition to 2 pounds of sugar and a heaping tablespoon of winemaker's acid blend (per gallon). After fermenting, this may be distilled (I filtered out the fruit pulp, but didn't clarify beyond that) in a potstill to produce a nice dram.*
>
> *The problem most people get (myself included) when making a fruit wine into a brandy is the fact that not enough fruit is used in the mash. Most wines use 2 to 3 pounds of fruit per gallon- when distilled they taste like unrefined sugar spirit with no fruit flavor- if you up the fruit to 4 to 4.5 pounds per gallon and ferment out to 10 to 15%abv you'll get something*

> *worth distilling. So far I've tested this on cherries (sour and black), raspberries, blackberries, peaches, and plums- all have worked wonderfully.*
>
> *Tips for apple schnaps: DON'T use any sulfite- use a large amount of yeast with competative factors (lalvin K1V-1116 is the best choice) Ferment the juice in a cool area (to aid with a mellow flavor and to help slow up any contaminating bacteria) If you do the above, and stick to basic sanitary wine making practices, you'll be just fine.*

Jack gives an update ...

> *After much frustration and experimentation with fruit (I'm known to every single orchard owner within 60 miles- I'm also well liked- the orchard owners get an average of 20 liters of schnaps from me for each fruit they donate- which they do by the truckload), I've finally nailed down this schnaps thing to a simple recipe. Here is how it's done:*
>
> - *Stone/ pit the fruit after washing it and culling anything that is rotting/moldy.*
> - *Add an equal VOLUME of water, which has dissolved in it: (boiling the water sanitizes the fruit, making sulfite a thing of the past):*
>   - *Enough sugar to bring the final abv to 16%abv*
>   - *Enough acid blend/citric acid to drop the pH down to 3.*
>   - *Pectic enzyme: about a teaspoon per 2 gallons*
>   - *Diammonium phosphate yeast nutrient: a shy teaspoon per gallon.*
>   - *A good strong yeast like Lavlin's K1V-1116 or EC-1118- 2 packets (5gram) per 5 gallons.*
> - *Ferment at the lowest temperature the yeast can work at in order to preserve the aroma of the fruit. Mash/stir the fruit daily during the ferment, in order to prevent a dried out layer of fruit from forming on the top of the mash- this will cause mold problems.*
> - *After fermentation is complete, filter out the solids, and let it stand till clear.*
> - *Run it through a potstill once, collecting the heads as you normally do, and keep collecting spirit until you no longer like the taste/smell (best method- everyone's tastes differ), or stop when your hydrometer shows the spirit out of the still is below 40%abv.*
> - *For those using an ice-water-wok still, freeze concentrate the wine down by half, and for every gallon of freeze concentrated wine, add a teaspoon of table salt, then run it however you normally do- ice-water-wok type stills are very odd in how they are*

> > *run- it's up to the individual on how to make the cut. Just remember to separate out the heads.*
>
> *I have been trying to figure this method out for a while now- going by weight of fruit (fruit wines use 2 to 3 pounds- a good fruit mash: up to 4 pounds per gallon)- but it's always given very different results- going by volume of fruit is much easier- and makes MUCH better Schnapps.*

Rutger writes ..

> *You should just pulp the pears, put in a little pectinase or other enzymes to break down the pectine (to prevent methanol) and ferment the whole bit. Fermenting will also decraese the viscoity of the mash. Then press it, after fermenting, that is. Distill twice in a potstill.*
>
> *I made a lot of calvados and other pear- and applebrandies, and fermenting the peel and other bits makes sure you get the right taste. A juicer will not do it.*
>
> *For Poire Williams you will got to have the right pears, simple consumption pears wil not give the distinct taste. It will not be very bad, but not the right Poire Williams taste.*

Another contributor adds ..

> *I had a glut of blackberries this year so I collected a large bucket of them and pulped them (unwashed) to give me three gallons of unstrained fruit pulp. I innoculated this with some actively fermenting beer wort and added a little wine yeast for good measure. Left it in a bucket to finish fermenting (about two weeks) and ran it though a pot still. As the still isn't large and over boiled a couple of times, I ended up putting all the fractions I'd collected into the last bath of wash and distilling very slowly. This gave a final product at 70%ABV. Most of this I diluted with water to 40% (BTW things are vastly improved if you use a decent mineral water for dilution rather than tap water), some of it I diluted to 40% using strained blackberry juice.*
>
> *An odd thing has happened - the water mixed batch has produced a fair number of plate like crystals* (a fruit acid or salt ?) *which slowly settled of of suspension yet the spirit wasn't cloudy in the slightest. The flavour is good - sweet, oddly coconutty with a hint of rum and fruit. The juice diluted batch is in sore need of a little sugar but I'll add that when it's*

finished ageing, at the moment it's firey, fruity and quite sharp but not unpleasant - it goes well diluted with a bit of lemonade or soda.

The second recipe -

A gallon of rowan berries (mountain ash) washed, cleaned and crushed. To this I added three pound of honey dissolved in one gallon of boiling water, the water was added whilst still boiling. Once it was cool I topped up to two gallons total volume added yeast and left it until it stopped fermenting (like the blackberry one it was too thick to get a reliable SG). Double distilled in a pot still this has given a 70% spirit (not yet diluted) which has the light flavour of rowan berries with a good honey kick in the after taste - extremely pleasant and watered down in the glass to 40% it's easy to drink.

Wal writes ..

Normandy in France is wet and cold for grapes. Great for apples. So they make cider and distill it to make calvados which when aged in oak is not inferior to cognac. Cider is double distilled and aged a minimum of 2-3 years. Traditionally cider is made by fermenting only apple juice & nothing else.

Cider recipes for distilling into calvados:

***Dry cider using fresh fruit** -*

- *4kg sharp apples*
- *2kg bitter-sweet apples*
- *2kg sweet apples*
- *Champagne yeast*
- *Mince, slice, chop fruit*
- *Add yeast and ferment on pulp for several days until pulp has softened.*
- *Drain free running liquid into fermenter and press out extra liquid from pulp and add to fermenter. A straining bag is useful.*
- *Add water to bring volume to 5l.*

***Using fruit juice/fruit juice concentrate** -*

- *Use pure juices without preservatives*

- *An economical version is to use equal quantities of juice and water to make 5l, and to add 800g sugar. There are 4kg apples (400g sugar) in 2.5l juice.*

  For more about cider : http://consumer.lallemand.com/danstar-lalvin/InFerment/Cider.html

Jack writes ...

> *Hard apple cider is simply the fermented juice of the apple. Apple wine has had the sugar level of the juice fortified with sugar or honey. Apple jack is a freeze-concentrated apple cider/wine- bringing it into the 20 to 30%abv range.*
>
> *Distilling apple cider/wine will give apple schnaps- but ageing it on some oak may make a much better apple brandy.*
>
> *Distilling the cider/wine and then mixing the brandy/schnapps with fresh (unfermented) apple cider at a mix of about 50/50 gives something the French call "ratafia" (from the latin rata fiat- let the deal be settled)- a traditional drink at the end of a negotiation. In the Cognac region it is made with Cognac and fresh grape juice and is called Pineau des Charentes. The Armagnac region calls their version "Floc de Gascone. The Normandy region (where they make it out of apple brandy and fresh cider) they call it "Pommeau". The mix results in a 17 to 25%abv sweet drink, believed to be the ancestor to the liqueur.*
>
> *Most grocery stores have unfiltered, no chemicals added, pasteurized cider (typically in a milk jug in the produce section), that can be fermented by pouring it into a sanitized container and adding yeast (a slow, cool ferment with Lavlin's K1V-1116 wine yeast makes excellent cider- adding a an ounce or two of French oak shavings (per 5 gallons) to the ferment also helps with the complexity- the cold ferment is needed to preserve the aroma.). You don't need to boil cider- if you do it can set a pectin haze- ever since the E-coli outbreaks pasteurization has become law (within the U.S.A.).*

Scrounge adds ..

> *Another tip - if you rough chop the fruit and freeze it and then allow it to thaw, it gives up its juice with much less effort, the technique works with most fruit and doesn't affect the flavour*

Regarding slivovitz, Wal writes ..

> *Traditionally in the Balkans and Eastern Europe plum brandy (similar to apple cider) is made from the pure fruit only, with no sugar or water added. Relying on wild yeasts, it ferments naturally for 5 weeks. Alcohol content would be about 5%a.b.v. It is double distilled to 70%a.b.v. For this method you need lots of plums. I drank kosher Passover sliwowica (70%a.b.v.) in Poland and it tasted great. Had an amber tinge. Drank plum brandy from yellow Mirabelle plums in France and this tasted a bit mellower than from black prunes. This was a white distillate of 50%a.b.v. In the Balkans they steep whole plums or dried plums in the final distillate to increase the plum flavor and to give a bit of color.*

Homemade press for grape/fruit(cider) musts. See: http://members.iinet.net.au/~kookie/frame.html and http://www.geocities.com/NapaValley/Vineyard/1762/pressplans.html Using **citrus**. Wal explains ..

> *Citrus fruits are low in sugar content but high in acid, so they are not an ideal fruit for wine or distilling except for the home winemaker, who has to make appropriate adjustments (see fruit wine sites). There is more money possibly in citrus juices and jams. Fruits like apples, plums and bananas which have a high sugar content are used extensively.*
>
> *On the other hand citrus peel is used extensively for flavoring alcohol - by double distilling the macerated/infused peel in 45% alcohol to get a clear citrus flavored spirit (e.g. Cointreau), or by just infusing peel in alcohol (usually 30%) to make a liqueur (e.g. Limoncello). Sugar is added except where citrus peel is part of the botanicals for a dry gin.*
>
> *There is a lemon brew (alcoholic lemonade) recipe which uses the juice and rind of 3kg lemons, 2kg sugar, 0.75kg lactose (to sweeten as it does not ferment), beer yeast.*
>
> *I have made citrus mashes using the peel and juice to make my equivalent*

to Cointreau, as I have citus trees in the garden. For a 25l mash I used 5kg of sugar with either the peel and juice of 30 lemons or 15 oranges - do not use the white pith though as it is very bitter. I diluted down to 50%abv and added sugar to taste (to remove the natural bitterness). I was pleased with the result. I have just planted a Seville orange and a Citron - the peel of both are used for flavoring, although the fruit is too acidic to eat.

Prickly Pears ...Wal writes ...

> *For those who have an abundance of prickly pear cacti. From a Californian site - http://www.geocities.com/NapaValley/Vineyard/1762/wine34.html*
>
> *Prickly Pear Wine (or Mash for the distiller)*
>
> - *A 5 gallon (20 L) bucket of Prickly Pears makes about 2 USgallons (8 L) of juice*
> - *2 lb sugar (900 g)/1 USgallon (4 L)*
> - *yeast 1 tsp/gallon*
> - *nutrient 2 tsp/gallon*

Rob writes about Macedonian spirits being made in Melbourne ...

> *Their system is gloriously simple. Buy boxes of grapes (anywhere along Mahoneys Rd and many other Melbourne sites), bung them in a 220litre barrel (Mernda market, flemington market and many other sites), squish a bit, stir daily. (some advise to take out stalks, I do, but many don't. Tastes a bit better without.) When finished take off wine as you choose. The wine is usually great, but you need some liquid in the still so the grapes swim. You can add water. The stills are traditionally 2x old coppers, the washing clothes ones. You join them with dough. It is all so simple, and the results are mostly delicious. I started out with a reflux still from NZ, but now I have my pot still... 60 litre capacity, the gas ring is the perfect temp, so no fuss with thermometers. Just light and let it run. The cut off with heads is based on taste for me. Others mix it all back in, or throw a bit away. You can add aniseed, or mastica, rub honey around the top copper. It's all good. I have tasted so many great spirits. If you start with good flavour, then use a pot still to keep the good flavour, you can't go wrong.*

Extra Sugar ?

There's a little debate around over the pro's & con's of adding extra sugar to a fruit mash. The traditional approach is that it ain't on - that all you're doing is making extra alcohol without getting extra flavour, hence getting a lower quality product (see Ups's comments below re Brandy - that you want the multiple distillations from a low % to concentrate the flavour).

Gert Strand however, at http://www.turboyeast.com/, however suggests that the extra alcohol (and CO2 produced) extra MORE flavours from the fruit. See his site for excellent instructions on various techniques & recipes when using his Turbo yeasts.

As Rob explains ..

> *The trick is, you can distill a fruit schnapps out of say 18% mash in one distillation; if your mash is only 6 or 8% you'll have to distill twice, which causes loss of flavour. Also, when you distill only once, the resulting distillate is lower in alcohol than after double distillation, so you add less water to dilute to drinking strength; this way you also dilute the flavour less. Of course single distillation requires good separation of the middle cut; stop well before the heavier stuff starts coming out.*

So the choice is yours. Both ways probably have their own merits and pitfalls.

Brandy

Ups474 writes ..

> *It seems that the flavor of the brandy can be improved by fermenting the wine out to a lesser amount of alcohol. Most of the time, when reading about someone who made a brandy (don't get me wrong here, I'm positive you are already making top of the line stuff, I'm just showing another way of doing it) they use a starting wine with a minimum of 10% alcohol.*
>
> *It is a well known (obvious) fact that distilling concentrates alcohol, it is a lesser known fact that it also concentrates flavor. If you have ever had (or made) a very high alcohol white wine, you've probably noticed that it was pretty insipid in the taste department, that is because alcohol seems to displace flavor, so the less alcohol there is, the more the flavor can come through.*
>
> *Consider these numbers: A wine of 10% alcohol that is distilled to a final 70% has been concentrated seven times (so has the flavor!), a wine of 5%*

> *alcohol distilled to the same final 70% has been concentrated a total of 14 times! This would allow for a richer flavor to be concentrated in the resulting spirit.*
>
> *This is how commercial apple brandies and the like are produced (no added sugar is allowed-keeping the starting % low), and may be part of the reason for the great flavor they have. Hope this helps someone. Cheers!*

Wal offers ...

> *Brandy in Australia, if made in a pot still (getting rarer), is a double distillation process. The heart of the run has a strength of between 74%abv and 83%abv. By law it must be below 83%. The Australian pot still differs from the pot still used in the Cognac region of France (alambic Charentais) in that there is a tall tower (no plates) and an upwardly inclined lyne arm. Both have some reflux capability. In the French version, reflux is limited to the header chamber. Therefore removing scrubbers from a tall reflux column, or using a short reflux column could give the equivalent strength in one run.*
>
> *No access to grapes? You could get the same taste profile using raisins or sultanas. 8kg of fresh grapes produce 5l of wine. Raisins have a drying ratio of 1:4, therefore 2kg of raisins or sultanas (shredded) with 5l of water would be a reconstituted equivalent. 14lbs of grapes produce approx. one U.S. gal of wine(4l). To reconstitute raisins, for each 1kg (2.2lbs) add 4l (1U.S.gal) of water. Since raisins are 60% sugar, you could use 1.5kg of raisins for each 4l of water or 2kg of raisins/5l water which is the max. yeast can ferment (about 2lbs of sugar/U.S. gal). Most commercial raisins are sulphited and covered in vegetable oil - preferably use naturally dried raisins, or wash well in hot water.*

Split Brandies

Sam writes ..

> *Some of THE best liquor I ever made was some split brandy.*
>
> *I took some previous slop with the usual wheat bran grain that I used and separated it into two barrels. Water and 50 lbs of sugar. I also used either apples or peaches. I took the fruit and run it through one of those juicer machines that separate the juice from the pulp.*

> *I put the juice in one barrel along with the mash and the pulp in the other barrel with the other mash. I fermented and distilled them separately. Then when I was done with that I would carefully mix the two in a blend that was superb. This worked out better for me than just throwing everything in one barrel and running it. Something about the separation and then the blend. Much better taste and smoothness that way.*
>
> *Of course the longer it sat the better it was. A friend of mine kept some for several years and then broke it out for Christmas one year. I/we couldn't beleive how good the flavor/buzz was.*

Mock Apple Brandy

Jack writes ..

> *Faking fruit brandy is a great way to use up any 95% sugar spirit you have laying about that you can't figure out what to do with. I found this recipe in an old distilling book and scaled it down for home use (the original makes about 100 gallons).*
>
> *Mix together:*
>
> - *32 fl.oz. (950 mL) 95%abv sugar spirit*
> - *10.5 fl.oz. (310 mL) apple cider (the sweet cloudy type bottled in milk jugs in the cooler in the produce section of the grocery store)*
> - *34 grams of table sugar*
> - *20 fl. oz. (600 mL) distilled water*
> - *2.13 grams of cream of tartar(spice section of grocery store)*
>
> *Mix this up until everything has dissolved, then reflux this mix in a stockpot on the stove (low heat) - put the lid on the pot upside down and fill it with ice to keep the alcohol from boiling off. Bring it to a thorough boil for about 10 minutes, then lower the heat until it is just evaporating the alcohol (and the lid is condensing it). Let it cook on low for 4 hours, at the last ten minutes, bring it back up to a good boil, and hold it there while replacing the ice (you can't boil it for the entire time - you'll run out of ice).*
>
> *After the 4 hours, cool this mix and let it settle out, the stuff is ready to be treated as an "apple spirit" from here on- It's good (but sweet)*

> *straight- aging it in some charred American oak chips (not much - maybe a teaspoon - don't overdo it) will make it taste more like an "aged in wood" brandy. This is suprisingly good, considering how easy it is to make.*
>
> *If you want to use apples instead of cider: use 1 and a-half pounds (680g) for the batch size above - chop up the apples, add the sugar, one fourth of the alcohol, and 2/3's of the water, mix (blending the apples is best), and let sit (covered) in a cool spot for 8 days, then press out the liquid, mix with the rest of the water and press again, add the last of the alcohol, and proceed as above. This method also works well with pears and plums*

Arak or Raki

For a Greek "raki" alembic still see: http://www.paleochora-online.de/raki_eng.htm

Roger is still working on improving the following method for making Arak ..

> *Arak is the national alcoholic drink of Lebanon. It is a distillate from grape alcohol and aniseed similar to Ouzo, but without sugar and gum mastic added...*
>
> *Crush grapes, allow to ferment completely, distill alcohol. Clean pot still and redistill alcohol (which I run through activated charcoal), return alcohol which is about 150 proof to the still adding one third the volume of alcohol, water plus 2 pounds of aniseed per gallon of alcohol. The aniseed is kept whole and is soaked in hot alcohol in the still the day prior to distillation. Distill a third time.*
>
> *What I get is a distillate that is 170 proof which is diluted with distilled water to 100 proof (if the proof is less than 100, Arak turns cloudy). It is aged in pottery crocks for a month. Another method is to blend 190 proof alcohol with anis oil (produced in Spain).*

From http://www.chios.gr/products/ouzo_en.htm about Ouzo ..

> *The island of Chios, known as the cradle of spices and aromas, produces a variety of soft and smooth ouzo, which depends on the recipe used. The*

> *traditional ingredients include glykanissos (aniseed) combined with maratho (fennel), koliandro (cilantro) and the unique mastic.*
>
> *Clearly disassociated from the local tsipouro (raki) and from souma (suma), which is mainly produced by figs. Chian ouzo is still distilled primarily in the small copper stills (kazania) of traditional family manufacturers.*
>
> *The classic Greek drink Ouzo begins as alcohol made from grape skins or other local produce. It is then brought together with herbs and other ingredients, including star anise, coriander, cloves, angelica root and even cinnamon and lime blossom. The mixture is boiled in a copper still and regulated by a taster. The resulting liquid is cooled and stored for several months before it is diluted to about 80 proof or 40 percent alcohol. However, homemade ouzo can be a deliriously strong 80 percent alcohol.*
>
> *Ouzo is usually served as an aperitif, but is also used in some mixed drinks and cocktails. When mixing Ouzo with water, it turns whitish and opaque. The reason is that the anise oil dissolves and becomes invisible when mixed with a conventional alcohol content, but as soon as the alcohol content is reduced, the essential oils transform into white crystals, which you cannot see through.*

Wal writes ...

> *Anise flavored spirits: Arak (Lebanon),Raki(Turkey,Crete), Tsikoudia (Crete), Tsipouro, Ouzo (Greece), Ojen (Spain), Pastis (France) -*
>
> *Arak, Raki, Ojen is distilled from grape pomace in alembic stills capable of holding 40-130kg. to which aniseed is added. I gather the proportion is approx. 500g/25l of wash.*
>
> *Saw in 'Lebanese Cuisine' by Anissa Helou, 1994, on p.35 a method for Arak*
>
> - *First a white wine is distilled.*

> - *To 100 litres of this 'low wine' distillate, 10 kg of aniseed and 50 l of water are added and redistilled. (This corresponds to 100 g of aniseed/litre alc.)*
>   - *Then more aniseed (amount not given) and half the amount of water (25 l) is added and redistilled.*
>   - *This process is repeated 2 more times (4 distillations in total) to get a 60%abv product. I gather the amount of water is half each previous amount.*
>
> *The approx. volume of 60%abv from 100 l of low wine is 20 l. The essential oil yield of aniseed is about 2%, but assuming there is much loss due to the distillation method, we could assume 1%. Therefore the amount of anise essential oil (from the 10-20? kg of aniseed used) in 1 litre of the 60%abv Arak is between 5 ml and 20 ml or 1tsp-4tsp (100-400 drops). I would say 1tsp of esential oil/litre 60%abv is sufficient.*
>
> *Ouzo has other herbs and spices added such as coriander, cardamon angelica root, cloves, fennel, nutmeg, mastic, tillium flowers. It is usually distilled once (40% a.b.v.) or sometimes twice (60% a.b.v.). I suspect the aniseed was originally added to mask the roughness, as no thermometer was used to control the distillation.*
>
> *In Turkey they now use shredded raisins (70% sugar), instead of grape pomace. To reconstitute a grape wash use 2kg unsulphured raisins/5l water. First they produce a raisin distillate to which aniseed is added (approx.100g/l of spirit) and a second distillation is carried out. Aniseed gives a 3% oil yield. Sugar and water is added and it is aged for a month. Arak (from grape pomace) is aged in clay pots for up to year & a 3% evaporation loss occurs. Anisette and Sambucca are sweet aniseed based liquers.*

Jack writes ...

> *The old arabic word for "juice" (araq) gives us the name for a seemingly misunderstood class of spirits. Most of the time this name is given to a distillate made up with a mash of fermented palm sap, and/or some rice. It is also made from (more recently) figs, dates, raisins, and plums. It can be found (most often) in an unaged (white) state, typically at a high strength. In the west it is mostly encountered in the form known as "raki" - a fruit wash (as those listed above), flavored with aniseed. Rarely it can be found unflavored and cask-aged, following the tradition of fine*

brandies. It is most common in the Balkan countries of southeastern Europe, as well as the Middle East and north Africa. It is most often had as an aperitif, but if you are lucky enough to find (or make) a mellow bottle, it is better at the end of a meal, after coffee.

Here are my 2 favorite methods of making this drink:

1 (cheap, but very good:1 US gallon recipe)): soak in enough water to cover them (overnight) 2 pounds of raisins- after the soak, blend them into a mush in a blender, and pour this sludge into your fermentor. Add 1/4teaspoon of powdered tannin and one teaspoon of acid blend to the raisin sludge. Boil a gallon of water on the stove and dissolve 2 pounds of sugar in it, once the sugar is dissolved, and the water is boiling, pour the hot water onto the raisin sludge. Allow to cool on it's own, and when cool, add 1/2teaspoon of pectic enzyme, and yeast (I use Lavlin k1v-1116 in both of these recipes). Ferment till dry, distill when clear. Distill in a potstill (or a stovetop inverted lid chinese type still) to about 50% (the total run) stop if tails show up before this. Dilute to where you want it and drink (note-copper is essential in the still when making these drinks!!).

2 (fancy, great taste, not one you advertise, lest you have to share it. one gallon recipe). Soak 6 pounds of raisins overnight, blend into a mush, then add 1tablespoon of acid blend. Bring a gallon of water to a boil, and pour it hot over the raisins in the fermentor-no sugar is added (no tannin either- the acid blend is to balance the fact that table grape raisins lack winegrape varietal acidity, and tend to make a "flabby", one-dimensional brandy on their own). Once cool, add 1/2teaspoon of pectic enzyme and the yeast (same as above). Ferment till dry, distill when clear. Distill the same way as above.

Distilling in a reflux still with it's packing removed to lower effeciency also makes a great spirit from these two "wines"- By the way- no solids are put in the still- the wine is totally clear when it is distilled. It is best if the fruit wines (they are stable wines, capable of being aged and bottled, if you want) are allowed to mellow a bit before they are distilled (mine is a year old before it goes into the still). On their own, they make very nice dry wines with a sherry taste to them (I tend to prefer them distilled, personally).

> *Almost forgot, during fermentation, the raisin pulp rises to the surface. It will dry out and harbor bacteria if not broken up. You need to mash down and stir in the "cap" that the raisins form at least twice a day. Also, resist the temptation to boil the raisins directly- you can pour boiling water on them, but don't boil them on their own- the wine (and spirit) that comes out if you boil them tastes like Christmas pudding- pretty gross.*

Wal adds ...

> *Seeing that a source of the method of makin arak and quantities used is rare, I will quote the 'Distilling Raki' from 'Rayess Art of Lebanese Cooking' by George N. Rayess, which I found in Google group soc.culturelebanon.*
>
> *"Method:*
>
> - *Grapes are gathered and are crushed and put with all their elements (seeds, stems, juice etc...) into wells or wooden barrels or glazed earthernware barrels stored inside. It is stirred well once a day for 15 days until it ferments. The sign of that is the appearance of foam on top of it. Then discontinue stirring and leave it set till no more foam appears and the top of the juice appears clear by the rest of the elements having settled at the bottom.*
> - *Now pour all the mixture into the distilling vessel, the 'karaki'. Distil over very low heat until all alcohol is drawn out of it. Now pour out all the remains in the karaki and wash it well. The next day, pour in the karaki the following proportions:*
> - *For each 6 gallons of alcohol, add 4 gallons of water and 11 pounds of aniseed. Stir all this well then seal the karaki well with flour paste or dough so that none of the steam may escape. Put the karaki over low heat and when it starts dripping, cut off heat for 24 hours until aniseed is well soaked in the alcohol. Then put on high heat until it starts distilling, then reduce heat until arak starts dripping with quick but disconnected drops. Water in top part of karaki must remain cool throughout entire operation before it gets hot.*
> - *When the color of arak starts turning white, put aside what has already been distilled. Increase heat and repeat the operation. Distilling is stopped when the amount of alcohol in the arak has become very weak. The last portions distilled are added to the first portions.*

- *Arak is stored in large containers painted on the inside. Store for three months or longer until it has cleared and mellowed. If stored in glass containers, it requires over four months for it to become good enough for use. At this point add enough water to reduce the rate of alcohol so that its content measures 21 according to an alcohol measure."*

As a rough estimate this might be equivalent to 200 grams of aniseed for 1 litre of 40%abv or 1/2 tsp of aniseed oil/litre 40%abv assuming an essential oil yield of 1.5%.

Moroccan 'Mahia'

In Tunisia the local specialties are 'Boukha' or fig brandy (eau-de- vie de figue) and a date liqueur called 'Thibarine' (possibly named after the Thibar mountains?). What about those contemplating to go to Morocco? 'Mahia' is the local Moroccan spirit. A 1848 source says that it is distilled from dates, although it could be a local generic name for an eau-de-vie made from various things. Like the Lebanese 'Arak' it is anise flavored. The Turkish 'Raki' which is similar to Arak was once made from grape pomace but these days is made from raisins. Mulberries were sometimes used also. "The restaurant sometimes has available mahia, or home-made l'eau de vie, the anise-flavored drink for which Moroccan Jews are well-known." 'Jewish Morocco' http://rickgold.home.mindspring.com/page17.html

Dates are a good source of sugar (70%), so I decided to make my own Mahia using dates which I obtained at the equivalent of $US1.50/kg or about $US1/lb. A malt extract (70% sugars) costs double that price. I made a mash giving the equivalent of 300 g sugar/l, using Lalvin EC- 1118 yeast which can tolerate 18%abv:

Moroccan 'Mahia' *(20 litres or 5 US gal)*

- *5 kg (11 lbs) dates - washed and sterilized with boiling water (This amount of dates is equivalent to 3.5 kg of sugar.)*
- *2.5 kg sugar (5.5 lbs) (The dates and added sugar gives the equivalent of 300 g/l sugar.)*

> - *1 kg crushed aniseed (This amount of aniseed would give the equivalent of about 200 g/l of aniseed to the final alcohol of 50%abv.)*
> - *40 g Lalvin EC-118 yeast*
> - *20 g DAP yeast nutrient*
>
> *I decided to use the crushed aniseed in a single distillation as I would be producing a distillate of 75%abv which should still retain a lot of flavor.*

Grappa

Wal also writes about **Grappa** ...

> *Rum is made from the waste material (molasses) from sugar processing. Grappa is made from the waste material (pomace) from wine making. It was the drink of the frugal rural folk as there is still sufficient alcohol at about 12% present in the pomace. A more literary name would be "acquavite di vinaccia". Vinaccia is Italian for pomace. For similar reasons in Greece they make tsipouro/raki/ouzo out of stemfila which is Greek for pomace.*
>
> *For the Greek version and using a single distillation, herbs (anise seeds etc.) are placed in the bottom of the pot to prevent the pomace from burning. Possibly 500g of aniseed/100kg pomace is used (this produces about 5l of spirit). For a second distillation product, steeping 100g of aniseed/litre of spirit and redistilling seems right (about the equiv. of 50 drops of aniseed oil/litre of spirit). In France grape residue is called marc and its used to make "eau-de-vie de marc".*
>
> *Because grape residue contains seeds and stems, elementary distillation produces a rough product which was avoided by more discriminating drinkers. The seeds also produce quite a bit of methanol. Pomace after a first pressing contains much of the flavor of the particular grape type and thus the final product resembles brandy or fruit-based liquor. Lighter pressing of the grape must, better distillation techniques and packaging have made grappa into a sophisticated liquor.*
>
> *The vinaccia should be distilled within 48 hours of pressing otherwise the aromatics disappear, and oxidation and acetification starts. On average 100kg of grape pomace yields from 4 - 8 litres of grappa at 70%abv. In making white wine, the grape is pressed first to extract the juice (100kg grapes produce about 55litres of juice), so the pomace from white grapes*

must be fermented separately to produce grappa. Water (or steam) is added to the red grape pomace resulting in a slurry called flemma which is then distilled. Water is added to white grape pomace which is first fermented and then distilled.

Traditional method:
Load 100kg of pomace with an equal weight of water (100litres) in a pot still and distill. Triple distillation is common commercially. Normally it is diluted to 45%abv.

In Italy grappa is normally an after dinner drink (digestive), or on a cold day you can have it with your morning coffee! Last vintage I decided to try a modern method using the red pomace to provide nutrients and flavor. The yeast was already present.

Grape's Components:

- *Stalk 3-5%*
- *Skin 6-10%*
- *Pulp (water, sugars, minerals) 82-90%. The actual water content of grapes is approx. 65-75%.*
- *Seeds 2-4%*

The grape pomace (vinaccia in Italian) contains about 10% sugar or 5% alcohol if fermentation has occured. Traditionally equal quantity of water was added and redistilled in a pot still. A modern grappa recipe could be based on making a 'false wine', as sugar is affordable these days, and then distilling as for brandy.

Modern method:
50 kg of pomace with 100litres of water (2 kg / 4 L)
25 kg of white sugar (1 kg / 4L)
Referment for a week, press out and distill the clean wash. I used a reflux tower with a jacket reflux and vapor condenser and which produces 75%abv which is a great brandy base. I kept 5 litres of the reconstituded wine under an air lock for 6 months and it made a reasonable light wine. This is based on the fact that to "reconstitute" the pomace to make a pseudo wine, we need 2kg pomace, 4l water and 1kg of sugar. These proportions are approx. equivalent to 7kg of fresh grapes which give about 4l of wine.

For more links on grappa see http://www.terradimare.com/odello/istitutograppa/index-g.html

Tequila

Tequila is made from the nectar of the agave cactus. You might be able to source some bulk agave nectar from a local health / natural food store.

Donald advises ...

> *Tequila can be made at home using agave nectar, water yeast nutrient and yeast. Additional sugar may added (Jose Cuervo Gold uses 50% sugar). Agave nectar may be obtained from Crosby & Baker, Westport MA, USA.*

Using Potatoes

For those of you interested in making authentic Vodka or Schnapps from potato, the following emails from David Reid should be of interest. The problem with potatoes (as all starchy vegetables) is the need to first break down the starch into basic sugars so that the yeast can use them. This is done by using enzymes, either via malted grains or from a packet.

> *...there are probably better instructions and details in books on Schnapps of which in English there is a real dearth of. I would imagine there are some very good books available in German. What I have described is basically the process for saccharifying barley which applies to all grains as long as sufficient enzymes are added and the starch chains are not too long or complex. Barley has by far the highest % of natural amalase (diastase) enzymes plus a very high starch content of a fairly simple nature which is more readily broken down than most grains hence its widespread use and popularity from the ancient Summerians and Egyptians to the current day.*
>
> *The advantage of potatoes over most grains is the amount of starch that can be produced per acre (up to 80 tons per hectare with the world record being about 120 ton. Note wet weight not actual starch content although this is generally 80% + of its dry weight). Its disadvantage is the lack of enzymes which must be added (until 40 or 50 years ago not fully understood). I believe the only one that can equal potaoes is cassava (tapioca) but you need a tropical climate to grow it. Traditionally these have been processed at lower temperatures and left soaking for quite a reasonable time, basically to give the enzymes time to do their job and to*

save energy I would imagine.

I suspect the reason Simons first attempt failed was largely because of insufficient amalase enzymes. Temperature possibly also had a small bearing.

I would imagine there is not that much difference in basic processing of schnapps and vodka both being identical in the initial processing although I have not done a lot of reading on the matter.

To get this better we really need to know the proper composition of potatoe starch and its liquifaction and saccharification temps. Somewhere I have some general details on these last two especially liquifaction but todate do not have accurate details on starch composition. I believe the Danes have done quite a bit of work and reasearch on this aspect (composition).

Potatoes are harder than most people think and you need a bit of experience to get them right. Books make it sound so easy because they tend to simpIify the process and take for granted that you have a full understanding and experience of all the steps involved quite often leaving out some of the elementary steps. Most of us need to fully understand the basics first before we really begin to learn. I have not tried potatoes yet myself but know this from my reading, broad experiernce of other aspects, and experience with other forms of starch.

What you will probably need to do is what is called a Stepped Infusion Mash. This is where you start the saccharification process at a low temperature and then move it up in steps, halting for a certain time period at each step to give each enzyme time to break down as much as they can at each stage. If you have made beer in the past using an all-grain mash you will understand the process.

To get a feeling for it and to understand the process better try the following:

1. *Cook your potatoes so they are still stiff - about 12- 15 minutes at reasonable heat. Up to 20 minutes at low heat. Note they should still be a bit undercooked, definitely not soft, mushy, or floury.*

2. *Add coarsely milled barley (particles mostly about 1/16 to 3/32" in size. Definitely not too fine.). Use malted Ale barley or standard malted barley rather than Lager barley as it is definitely higher in enzymes and enzymatic action. Note you need sprouted malted barley not spray-dried malt which is normally on a maltodextrin base and has had most of the enzymes destroyed or inactivated because of the excessive heat used in the drying process.*
3. *Cover with sufficient water and bring to 113 F (45 C). Hold 15 minutes stirring regularly.*
4. *Bring up to 133 F (56 C). Hold 15 minutes etc.*
5. *Bring up to 149 F (65 C). Hold 15 minutes stirring constantly.*
6. *Bring up to 158 F (70 C). Hold 15 minutes stirring constantly. All up this makes 60 minutes which should suffice for a small batch. Some batches will take longer especially bigger batches. Most of the liquifaction and saccharification occurs in steps 5 & 6 rather than 3 & 4. If you want to alter this reduce 3 & 4 to 10 minutes and increase 5 & 6 to 20 minutes or longer where required.*
7. *Once virtually all the starch is liquified and broken down to simple sugars to halt the enzymatic process raise the temp to 176 F (80 C) (Mashing Out) and then drop it back as quickly as possible to between 140 F (60 C) and 122 F (50 C) so the sugars dont get scorched or burnt.*
8. *Cool down further to 75 F (24 C), establish an SG of 1060 (min) to 1080 (max = ideal) and begin fermentation.*

If you muck around with the basic formula doing several batches, altering the temperature and times a small amount each time you will quickly get a feel for it and learn far more than you can learn initially out of books or I can spell out for you.

I suggest you start with 3 or 4 kg of potatoes and 1/2 kg of barley each time so you have plenty of enzymes together with a very large pot so it dosnt boil over. Once you have got this basic process under control and gained a bit of experience I can help you further with advice and help with enzymes. Also once you have the experience and understand fully what you are doing with the right selection of enzymes you can reduce this 4 to 5 steps down to 2 or 3 steps and save a lot of energy and time producing virtually the same result.

At first for the small amount produced it hardly seems worthwhile but you will be amazed at how quickly you have control of the process with a bit of experience. Learn this process properly now and it will save you a lot of time later.

The most important enzymes are Alpha amylase, Gluco amylase and to minor extent Beta amylase. Beta has largely been replaced by Gluco. The other important factor is temperature with each of these working best (most active) at certain temperatures. Alpha works best at higher temperatures normally chopping the starch into smaller blocks whereas Gluco and Beta work from the ends. Temperatures required of the process are therefore dependant on makeup and complexity of the starch.

As mentioned without knowing the exact composition of the potatoe starch I cannot advise exactly the necessary temps and times. The setup I have given you is basically for barley but should work quite satisfactory with potatoes because of the range of temperatures involved.

What I am saying here applies to barley as well as individual enzymes. The heat of cooking the potatoes will start the process. For all I know it may help to throw a handful of barley in with the potatoes when you begin cooking. Keep good notes of amounts, times, and temps and if you have much better success compared to the last time or another batch you should be quickly able to repeat it. By doing this you will quickly get a good idea of what is required. Keep me up todate with how you get on.

Be aware that enzymes are protein and bio-catalyst and like other proteins consist of long chains of amino acids held together by peptide chains. They are present in all living cells where they perform a vital function by controlling the metabolic processes and hence the breakdown of food into simpler compounds eg. Amylases break down starch into simple sugars. As bio-catalyst by their mere presence and without being consumed in the process they can speed up chemical processes that would otherwise run very slowly being released at the end of the process to begin it all again if required. In theory this can go on forever but in practice they have a limited stability and over a period of time they lose their activity because of variables particularly temperature changes and are not useable again. In practice therefore be very wary of quickly changing and wildly fluctuating temperatures.

Good luck

Teemu writes ...

- **Making vodka from potatoes**

  Two good reasons for using potatoes:
  1. Traditionally vodka is made of grain or potatoes to achieve the smooth & soft aroma; witch is typical to commercial European vodkas.
  2. In Finland 1kg of sugar costs about 1,9e, 25kg sack of (feed) potatoes from local Agri-Market costs 2e...

  The recipe, which may lead to prosecute:
  20-25kg potatoes
  1kg of barley, malted and gristed
  50-100g of good (Turbo/Prestige/Partymann...) yeast (hydrated)
  Some fresh water

  Equipment needed:
  30 litre beer fermenter
  A large (30-50litre) kettle (I use a milk can...)
  A meat grinder (for mashing the potatoes)
  A large scoop or a "wash paddle"
  A hotplate with a thermostat

  1. Clean all the dirt from the potatoes, (don't bother to peel them)
  2. Put the potatoes in to kettle and cover them with water, bring to boil. Cook until the first ones break down -this should take about 1hr. In meanwhile hydrate the yeast and mix 1kg malt and 2litre of water (if you use homemade malt, don't dry them -it weakens the mysterious "amylathic power").
  3. Pour the water out from the kettle (use mittens, be careful). Mash the potatoes in the grinder while they are hot. (If done right the mash looks like thick porridge.)
  4. Put the mash to kettle (and adjust the hotplates temperature to 60C). Add 1/3 of the hydrated malt to the kettle and stir well. Wait until the temperature has dropt to 65C. Add the rest of the hydrated malt and stir in well. Let sit there for about 2 hours. Stir often. (If done right the wash should have turned flowing.)
  5. Turn the hotplate off. Put the kettle in somewhere cool. When the temperature has dropped down to 25C pour to fermenter and add yeast (no nutrients needed). First carbon dioxide bubbles should rise after couple of hours; main fermenting takes about two days, ready for distilling in four days -if you have done everything as written. Result will be 7-12vol%, depending the starch level of potatoes.

  This is how I do it. There are many different ways too-but there are always four steps.
  1. Softening the cellular walls.

2. Mashing the potatoes.
In industrial scale steps one and two are usually done by using the HENZE-kettle, witch is basically a direct-steam heated pressure cooker (pressure is up to 8atm and the cooking time about 40min).
3. Converting the starch to maltose.
4. Fermenting.
Notice that there are only those 2L of water added to mash, no more are required because the potatoes contains $\frac{3}{4}$ of water.

P.S. If the wash is done right you should be able to distill it with a still that has an inner heating element -I have a 2kW inner (silver plated) heating element in mine.

When I asked if he needed to filter the wash before distilling it, Teemu replied .. *No, no filtering required, but if want to be really sure strain trough a kitchen sive (hole size about 2mm) to get rid off the peaces of malt. The reason why grain washes burn onto the element is that they contain a lots of cellulose (like porridge). [Dry grain (rye) contains up to 40% of cellulose.] Potato wash wich is mashed well and fermented dry contains such a tiny amount of cellulose (like soup), so that it won't burn onto the element! (Fresh potatoes contains only about 14% of cellulose.) You can see this in practice -- typical ready grain wash is thick stuff like (milk) cocoa, ready potato wash is flowing like coffee. Just keep sure that the potatoes are mashed enough small bits (>0.1mm) before adding the malt.*

More scientifical explanation why the potato washes don't burn on to the element:

Potato vs. Grain

	Water	Proteins	Fats	Starch	Cellulose
Oats	12%	13%	7%	60%	12%
Barley	12%	11%	2%	63%	12%
Rye	12%	12%	2%	62%	12%
Wheat	12%	11%	1.5%	64%	11%
Potatoes	75%	1.5%	0.1%	14%	1%

> *Now if we calculate the water and the starch as element-friendly materials and others as un-element-friendly materials we found that the grains contain ca. 26% of un-element-friendly materials (non fermenting, burnable, low heat transfer rate...), when potatoes contains only ca. 2.6% of un-element-friendly materials! In practice this means that there is only about half a kilo of un-element-friendly materials in 25l batch of potato wash, but in 25l of grain wort the number can be as high as 1.5kilos! Other reason why the potato mash doesn't burn onto the element is convectional floating; the viscosity of fermented potato mash is enough near of water to create the enough rapid convectional floating.*

Dane writes ...

> *potatoes work really well, It is the enzymes in the barley malt that convert the starch in the corn, Potaoes are almost entirely starch, and water. I use 20lb of 'taters with 5 gal of water, cook for an hour+ mash them all up well, so it's a rumnny, thin mush. Add a couple spoon fulls of acid blend. Add 2 lb of 6 row malt at 150 deg. maintain temp and stir for several hours. let cool add another couple spoons of acid, and nutrient. Add about 1 lb or 2 of pure sugar for some added kick. Use Ec-1118 and wait a week It makes a really good spirit after 2 distillations and a little polishing*

Potato Mash

Here's one recommended by Andrew, from Eastern Europe. Combine all ingredients and leave until fermented, should take approx. 2 weeks

- 21 Litres of water.
- 7 kg of sugar.
- 175 grams of yeast.
- 3 small (125 mL) packets of tomato paste/concentrate.
- 0.5 litres of natural plain yoghurt
- 1.6 kg raw grated potatoes.

Wal writes ...

> *If you do not have too many potatoes, you can make a potato and sugar mash, as suggested in a Russian samogon site. This would be a good way to get an idea of the effect of potatoes on taste. In the Russian language site there is no mention of adding malted grain to convert the starch to sugars, which could be a problem, unless the potatoes they use have sprouted so much that most of the starch has already been converted! It is recommended to use about 5% malted grain for potatoes as otatoes have about 20% fermentable material, the rest being water.*

Potato and Sugar Mash

4 kg potatoes
200 g crushed malted barley
4 kg sugar
20 L water
Yeast

Peel and cook the potatoes in a minimum of water. Mash. When cooled to 65C, add crushed malted grain and leave for 90 minutes for conversion. Combine mashed potatoes, sugar and water, add yeast and ferment.

There is one Russian samogon recipe that combines potatoes and oats, which could also give a good Irish poitin mash, as oats and potatoes are common Irish ingredients. Although it suggests crushed oats, rolled oats would be more convenient. No malted grain is mentioned, but the addition of up to 1 kg of crushed malted grain would be useful. Here is my modified version of the recipe:

Potato and Oats Mash

5 kg potatoes
4 kg rolled oats
1 kg crushed malted grain
20 L water (5 US gals.)
Yeast

Grate the potatoes. Add some boiling water to grated potatoes and rolled oats mixture. Allow to cool to 65C and add crushed malted grain. Allow 11/2 hours for the conversion. Place mixture in a fermenter, adding additional water to make 20 l. Add yeast and ferment.

Whether potatoes were used to make poitin is debatable, due to the lack of information except for oral stories. Malted barley was the original ingredient for poitin/poteen (unaged whisky), but later other unmalted grains, treacle, sugar were used due to availability and cost factors. Recently even sugar beet pulp is used!

A method of producing spirits from potatoes was developed in 1669, but commercially potatoes began to be used for distilling alcohol sometime after 1820.

Lex Kraaijveld (http://www.celticmalts.com/edge.htm) has a couple of references to the use of potatoes in Scotland and the British island colony of St Helena.

> *From June 1, 2002 - "Evidence for this in Scotland comes from the goldmine of information, the 'Statistical Account', compiled and published in the late 18th century. Besides barley and bere, potatoes are mentioned several times as a product from which a spirit is distilled. The quality of potato spirit was not considered very high. Rev. Joseph Macintyre, of the parish of Glenorchay & Inishail in Argyll, writes: 'Some distill a fiery and harsh spirit from potatoes.' and the writer of the Aberdeen parish report agrees. 'Potatoes are less fit for distillation than barley; the spirit produced is much fouler'.....Rev. Alexander Small writes in his report of the Lowland parish of Kilconquhar: 'Potatoes were scarcely known in this country 40 years ago; they now afford the poor half their sustenance, and generally appear at the tables of the rich; they are well known to be very proper food for horses and other animals, and are sometimes distilled into whisky.'*
>
> *From February 1, 2003 - "St Helena is a small island in the middle of the Atlantic. In the late 17th and early 18th century, distillation of 'arack' from potatoes was a common activity....In the St Helena records it is written in 1717: 'The miserable devastation formely made by distilling Arack from Potatoes is too sencibly felt now by ever one in the place....." The population of St Helena is of mixed ethnic origin but it is recorded that 'Irish cottagers' grew potatoes there. (Five Views of the Island of St Helena, Lieut. W. Innnes Pocock, 1815)*

So it seems quite probable that in Ireland, poitin (whisky's illicit sister) was also made from potatoes, although due to taste, I suspect that barley would have been the preferred traditional source.

Fermenting

Summary
Ferment the mash/wash at a constant 25°C, using 1.5g/L of good yeast suited to the wash. Use an airlock to let CO_2 out but not let air in. Let the yeast settle out, and possibly even filter the wash before putting it into the still.

Introduction

Fermentation is the conversion of sugar to ethanol and carbon dioxide by yeasts (wort to wash). Whilst doing this, it can create a range of flavours beyond what the wort started with. During fermentation yeast converts sugar into alcohol and carbon dioxide by feeding on a series of increasingly complex sugars, essentially breaking the sugar down into other compounds which enable it to grow. First on the menu is glucose, before moving onto maltose, then maltotriose. Depending on the strain of yeast, these sugars may be tackled at different rates, and not always strictly in sequence. Although sugars account for the majority of flavours, yeast works on various other compounds, including amino acids and fatty acids, which also contribute flavours.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \longrightarrow \underset{\text{Ethanol}}{2\,C_2H_5OH} + \underset{\text{Carbon Dioxide}}{2\,CO_2} + \text{Heat}$$

Theoretically 10 kg of sugar will produce 6.5 L (5.1 kg) of ethanol and 4.9 kg (4900L) of carbon dioxide. In doing so, some energy is released too (about 2.6 MJ/kg of ethanol).

Yeasts are single-cell fungi organisms. The most important ones used for making ethanol are members of the *Saccharomyces* genus, bred to give uniform, rapid fermentation and high ethanol yields, and be tollerant to wide ranges of temperature, pH levels, and high ethanol concentrations. Yeasts are facultative organisms - which means that they can live with or without oxygen. In a normal fermentation cycle they use oxygen at the start, then continue to thrive once it has all been used up. It is only during the anaerobic (without oxygen) period that they produce ethanol.

Gil explains ....

More correctly, in the absence of free dissolved oxygen the yeast will continue to breath by scavenging oxygen from the sugar molecules, and by doing so will continue to exhale carbon dioxide but leave the remnant sugar molecule behind in the form of ethyl alcohol.

The yeast does not consume sugar as food, but the other nutrients added to the wort. Mead making is an interesting experiment in this respect since unlike grape juice honey water will not in itself sustain yeast, and any half-decent distiller will do themselves a favour by mastering the technique of making such an environment more friendly.

Over the years I have learned to sustain the yeast in mead batches on a mixture of Vegemite and Epsom Salts, then aerate the wort thoroughly before activating the yeast and pitching. You can experiment with any number of nutrients and aerating systems to breed as much yeast as you want, but I have found the above mix avoids an off-taste in the finished mead and is easy to introduce to the colony.

The process implies two distinct fermentation phases. The primary fermentation takes place as the yeast breeds rapidly in the initially aerobic environment and the colony comes up to strength. Then the secondary fermentation takes place in the anaerobic environment thus generated, as the yeast strips oxygen from the sugar molecules in order to avoid suffocating.

Fermentation does not mean that alcoholic is being produced, only that the wort is in a ferment; that is, bubbling merrily.

Throughout both stages there is an abundance of carbon dioxide being exhaled which assists in maintain the anaerobic environment conductive to the production of ethyl alcohol. It does need to be kept in mind that it is not the yeast colony's intention to produce the alcohol, but ours.

All the yeast is trying to do is avoid suffocating in anaerobic conditions.

Beyond that it is fundamentally misleading to suppose that yeast is much interested in sugar, which can kill it the same as alcohol does, and here we must also recall that we are merely exploiting its ability to adapt to what are essentially hostile conditions.

My reference is A.J. Salle, "Fundamental Principles of Bacteriology", 3rd Edition, New York: McGraw-Hill, 1948.

Another book that must be read is Bill Mollison, "The Permaculture Book of Ferment and Human Nutrition", Tyalgum: Tagari Publications, 1993.

The influence of the yeast depends on the sugar concentration in the wort, the pitching temperature, and the rate of fermentation.

There are three phases to fermentation once the yeast has been added:

1. an initial lag phase, where little appears to be happening, but the yeast is adjusting to its new environment, and begining to grow in size
2. after about 30 minutes, the yeast begins to reproduce rapidly and the number of yeast cells increases exponentially (thus known as the exponential growth phase). Carbon dioxide is released in large quantities, bubbling up through the liquor. As the fermentation proceeds, the yeast cells tend to cluster together (flocculate).
3. The last phase is a stationary phase during which nutrients are becoming scarce, and the growth rates slow down. The evolution of carbon dioxide slows down, and the yeast settles to the bottom of the fermentor.

Under optimal conditions, a yeast cell is able to split its own mass of glucose (ie about 200 million million molecules) into alcohol and carbon dioxide every second.

For more information about fermentation, see Fermented Fruits and Vegetables - A Global Perspective, and Brewing Yeasts.

Yeast produces 33 times more alcohol while reproducing than when resting (so most of the gains are in the first couple of days, then you're just relying on the large numbers of yeast finally present to slowly work their way through the remaining sugars)

Once the nutrients have run out, and the fermentation has become "stuck" or sluggish, it is then too late to provide either nutrients or new yeash. If this happens really early during the fermentation, then you're in trouble.This is because when a yeast is deprived of a nutrient, it grows as best as it can with what is available, and then growth comes to a halt. Those cells are then put together with less than satisfactory levels of (lets say) protein due to deficient nitrogen. Their enzyme content is less than adequate, and they don't metabolize well at all. Growing cells are ~33 x faster at ethanol production than non-growing cells. Supplementation at that point does not reinitiate growth in the older cells. By that time the medium is higher in alcohol and still deficient in some nutrients. Some cells may even have died. Even supplying the combination of BOTH nutrients and new yeast won't get the activity restarted again. So the trick is to ensure you have enough nutrients available at the start of the fermentation.

You end up with having grown about 2g per litre of yeast (eg 40g in a 20L wash) This is why you don't get the full 51.1% conversion of sugar to ethanol, and gives some idea of the amount of nutrients - particularly nitrogen - that you need to supply.

Bakers yeast will produce a maximum of around 14% alcohol, whereas the "turbos" can generate up to 20% alcohol. Obviously you'd use different amounts of sugar for either case. Its not that the Turbo makes a higher % from less sugar, its advantage is that it can handle the higher concentrations (first of heaps of sugar, then later, the high alcohol %), and hence you need proportionally less water. Hence you end up with more alcohol in your 20L wash, because you are able to put more sugar in. Only use the Turbo's if you're after a "neutral" alcohol. If you're trying to make a flavoured spirit, (eg corn whisky, brandy, rum, etc) then use a yeast which will help give you the flavour profile that you desire.

While making the ethanol, the yeasts will also make very small amounts of other organic compounds - including other alcohols, aldehydes, esters, etc. These are known as the "cogeners" or the "fusel oils". It is the presence of these that give the alcohol its flavour. So when trying to make a neutral spirit, we'd try to minimise their presence, but if making a whisky, rum, brandy etc, then we need a very small proportion of them present.

Fusel oil concentration in the wash can be up to around 0.24 g per Litre from 20% sugar (eg about 3.2 mL from a 20L wash)

Fusels increase depending on ...
* yeast strain (eg Saccharomysce cerevisia makes more than S.carlsbergensis)
* temperature (higher temp = more fusels)
* increased aeration and agitation (news to me ! so don't over-stirr it !)
* wort composition (nitrogen sources and readily metabolised sugars)

The most common limiting factor for yeast growth is a lack of nitrogen. Nitrogen is approx 9% of the cell mass. Most common form to add it is as the ammonium ion, as the sulphate and phosphate salts (phosphorus is approx 1-2% of the cell mass, and sulfur 0.3-0.5% so these are needed too - this is a nice way of getting all three in there). Add the ammonium phosphate at a rate of 25-50 gramms for a 25L wash.

The second most common limiting factor is a lack of oxygen, but it only needs it until high cell numbers are present (eg during the first day) (so make sure that you've aerated the wash well just prior to adding the yeast, but don't do this too much later in the game) "Splash filling" is enough to do the job.

Bacteria can double in number every 20-30 minutes, but yeast takes 3 hours (so guess which one will win the race if an infection gets started and you don't deal to it). Another technique to help with this is to use a lot of yeast - when using Bakers yeast, use at least 150g for a 20L wash. Note that using more yeast wont make the yeast work through to a higher % alcohol, but just enable it to get where its going, faster.

Theres a fair bit of choice available as to which yeast to use. I'm personally inclined to use the "Turbo" yeasts, which are pre-packaged with all the nutrients etc necessary. Thats because I'm only ever doing sugar-water washes for pure neutral spirits, and I find it easy, convienient, and reliable. I don't try and reuse it a second time, as I only distill every couple of months, and can't be bothered storing it for that long. If however you are doing more of a grain or fruit based mash, and interested in flavours, then consider some of the other yeasts.

How do you know when fermentation has finished ? Alex tells ..

> *You determine the end of fermentation with these signs:*
> *1. There is no more bubbles coming to the surface.*
> *2. There is no more hissing noise inside the vessel.*
> *3. Gravity of the mash sinks equal or below 1.00*
> *4. The mash does not tast sweet anymore.*
> *5. It has been sitting in the bathroom for three weeks.*

Hector writes ...

> *Yeast, as simple a living organism as it is, has some complex nutritional needs, certainly more than just sucrose. However there's a wide variety*

of yeast strains who's needs differ widely. Alcohol producing strains fall always under the Saccharomyces family, and they, and their metabolic needs and environment adaptation pathways have been the subject of much study. There are "usual" metabolic mechanisms for the fermentation of grape juice, beer wort, et all, by specific members of the Saccharomyces family (e.g. bayanus or capensis in wine, cerevisae and carlsbergensis / uvarum in beer). All of those mechanisms require the presence of their specific sugar and nutrient carrying mediums (grape or apple juice, malt wort, etc.) because their specific yeasts are perfectly adapted to this environments. There's no such thing as an alcohol producing yeast strain that can thrive in such a nutrient deprived medium as a sugar (sucrose) wash. Saccharomyces family strains are all adapted to nutrient rich environments as those cited before, but being that there's no other organism in earth that adapts and mutates as readily and fast as yeast (that's a fact, and it's why yeast is the natural "guinea pig" in cellular death studies that are being advanced right now in the hope of learning to fight cancer), it always finds a way to survive as long as some type of nourishment can be found. This "ways" almost certainly imply a certain loss in the edible qualities of the fermented product because the chemical compounds generated by starving and abused yeasts usually form azeotropic bonds with the ethanol molecule, which is the product you concentrate when you distill an alcohol carrying substance. This compounds are mainly fusel alcohols, esters like amyl and ethyl acetate; diacetyl, acetaldehyde and sulfur compounds like ethyl mercaptin and dimethyl sulfide and disulfide, just to mention the beer (my specialty) pertinent, but universal in this scenario, by-products.

I understand that the much popular ... "turbo" yeast products are no more than specially packaged Saccharomyces strains that include the bare necessities (in nutritional terms) that yeast will need to barely ferment just one sucrose based batch. That's why you guys find the notion of re-pitching your yeast so alien. I believe turbos are a very good thing for the yeast industry and truly they deserved a break. But I find they could try to strike a more consumer wise equilibrium on pricing (IMO they're obscenely expensive). However there's a notion that I believe would make this group improve exponentially their distilled products (and that I haven't read about in any post so far) and it's that whatever you can do to enhance your wash's quality as a fermented product brings by itself a better spirit. I'm no fanatic on this. I don't drink my molasses wines, for

> *instance (though my whiskey's beers are just as good as the product I sell commercially, sans the hops, of course). It's just little things you need to do to avoid the basic problems, like always boiling and quickly cooling the wash, aerating the cooled wash prior to inoculation, keeping the fermentation temp below 23 deg. centigrade, and the original sugar concentration below 17-19° Brix (1.070-1.079 s.g.), and of course, work sanitarily. That's all.*

Which Yeast to Use

Ted recommends

> *I have a yeast that can ferment to 17% with greater than 80% attenuation in less than 4 days at 75 degrees F. It has a slight* H_2SO_4 *nose to it but it clears bright in 2 days and then you can't smell the* H_2SO_4*. Esters and phenols are slight to none. No breadiness, sour or vegemite aromas from the yeast that has been stored for 2 weeks and its viability is 94% after 34 generations. This yeast is a work horse! www.whitelabs.com - California Ale Yeast This isn't the only one out there that is fantastic either.*

Jack recommends ...

> ***Types of Yeast***
> *The yeast selection pretty much depends on what you are making -*
>
> - *For **whiskey** (corn or malt) the best bet is a dry ale yeast - Doric brnad ale is my favorite (ask your homebrew shop owner what his most attenuative, alcohol tolerant dry ale yeast is and use that).*
> - *For **wine and mead** the best choice is Lalvin's K1V-1116 - it has a 16% alcohol tolerance and is very fast (it also has the ability to fight off bacterial contamination).*
> - *For **plain sugar** mashes (to be made into vodka) the best bet is Lalvin's EC-1118 - it has an 18% alcohol tolerance and is faster than the K1V-1116 - but it tends to result in a stale, brackish flavor in the wine and the distillate - making it a bad choice for a wine yeast (by overpitching this yeast - 100grams in 20 liters and about 100 grams of yeast nutrient with 6-8 kilos of sugar you can make your own Turbo- style yeast) - carbon polishing will take care of the stale taste from this yeast- making it a good vodka yeast.*
> - *For making **rum** out of molasses I like to use plain old bread yeast- it has a nice flavor when it's distilled, and while it's fermenting the house smells like cookies.*
> - *NEVER use Montrachet yeast. I have had many recipes for wine taste horrible becuase this yeast was what the recipe said to use-*

> *it always ended up tasting (reeking) of sulfur- even when no sulfite was used to make the wine. The sulfur smell it makes is more than capable of carrying over into the distilled product (rotten egg schnaps was not what I was trying for). If you find a recipe that uses this yeast- use the K1V-1116 instead. I later found out that Montrachet was prone (genetically) to producing hydrogen sulfide gas, hence the sulfur taste/smell whenever I used this yeast. Avoid it at all costs.*

Ken recommends ... *"SAF-DISTIL.B-28" from D.C.L.Yeast*

For more on EC-1118 see http://consumer.lallemand.com/.

See also http://www.hambletonbard.com.

A new White Labs strain WLP099 claims to do up to 25% EtOH : http://www.whitelabs.com/

Donald advises ...

> *Distillers' yeast is now sold in slurry form in the major homebrewer's yeast banks. Unless you are making neutral spirits, do not use a distiller's "fuel yeast". The Tennessee whisky yeast, Highland Scotish yeast, Fruit Brandy/Eau de Vie yeast, ect. all add extra oganoliptics that fuel yeast cannot.*
>
> *Ryzopus derived Ryzozyme (Alltech Biotechnology) is a "cold mash" koji (not aspergillis as used in Sake) now for sale from Alltech, Inc. Ryzozyme step converts starch to sugar at room temp. I achieved a yield of 23.6% alcohol (yes that's right) in 40 hours with 100% corn mash this fall at the Alltech Alcohol School. (1 week for $950.00 US$). The entire Alltech Biotechnology line is sold through Crosby & Baker in the USA. Alltech, Inc. products are sold world wide, so check the web. if your local suppliers don't carry this yet. They also have great distillers yeast, yeast nutrient and other biotech fermentation supplies. The brave new worlds' bright side is here at last !*

Patrick writes ..

> *For those of you not using turbos in the US. Check out this site, you can purchase 500g packets of wine yeast at HUGE discount! There is a Red*

> *Star yeast, same strain as Lalvin EC-1118 for $8.95 US for 500g! Thats just over a pound! Presque Isle Wine Supplies http://www.piwine.com.*

M writes ...

> *I recently purchased a pound of "SuperStart" Distillers Yeast by Alltech from Crosby & Baker. (http://www.crosby-baker.com) According to the spec. sheet the optimal fermentation temperature is 90F +/-2F. So for those of you in hotter climates this may be just the ticket. Also, Seth from C&B reported that it is very possible to get a 21-22% yield from this yeast.Pricewise - 1lb. - $3.15 US (label states that 1/2lb will ferment 1000gal.*

Baker writes about Red Star Ethanol Red (ER) :

> *From the product sheet ...Ethanol Red is a specially selected strain of saccharomyces Cerevisiae that has been developed for the Fuel Alcohol Industry. ER is a fast acting, temperature tolerant dry yeast that displays higher alcohol yields and maintains higher cell viability during fermentation as compared with standard distiller's yeast. Designed for producing alcohol at elevated temperatures, ER is capable of maximizing alcohol yields under a wide range of temperatures. Yields of 48g ethanol/ 100g sugar at 35C have been reported. Lower cooling costs, higher ethanol levels, and increased fermenter through put can be expected using ER. Industrial fermentation for the production of fuel alcohol from grain mashes is the primary application for this strain. this strain performs well for the production of ethanol from a variety of carbohydrate sources including molasses, citrus pulp and corn syrup. Pitching levels between 25 - 50 g per hectoliter will give an initial yeast density of approximately 5 - 10 million yeast cells per mL. Prior to inoculation, yeast should be rehydrated in 4 -5 times its weight in clean 40 C water.*
>
> *[in comparison ..] Alltech SuperStart is a superstarter, but rapidly peters out. It performs better with a protease to provide FAN, but even with a protease does not perform as well as Red Star without. Red Star performs equally well with or without a protease except in a milo mash where adding the protease improves its performance.*

Mike cautions though ...

> *Just an aside for "newbies", please don't get the idea that some yeasts produce more alcohol from a given amount of sugar than others. The "higher alcohol yield" bit refers to the tolerance of this yeast to alcohol during fermentation. For example, the strains of yeast used by bakers cannot tolerate concentrations of alcohol higher than around 8%, so any sugar left in the wash once this level is reached remains unfermented. Other strains are more tolerant to the alcohol they produce, and are therefore more efficient if the aim is to process as much sugar as you can in the shortest possible time ... which is what cost-effective production of fuel alcohol is all about. The downside for us, trying to produce potable alcohol, is that the hotter (and faster) the fermentation, and the higher the alcohol tolerance of the yeast, the more likely it is that other compounds will be produced with the ethanol, so we will have more heads and tails to deal with. For example, the new "24 hour" turbos perform as claimed (stand well back!), but the downside is that the concentration of ethyl acetate is very much higher than their slower cousins. In their defence, they are much "cleaner" than the Zippo yeasts favored by the Fuel Industry which, to be fair, is not concerned about how the product tastes so long as it burns well.*

You can make your own Turbo yeasts. Jack wrote ..

> *Use large amounts of the wine yeasts called "prisse de mousse" (by the Red Star company), or EC-1118 (by the Lavlin company) - these are the yeasts used in the Turbo yeast packs- you just need to buy 100 grams (4 ounces) of it and pitch it all at once to get the turbo yeast performance (this also requires 100 grams of citric acid and about 100grams of yeast nutrient). Both these yeasts are common winemaking yeasts in the U.S*

Mike adds ...

> *It is very easy to stretch a turbo (or any yeast, for that matter), but the process is a tradeoff - more work and time spent.*
>
> *The procedure is similar to that spelled out as "the Cone Protocol" in The Compleat Distiller - you manage the stresses that the yeast sees during the ferment.*
>
> *What are those stresses? Osmotic potential (sugar concentration), temperature and alcohol concentration. One of the reasons that turbo*

yeast packets contain so much yeast is that up to 80% of the yeast cells are killed or severely damaged when they are put into the wash - too high a sugar concentration and too low a temperature slow down the entry of water into the cells and allow a lot of damage to occur. Lowering the initial sugar concentration allows a lot more of these cells to survive, meaning that they can do more work.

Temperature - the active and rapid fermentation produces a lot of heat. Gert has published tables of yeast viability by temperature and alcohol concentration, and the higher the alcohol concentration, the lower the temperature that will kill them off. Lowering the initial sugar concentration will reduce the heat production and temperature rise in the wash. External temperature control is also very useful for extending a turbo.

Alcohol concentration - Alcohol is a yeast waste product. The more of it that is present, the harder is is for yeast to produce more, and the more stressed the yeast is, making them even more sensitive to osmotic and temperature effects. Sugar should be added in decreasing amounts throughout the fermentation as the alcohol concentration rises.

WARNING!! Active ferments are supersaturated with CO2!! If you just dump in some more sugar, you will see foam like you could not believe, and will lose several liters of wash to the surrounding environment. When you add sugar, begin stirring the wash, and trickle a spoonful of sugar into it. It will foam semi-violently, but will not overflow. Repeat a few times until it quits foaming when you add a little sugar. Now you can add it more rapidly.

Here is one way to stretch a turbo (based on the "20%" regular speed turbos out there). This method takes two weeks to complete. It is designed to completely use a standard (American) 25 pound sack of sugar. The Final volume is 8 US gallons instead of 25 liters. Pour 13 pounds of the sugar into the fermenter, and make up to just under seven gallons with warm water to end up at 30 deg C. Stir to make sure the sugar is all dissolved, then stir in the turbo and vigorously stir for a couple of minutes. You probably want the fermenter set into a tub of water to avoid a sharp temperature rise when fermentation takes off. (This is for two reasons - one to preserve the yeast, second, because a cooler

> *fermentation is a cleaner one!) Control the temperature of the water jacket to about 18 deg C.*
>
> *Float a hydrometer in the wash. Intial reading will be about 1.080. When it has dropped to about 1.010 - 1.020, add seven pounds of sugar. When it has dropped back to 1.10, add another three pounds. When it drops to 1.005, add the final two pounds. If done properly, the terminal gravity will be about 0.9.*

Mixing Different Yeasts

It is sometimes useful to use two different stains of yeast at the same time; one strain for flavor and another for the alcohol content. Sometimes distilleries will mix brewers yeast with distillers yeast - thinking that the brewers yeast will add a heavier, fatter, mealier quality to new spirit. Others reckon it makes no difference.

Ray writes ..

> *It is quite a common practise to use a combination of yeast strains to acheive the desired result e.g. I have seen a good general purpose type yeast which is designed to go to around 13% mixed with a high alcohol yeast strain which is designed to go to 18% or higher, the idea being that the general purpose yeast does the majority of the work converting the sugar to alcohol then the high alcohol yeast kicks in and takes the percentage up to the next level. I haven't used that method for a long time but it seemed to work fine at the time.*

Ted suggests ..

> *Use the low alcohol tolerent yeast to ferment first to get as much of that yeasts "flavor " as is possible. Then add more of the first strain to your ferment to push it along a bit further. The reason for this is that most yeast can withstand high levels of alcohol for a while before they go into stasis (they aren't really dieing off). then go for the tolerent yeast. Be aware that in high gravity ferments that the number of yeast cells must be increased a lot!!! (High gravity is anything over 1.060) Most yeast producers won't tell you this but, many strains are mixtures of yeasts that have different profiles and variing flocculation habits. On your recipe, you could try two seperate ferments one at a low gravity and one high then combine for distillation.*

The Omnipresent Mecakyrios does similar ..

> *I like the "Two Fermentations" idea. I brew my batches (a hard Cider and Mead mix. Some call it a Melomel, but the taste is not like a Melomel at all) then use the following fermentation method: primary fermenter for about a month, rack into a secondary for about two months, rack into another secondary for about a month or two (depending on how the brew is doing), and if everything looks good I let it age for about a month and then distill it. After I distil it, I let it age for about three to six months.*
>
> *If I were to do the "Two Fermentations" idea, I could use the "flavor yeast" in the primary, and the "strength yeast" in the first racking of the secondary. Then I could shorten the first racking time and lengthen the second to even things out.*

How Much Yeast to Use

Jack advises ...

> To use the best brewing guidelines- use 2 to 4 grams of dried yeast per gallon of mash.
>
> - If the alcohol is in the 5% or less range - use 2 grams per gallon.
> - in the 5 to 7%abv range; use 3 grams per gallon.
> - In the 8 to 10%abv range use 4 grams per gallon.
>
> You will know when you have pitched the right amount of yeast because the high kraeusen stage (the tall foamy cap) will have formed in four hours or less. If it takes longer than 4 hours- don't worry too much. If it takes longer than 24 hours to form- you aren't using enough yeast.
>
> Higher than 4 grams per gallon will get you some sulfur flavors that can be hard to get rid of, so only use the 100 grams of dry yeast per 5 gallons (20 litres) rule for a pure sugar mash that is destined to be carbon polished and turned into vodka or a "base spirit" for liqueurs, etc.
>
> If buying that much dry yeast is a problem, you can make a starter. Make a small "mini batch" of your mash - using the same ingredients at the same concentration (no less than 500ml no more than 2,000ml for a 5 gal/20liter batch) and put it into a sanitized glass flask, bottle, jug, etc. Do this one or two days before you plan to make the main (5 gal/20L) batch. Add the small (typically 5 gram) packet of yeast to the starter,

> and when it is at high kraeusen, add it to the main batch. Yeast "learns" to feed on sugars when it wakes up from that little packet- it takes yeast seven generations to learn how to digest a different kind of sugar- therefore you MUST make your starter out of the same stuff you are going to make the main mash out of (this is why waking up your yeast in orange juice is a bad idea). Also, yeast is sensitive to sugar concentrations- so the starter MUST be the same strength or weaker than the main batch in order to prevent osmotic pressure from causing the formation of mutant yeast cells (a big cause of off flavors).
>
> The temperature the yeast is used at also can cause the flavor to degrade. Most whiskey mashes use an ale yeast- the ideal temperature range is 60 to 70 degrees F. Lower temps will slow down the yeast- if sanitation is good- this is not a problem. If a higher temp is reached - the yeast will undergo "stress" reactions that cause excessive ester and higher alcohol formation- this will result in a solvent- like flavor that can carry over into the finished spirit. Lager yeasts tend to form a lot of sulfur compounds at the begining of the ferment- during the lagering stage the yeast reabsorbs these sulfur compounds, leaving a crisp clean lager flavor in the beer- since you don't want to store a whiskey mash for 2 months in the fridge- it's best to use an ale yeast.
>
> When you are fermenting wine (for brandy or drinking)- it is best to use 2 grams of dry yeast per gallon and no more (two of the five gram packets per 5gal/20L batch). It's true that you would think to use 4 grams per gallon since the alcohol is so high (typically 10% or more)- but, with wine, in order to preserve the delicate aroma of the fruit you are fermenting, you need to have a slow, cool (60-70F) ferment to prevent the CO2 from driving off all of the more delicate flavors. A fast ferment in a wine will find the CO2 "scrubbing" the delicate flavors out, leaving you with a bland acidic wine that tastes pretty rough.

Note though that you can over-pitch a wort with too much yeast. Jack warns ..

> *when used at a rate over 4 grams per gallon (with ale yeast and a potential alcohol of less than 9%), dry yeast will give off some excessive ester/ sulfur compounds that are almost impossible to get rid of through cold storage (lagering). If the stuff is to be distilled, and you "overpitch" your yeast- just make sure you have a LOT of copper to get rid of the extra sulfur compounds.*

> *The very high cell concentrations typically cause a reduction in yeast growth. This makes the yeast that is pitched is the yeast that is responsible for the ferment- if the yeast viability is below 90%, stuck ferments may occur. Otherwise, the profile of the flavors that yeast makes is typically a mix of compounds made during both the aerobic and anaerobic phases- with the aerobic phase suddenly gone- some very odd smells occur (sulfur compounds), that, thanks to the stress of fermenting without any time to adapt (the lag phase), the yeast is damaged, and unable to reabsorb any of the esters and sulfur compounds when they go dormant (during the settling out and lagering phase-if any). The high cell count also makes fining and filtering more difficult.*
>
> *Overall, underpitching is more of a concern than overpitching. Underpitching causes a long lag time that can allow bacterial infection to take hold, overpitching can cause off flavors to develop that can be removed with a long lagering/secondary ferment, and alot of copper exposure.*
>
> *As a general rule, you use 400ml of yeast solids per hectoliter of wort (for a lager yeast), and half of that for ale yeast (granted, this is at 12degrees plato). For dry yeast, 2 to 4 grams per gallon of wort is best- 2 grams for standard beer, 4 rgams for doppelbocks, barleywines, etc. For an active yeast starter, the actively fermenting starter should comprise 10% of the volume of the mash/wort. It should also be of the same sugars/composition and at the same concentration (err on the side of a weaker starter, rather than a stronger one- yeast can go from "rags to riches", but not the reverse.)*

Ted Palmer writes ...

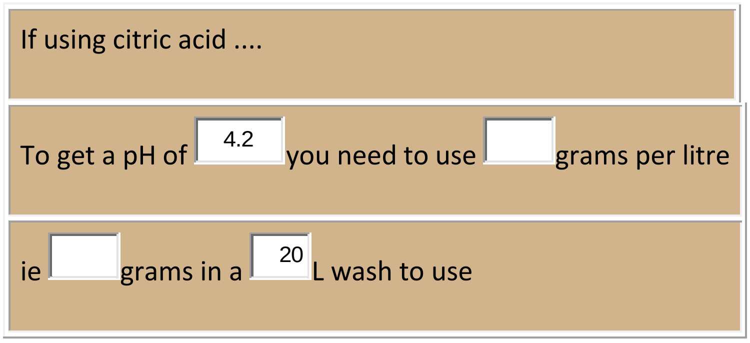
> *Many if not most commercial distilleries use some form of brewers yeast. What should determine the type and AMOUNT of yeast is the make-up of your wash. A common problem isn't the type of yeast that you are using but rather how you are using it. A 1.060sg wash will be reduced just fine by any yeast so long as there are enough yeast cells per ml. and enough nitrogen to keep the cells healthy. In fact by repitching more activly fermenting yeast several times into a high gravity wash, a "beer yeast" can ferment up to 16 to 18 percent alc. If you use a packet of dry yeast then there are too few cells let alone heathy ones.*

Here are a few guidelines for proper yeast use in any ferment:

- *You will need 10 X 10^6 cells per ml for any wash up to 1.050sg and 1 X 10^6 cells more for each 1.004sg above 1.050.*
- *Always use a rigorously fermenting pitch of yeast, ie: never use yeast straight from a package, always grow up enough cells for the SG you are using (called a yeast starter). Say you are going to make 10 liters of wash at 1.050, open the package and grow the cells in 10 ml. of 1.050 wash. When fermentation passes the most rigorous point pitch the 10 ml. into 100 ml. of 1.050 wash, repeat this into 1 liter and then pitch into the 10 liters. with higher gravities use 2 or more seperate yeast starters.*
- *Yeast need proper nutrition, nitrogen must be present. If using only sugar put 2 ml. of ammonia per 1 liter of wash. If using fruit juice or grain mash 0.5 ml. per liter. Yeast also need more than just sucrose for food, add some fructose, dextrose, maltose or any other simple sugar. An acid isomerization of sucrose(invert sugar) will also work if other sugars aren't available.*
- *Reuse the yeast from the last batch you made! This is the easiest way to make sure there are enough cells for your wash, keep any eye out for infections though and only reuse yeast that fermented properly in the last batch.*

Nutrients & Acidity

A slightly acidic environment is enjoyed by yeast, and also inhibits the development of bacterial contaminants. The pH of the brew should be adjusted to between 4.0 and 4.5 prior to fermentation, using citric or lactic acids. You can also use lemon juice rather than citric acid - it works great in distilling, but is bad in winemaking. Just use it on an equal volume basis- 1TBSP of acid blend = 1TBSP of lemon juice.



If using citric acid ....

To get a pH of 4.2 you need to use grams per litre

ie grams in a 20 L wash to use

This calculation seems on the low side practically - it must be that the citric acid sold in supermarkets / brewshops isn't 100% pure. Always double-check the pH using pH papers or some other test.

Nutrients also need to be present. Yeast cells require phosphorus, nitrogen and potassium, as well as amino acids and vitamins, for metabolic processes. The extent to how much is required depends on the feedstock being used. The nitrogen requirement may be supplied in the form of amino acids, ammonia, or ammonium salts. If the solids are separated from the sugar solution prior to fermentation (or say starting only with sugar) the bulk of the protein will be removed, and hence a potential nitrogen source lost. Ammonia or ammonium salts are the preferred source of of additional nitrogen if its needed, however avoid using excessive amounts because it can kill the yeast. Both nitrogen and phosphorus can be supplied by ammonium phosphate (commonly available as a fertilizer). Many fermentations will proceed satisfactorly without vitamin suppliments because the fermentation medium contains sufficient of these nutrients, however in most cases, cell growth is enhanced when B-vitamins are added.

Jack adds ...

> *DAP (Diammonium phosphate) is also known as "yeast nutrient" among wine/beer makers. Yeast energizer is typically a yeast hull extract- an all-natural version of yeast nutrient- it doesn't work as well, because there just isn't enough free-amino nitrogen in it. Most homebrew shops (who know what they are doing) sell the DAP salt- it should look just like any other chemical salt (like table salt, but with bigger crystals)- if it's off-white, brown, or any other color- it's likely a mix of yeast nutrient, yeast energizer, some B vitamins and other assorted junk (ie trace minerals, folic acid). If your local homebrew shop has it's head up it's arse, try checking online for a domestic home-brew shop that sells it online. Most homebrew magazines have dozens of adds for places like this- just find the closest one to save on shipping.*

One recipe for nutrient ale salts is

- 58 g sodium chloride (common table salt)
- 170 g citric acid
- 7 g ammonium sulphate
- 6 g magnesium sulphate
- 2.5 g grape tannin

This mixture is hygroscopic (attracts water), so keep it in a cool dry place with a good lid.

The "Great New Zealand Home Wine Making Book" suggests to ... "buy some ammonium sulphate or ammonium phosphate, and some pottassium phosphate or potassium sulphate and add 2g (1/2 teaspoon) of each to every 4.5 L. Another valuable addition is vitamin B1. You can buy these as tiny 3 milligram tablets from your local chemist or pharmacy and add one of these each 4.5 L" ...
Darryl offers ...

> *Before turbo yeasts came along, I would use a champagne yeast and my own nutient mix to ferement a sugar wash. For a 20 litre wash I would use 5 kg sugar plus the following nutrient mix:*
>
> - *4 tsp winemakers' yeast nutrient salts*
> - *4 tsp citric acid*
> - *1/3 small jar molasses*
> - *1 tsp marmite*

Concerning the use of Urea in nutrients, Des writes :

> *According to 'The Food Regulations 1984, Amendment No. 5' dated 2nd December 1991 regulation 235, General alcoholic drinks, subclause 3 says "General alcoholic drinks may contain any of the following:", paragraph (i) "Yeast nutrients, except urea"*
>
> *Which is what has been quoted in past correspondence and always referred to when discussing the issue, however: 'The Food Regulations 1984, Amendment No. 9' dated 10th of October 1994 regulation 101, (3) states "Regulation 235 of the principal regulations is hereby further amended by revoking paragraph (i) of subclause (3)." ie the exception to urea above is now revoked.*
>
> *On seeing this I contacted the New Zealand Health Department and requested, under the Official Information Act, all the paper work as to why the original banning and why the lifting of that ban. Of course, I got screeds of paper but the story is that the ban was instigated because of research done in England that pointed health risks of urea as an ingredient for fermentation. Thus it was banned.*
>
> *It was later realised that although these chemicals were present in the*

> *fermented wash, they were not present once the wash had been distilled. It appears that they are not carried over in the distillation process, thus the ban for this type of alcoholic product was lifted.*

Mike adds ...

> *Nothing wrong with urea in modest quantities... the human body excretes it daily, and in some quantity, so it is not a killer. However, only drawback with its use as a nutrient is that it encourages production of ammonia compounds, and that can taint a brew. This was a common complaint from people who had problems with early turbo mixes that used excessive urea. Current mixes appear to have overcome this problem, but addition of urea yourself should be governed by caution. A little goes a long way. DAP is a better nutrient to use as the ammonium radical is more tightly bound.*

Also, don't use too much nutrient. It won't make the yeast work any faster, once you've supplied its needs ... but it can make your spirit turn blue. Mike explains ...

> *... alkaline washes that hold a lot of nitrogen-containing compounds that have been put in as nutrients will liberate ammonia and that, being a gas, will get to the top condenser and form an aqueous ammonia solution, which is alkaline. Normal oxidation of copper under heat forms cupric hydroxide in an alkaline solution. This turns black when boiled with water, and is commonly seen on copper components in stills. This, in turn, reacts with ammonia solution to form Schweitzer's solution, containing the tetrammino-cupric ion Cu[4NH3]++, which is deep blue. Don't worry ... it won't hurt you, and you might even think the colour attractive!*
>
> *Answer is to ensure that your wash is not alkaline, but acidic. This is the normal condition after a fermentation, as yeasts tend to acidify the wash with their by-products. You say that you added yeast nutrients, and I suspect that you were a bit too enthusiastic, as this can tipp the balnace the other way. Addition of citric acid is usually enough to neutralise and then acidify a solution made too alkaline by overdosing with nutrients, but without acid buffers to control the pH. In an acidic solution, those nitrogen-containing compounds will react with the acid to form salts, and so will not ne carried up to the top condenser.*

If this happens, make sure you strip down your tower, and clean it well. The blue alcohol can be cleaned up by adding some citric acid (50g per 5L) (which will react with the ammonia to produce ammonium citrate which will precipitate out along with the copper leaving hydrogen sulphyte and or sulphide), and then filtering it through some coffee filters to collect the flocculant; the alcohol will then be ok to redistil.

Matt suggests

> *The White Labs site (http://www.whitelabs.com/) mentions that they are now distributing Servomyces a nutrient which apparently even conforms with the Reinheitsgebot! It was developed in Europe, and seems aimed more at the beer brewing market, but it might still give interesting results for those doing a low-nutrient wash ferment.*
>
> *Wyeast Labs of Oregon, USA also offers a yeast nutrient: http://www.wyeastlab.com/nutrient/nunutrie.htm*

Brians recommendation re nutrients is *lallemand fermaid k; use at a d/r of circa 60/100 g /20 litres* (http://www.lallemand.com)

Oxygen

During fermentation, yeast has a couple of choices. If it has oxygen available to it, it will be able to reproduce quite rapidly (doubling every 3 hours). If there is only limited oxygen available, it will turn its task to producing ethanol and other products (about 1300 in all), like higher alcohols (sometimes called fusel oils), esters, organic acids, and carbonyl compounds. To get good initial growth of the yeasts, you want to have a bit of oxygen available - but you can do this simply by stirring the wash vigorously when disolving the sugar. Once you have added the yeast, it is critical to seal the container such that air cant get in, but you can still let the CO_2 out, by using an airlock. To minimise the amount of other volitiles produced, make sure that you are using a yeast designed for the job, and keeping it happy with nutrients & with a stable temperature.

Fizz writes ..

> *..for those of us who have heard about the need for oxygenating the water prior to pitching the yeast and (like me) cannot afford extra equipment to do this I would recommend (if you have one) a kitchen stick*

> *blender, like what you use to make soups or sauces etc. 2 minutes in that baby and the water had that much O2 in it, it turned milky !*

If you're going to use an airstone to aerate the wash, Mecakyrios recommends ..

> *1.) I HIGHLY recommend for you to use an in-line HEPA air filter. This will allow for the air going through it to be essentially sterile when it comes out through the air stone. This aids in protecting your wash from becoming infected with unwanted nasties.*
>
> *2.) I would recommend using a racking cane with a small piece of tubing connected to your air stone. Let me try to explain better: You have you air pump connected to the correct length of tubing to get to your wash. You connect that tubing to your racking cane. To the other end of the raking cane you add a small piece of tubing, and to that tubing you put on your air stone. Then you submerge the air stone by placing the raking cane into the wash. What this will do for you is allow you to position the air stone where ever you may need to, but more importantly it will keep the stone from floating to the top of the wash. By using the raking cane (or similar device) method you now have more control over the air stone while making sure that it remains submerged.*
>
> *There are brew shops that sell both of these products. Some even sell special "air wands" that come with both the filter and a special "wand" that keeps the air stone submerged.*
>
> *If you would like more information, or at least a look at some products for this topic, I would recommend going to http://www.williamsbrewing.com/. Go to the fermenting equipment section and then go to "Wort Aeration" section to look at some products that deal with this issue.*

Ted Palmer writes ..

> *In order to properly "grow up" a series of yeast starters you must aerate the wash with sterile air or pressurized oxygen (O2). The reason for this is that yeast cells bud or reproduce only when there is enough oxygen present to grow. During fermentation yeast cells will still bud, but at a slower rate since it has to pull oxygen out of chemicals. The amount of O2 required is small, on the order of 20 microliters per ml. to support the budding phase.*

> *So how do you put O2 in your wash?*
>
> *Sterile air:*
>
> > *Pump air through a 0.02 micron filter and then a stone (fish tank bubblers work well) into the wash. If you can't get a filter use a jar setup like a thump barrel only put a stone on the inlet pipe, fill this with hydrogen peroxide halfway full. pump air through this jar and then a stone into the wash. Run this setup 20 - 30 seconds for each liter of wash.*
>
> *Pressurized O2:*
>
> > *Use any tank of pure oxygen fitted to a stone on a length of tubing, run for 5 - 10 seconds for each liter of wash.*
>
> *Aerating a fermenting wash will result in one hell of a lot of yeast and very little alcohol. Aerating a fermenting wash for even a short time will oxidize flavor components including ethanol !!!*

Cooling the Wort

Before you pitch the yeast, you need to cool the wort down below 26 ° C. You could leave it overnight to cool, but then you risk letting an infection get started. Its often better to force-cool the brew down. The rate and length of fermentation is adjusted by the pitching temperature, which in turn can influence the flavours.

Jack writes ...

> *If it's a pure sugar/molasses wash- your only concern is with the temperature. If you add the yeast when the temperature is still above 70F you are going to stress the yeast- and it's going to produce more higher alcohols (methanol, for example) than it normally would.*
>
> *If you are making a mash using grain (corn, rye, malt, etc) you should try and cool the mash down to 70F in under one hour. Otherwise, you are allowing the production of a chemical called DMS (dimethyl sulfide)- this is a chemical compound that gives beer/mash a buttery/ butterscotch flavor- in some dark beers, it's okay- in light beers and whiskey mashes it's a problem. Over time DMS is reduced into various other sulfur*

> *compounds- some will form a rancid butter flavor/oder, others will be estery (solvent flavor). By cooling the beer/mash quickly, you inhibit the formation of this compound. And, yes, the nasty flavors DMS can make will transfer over into the finished spirit.*
>
> *And, that's the prime time for an infection to take over. The rule is: cool to 70F as quickly as possible, and add your yeast as soon as you get to that temp.*

Tim writes ...

> *I have a counterflow wort chiller for my beer brewing. It's a 20' piece of 1/2" ID copper tubing inserted inside a 19 1/2' piece of 3/4" ID rubber hose. This whole thing is wound into a coil around a beer keg (then the beer keg is removed...)*
>
> *The inside of the chiller has to be spotless and sanitized to keep from contaminating the (then cooled) wort on its way to the fermenters.*
>
> *I've been using and cleaning this thing for 10 years and have NEVER had a contaminated batch.*
>
> *The vinegar/water mix makes it shine like a new penny!*
>
> *This method was told to me by a PhD Brewing Chemist who'd been doing this for years. It really works!*

Fermentation Tank Hydraulics

Jack writes ...

> *Traditionally, shallow, open, "wading pool" shaped fermenters were the most common found in old breweries/distilleries. Due to space concerns, "unitanks" (sealed on top, with a conical bottom and a valve to separate trub and yeast) have taken over, as they provide a more sheltered enviroment that, being tall rather than wide, allows companies to expand production at a fraction of usual expansion costs. After testing various fermenter shapes, it was found that the effective height (that which is actually filled) of the fermenter should be less than the fermenter's diameter. A few industrial studies show why this is so. In 1978 it was found that carbon dioxide gradients were present- the largest values being at the bottom of the fermenter. This caused s heterogeneous flow*

field that included isolated vortices. The maximum vortex formation was found at the top of the fermenter, which influenced temperature, sugar concentration, and Ph- effectively, tall fermenters have not one, but several fermentations taking place in parallel.

In order to counter this effect, the best method is to use a stirring device within the fermenter, or to recirculate a small amount of the mash (maybe 5 to 7% of the total volume).

Why was this done? Because short/wide fermenters work markedly better than tall ones. Check the numbers:

	Tall fermenter	**Short/wide fermenter**
Fermentation time:	10 days	8 days
Final gravity:	1.010	1.011
Diacetyl (mg/L)	0.350	0.060
Clearing	poor	excellent
pH at end point	4.6	4.4

The lower pH will provede a greater stability in the mash/beer during storage/secondary fermentation/ clarifying procedures. Blind tastings have also shown that the short fermenter in an "open fermenter" form (a large stainless steel stockpot with the lid on instead of an airlock) made for a cleaner, better tasting beer/mash. For large industrial concerns, closed unitank fermenters are a good business idea. For home brewers/distillers using a large (7 gallon) stainless steel stockpot with a lid gives you a great fermenter (even compared to carboys- just watch the sanitation in the surrounding area), that will give a faster ferment and a faster clearing time. That alone reccomends it for distiller-only hobbyists, but the flavor improvementsalso make it worthwhile. Remember, a still will not make a bad mash taste good- it will only make it taste stronger. As a result of this info, I now brew my beer (and bourbon) in an open fermenter. And I'm drinking/distilling it 2 days faster as a result.

Pitching Yeasts

When the temperature of the wash has dropped below 26 &degC, add the yeast. Do not add the yeast too soon - if the temperature is above about 34 &degC, it will kill the yeast.

You're aiming for around 10 million yeast cells per mL of wash. A 25L wash at 1.080 will therefore need about 3 cups of slurry. Get this amount by using the slurry left over from the previous run. See the comments below in the Reusing Yeast section.

If using dried yeast, it can be helped along by letting it soak in about 1C of warm (24 &degC) water for about an hour beforehand. Use a high alcohol yeast such as for champagne, or the new proprietary alcohbase or "turbo" yeasts which can generate up to 21% alcohol (who needs distillation ?). If the pack you're using is one of those small ones, it will pay to grow it up to a suitable size before using it (see Teds comments below).

Close the fermentor, and use an airlock. Keep the temperature around 28 C, and the specific gravity should drop to approx 0.980 - 0.990 g/mL and have ceased bubbling within 5 days.

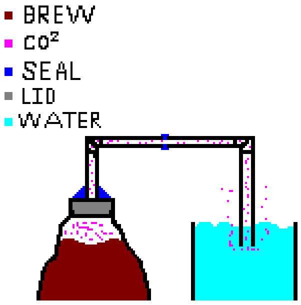
Jack H recommends ..

> *Try using cling wrap over the top of your fermenting vessel. Secure with a rubber band(I cut mine from an old tyre inner tube) Then prick about 6 holes in the wrap to allow the gas pressure to escape.You can see when the fermentation is over and I have found that I have never had a failure with this method as opposed to using a fermentation lock .*

MeadMaker suggests a method of making a simple airlock ...

> *while most people go out and buy a one way valve, it is realy quite easy to make at home. all you need is: (1) the lid of the bottle you will be fermenting in, (2) 2 straws, (3) something to seal with, (e.g. bluetac, wax (just melt a candle), glue (might make it smell though) and/or sticky tape), and (4) a glass of water.*
>
> *Now... make a hole in the lid using a hammer and nail, and then widen it using sissors to the diameter of the straw. Then insert the straw so that the end of it is just in the hoke in the lid. Wax/bluetac/glue so that it is sealed. Then make the straw so that it is on a right angle (I'm assuming*

> *ur using one of those "bendy ones". Insert the second straw into this, then sticky tape and wax/bluetac/glue so that it is sealed. Make THAT straw on a right angle, so that the end of it is inserted into a glass of water. Test by adding some baking soda and vinigar to the bottle. If the gas seems to ONLY be coming out through the glass of water, it works.*



> *Also, this is better for SMALL bottles, if ur making a big brew, i recomend u use a rubber pipe or something instead of straws*

Bill writes ...

> *Open (barrel) fermenters, Found the plastic used to cover windows, shrink wrap works well its nice and clear lets you check the temp. and specific g. without removing the cover and letting air into the fermenter. if its cut about two in. larger than the top it can be held in place with a bit of twine attached to an elastic band, then heated for a couple of seconds with a hair dryer, this makes it nice and tight and clear.*

If the fermenter doesn't bubble, check that the lid is sealing well. If you squeeze the container when you put the lid & airlock on, the water should move up in the airlock, then drop again when you let go. If it doesn't, then the lid isn't on correctly.

Another way of knowing how far the fermentation has progressed is to measure the weight of your fermentor & contents. Half the sugar is expected to convert to CO2 gas and bubble away. Theoretically the yield is 48.9%, but practically this is 40% because some of the gas dissolves in the wort. So if you have added 5 kg of sugar, and the weight has only dropped by 1 kg, keep it going for a while longer (you expect 5 x 0.4 = 2kg weight loss).

For excellent discussions about yeast, and how to get the best out of it, see the Turbo yeast and AllTech web pages.

Temperature Control

Temperature control is very important during fermentation. Yeast is a living organism, and will die if too stressed. Both alcohol and temperature stress it. With no alcohol around, it won't die until about 40 &degC. At 14% alcohol, it will die at 33 &degC, and at 25 &degC if in 20% alcohol. So keep it below 25 &degC at ALL times. Lower temperatures will also result in less volitiles. When the temperature has been kept below 30 &degC the production of fusel oils is minimal, and is extremely small if kept below a maximum of 25 &degC. This is where you get into a bit of a trade-off; if you keep it too cool, it will take heaps longer, with greater time for the risk of infection etc to set in. At 25 &degC, it will take 3 days to ferment 0.24 kg/L sugar, but at 15 &degC it will take nearly 2 weeks.

Higher fermentation temperatures will result in more fusels being formed. Jack advises ..

> *This is for the Wyeast1056/s001 strain that is used for Sierra Nevada's pale ale:*
>
> | Temperature | Ethyl acetate(mg/l) | Amyl acetate(mg/l) |
> |---|---|---|
> | 60F (15.5C) | 16 | 0.5 |
> | 68F (20C) | 26 | 2.0 |
> | 75F (24C) | 53 | 4.0 |
>
> *Technically, ethyl acetate and amyl acetate are considered esters, not fusels, but they act the same in the still. Fusel oils are formed by the ferment of amino acids- not sugars. There are two types of fusel oils; aliphatic and phenol. The aliphatic have a straight line structure and are volatile- they have a warming alcoholic/solvent note with fruity tones. They lead to definate harshness. Phenol types are involatile, aromatic alcohols with a madicinal flavor.*
>
> *Lager yeasts fermented at the right temperature (cold) form less than half the fusel oils an ale yeast does at normal temp. (25mg/l against 70mg/l for an ale).*
>
> *All yeast start to increase fusel oil production when sugar concentrations*

> *above 16% (sp.gr.1.065) are used.*
>
> *Mutated and first generation (air-bubbled "lab-grown" yeast) tend to make more than recycled yeasts do- hence the Scotch distillers use of second hand yeast from the Dublin breweries).*

Ian Smiley adds ..

> *However, when fermenting straight sugar-and-water with turbo yeast one is typically making grain neutral (i.e. vodka), and such congener production is not really relevant if using a high-separation still like a full-reflux fractionating still. Virtually all such congeners are stripped out during a double distillation anyway, so the distiller need not worry about off flavours and is typically better off with the faster turnaround of a hotter fermentation. Also, commercial distilleries have no problem separating comparatively high concentrations of congeners given the sophistication of their stills.*
>
> *The temperatures that I refer to, BTW, for the fast turbo yeast fermentations are between 80 and 90F (27 and 33C). And, in Making Pure Corn Whiskey I recommend a fermentation temperature range between 70 and 90F (21 and 33C) for the production of whiskey.*
>
> *Now, the production of beer, wine, and whiskey (or any other flavour-positive spirit, for that matter) is a different story, because the congener profile formed during fermentation will pervade through to the finished beverage. This is clearly true of beer or wine where no distillation is done, so whatever is formed is with the substrate for the duration of its life cycle. Flavour-positive spirits undergo distillation but since certain families of congeners are retained this makes such spirits sensitive to the congener make-up of the mash, unlike grain neutral where everything but the alcohol is stripped out.*
>
> *I have done extensive experimentation with whiskey-mash fermentation, including numerous different temperature regimens. I've even lagered whiskey mashes with bottom-fermenting lager yeasts for as long as 13 weeks. It produced an unhopped corn/rye all-grain lager that I swear I could have bottled and conditioned and consumed as a very light (and cheap) lager, and I'm confident that it would have been delicious and refreshing. However, when I distilled it, it was completely insipid. It simply didn't have enough esters to give it a significant flavour. It was*

pleasant enough, but it just wasn't whiskey, although when I rectified it into grain neutral it was very clean.

All of this would have been due to the long lager fermentation where the yeast literally consumes esters, aldehydes, and fusel alcohols during the late-phase fermentation cycle.

I have found that the best whiskey and schnapps flavours are in fact formed during a hot, fast, brisk fermentation, and that long languishing fermentations (i.e. other than lagering) are the ones that produce the less desirable flavours. Of course, this point would be subject to personal preference.

In another experiment, I fermented a corn mash with a wine yeast and let it ferment for over four months. The mash actually formed a sherry flor on top and oxidized and darkened and took on a very unusual but pleasant smell. When I distilled it, it had a distinct fruity/sweet fragrance and flavour that could only be described as a delicious liqueur. I haven't had time to return to this line of experimentation, but when I do I'd like to explore this further.

Just to clear up my use of the term "secondary fermentation", what I mean by that is the fermentation phase that takes place immediately following the high krausen phase. Wine and beer makers will recognize the pattern whereby their fermentations start out with a lag phase followed by a vigorous bubbling phase, often with foaming, then it settles down to just spurious bubbling. This vigorous fermentation is the high krausen phase, or primary fermentation. After that, the mash or must settles down to a spurious bubbling, this is the "secondary fermentation" in my parlance, and it usually takes one or two weeks for beer and one or two months for wine. After this, the beer or wine is left to age or lager (German for, "store in the cold"). In my terminology, the fermentation that naturally carbonates a beverage is called the "conditioning fermentation".

Just to recap, a mash intended for distillation only needs to undergo the high krausen phase in my standard processes.

The familiar rotten-egg smell ... is due to the formation of hydrogen

> *sulphide, mercaptans, and dimethyl sulphide. All of these compounds are usually consumed later in the fermentation in the case of beers and wines, but with distilled mashes, any amount of contact with copper in the construction of the still will instantly remove it.*

An easy way to maintain the temperature in cooler climates is to wrap a water bed heating pad around the fermentor, and tape the thermostat to the side of it before wrapping it all in a blanket. Other people just keep their fermenter in the hot water cupboard. Another way is to keep it in a small cupboard or box with a light wattage lightbulb to supply a lttle heat (but shield the bulb so that the beer doesn't become light-struck). Some even use immersion heaters like those for tropical aquariums - but these can be tricky to sterilise, you need to get the wires through the lid in an airtight manner, and if you lift them out of the brew without turning the power off, they can quickly overheat and burn-out (an expensive exercise in forgetfullness). Others yet put their fermentor into a larger drum/container, fill the gap with warm water & then use an immersion heater to keep the outer water warm.

If using the Turbo yeasts, pay particular attention to the temperature. These babies can raise the temperature of the wash by 5-8 &degC, so don't add them until the wash has cooled to about 18-20 &degC.

If you are fermenting large volumes, you may need to actually cool the wash, either by dropping in frozen 2L softdrink bottles of water, or getting fancy like big brewers, and running cooling water pipes through the fermentor. The larger the amount you are trying to ferment, the harder it wil become to control, yet it is critical that you try to keep it all at 25 &degC plus/minus only 1 &degC. You may find washes larger than 200L difficult to control & keep cool.

Ian writes ..

> *I have made "double" batches of wash - 50 and 60 litres. If you are in a warm climate be careful of the temperature. A double batch will heat up quite a bit more than a 25 - 30 litre batch. During the summer I used ice packs (the chemical that is sealed in little plastic bags - that you freeze for use in your cooler.)*

Jack writes ...

> *To heat up the batch- ferment in a glass carboy, set the carboy in a plastic bucket, fill the space between the two with water, and use a small immersible aquarium heater to keep it warm. To keep it cold, do the same as above, but, instead of the heater, toss a couple of those reusable ice packs in the water covering the fermentor, and switch them out with a couple more kept in the freezer when they finally melt. If you ferment in a bucket, freeze some water in a plastic jug, sanitize the outside of it and float it in the mash. To heat up a bucket, just sit it on a heating pad- start with the lowest temp- that usually is good enough. Putting an immersion pump in the mash also keeps the yeast from "retiring early" when it gets cold.*

Settling

Settling is probabaly THE best kept secret for getting really neutral spirits such as those used for gin. If you can really let your wash settle well, maybe even decanting it into another fermentor to let it settle a second time, then the distillate will be so much cleaner when distilled.

Once fermentation has finished (eg final specific gravity of 0.990-0.980 reached), turn off the heat, and let the finished yeast settle over a couple of days to the bottom of the container. Siphon the clear wash into the still, and you're ready to go. Be careful to not disturb the yeast layer, because if it gets into the still it can result in bad smells and flavours. If in a hurry, you can use finings (eg gelatin - 2g in 100mL to settle 25L) to help settle/clear the yeast, or try placing the wash in the freezer, to chill it fast & knock the yeast down. Passing the wash through a simple filter, or even a couple of paper towels to clear out the remaining yeast will also help improve the quality you later get. The simplest (& often most effective) technique though is just time.

There is also a new product available, called "Turbo Clear" which is said to help : http://www.aquavitae.co.nz/spotlight.html.
Jack recommends not to use gelatin ..

> *Gelatin doesn't work as well in sugar mashes - it works by binding to tannin- which sugar doesn't have. The best bet is Polyclar AT. It can be done in as little as a few hours.*

The settling/clearing behaviour of yeast depends on the type of yeast you've used. From Brewing Yeasts (rehashed a bit)...

> *Yeast normally reproduces by "budding". During budding a small bubble like protuberance from the mother cell is formed into which part of the cytoplasm as well as a daughter nucleus, formed by division, passes. In some yeast strains the mother and daughter cells separate from one another completely, in other strains the cells remain connected to one another and form chains. Bottom fermenting yeasts occur mainly as single cells or pairs of cells, whereas top fermenting yeasts form chains of budding cells. In the case of top fermenting yeasts the mother and daughter cells remain attached to one another for a longer time and as a result branched chains are formed. Top fermenting yeasts can be categorised as powdery and flocculent yeasts. In the case of powdery yeasts the cells remain very finely divided in the fermentation medium and sink slowly to the bottom only at the end of fermentation. The cells of flocculent yeast, clump together after a short timeto form large flocs and then settle rapidly. Bottom fermenting yeasts do not form flocs. Another difference is their ability to fermet the trisaccharide raffinose. Bottom fermenting yeasts can ferment raffinose completely, whereas top fermenting yeasts can ferment only a third of the trisacchride. So... flocculent yeasts produce a clear but less fully fermented beer, whereas powdery yeasts and bottom fermenting yeasts produce a turbid beer with a high degree of attenuation. They also differ in regard to fermentation temperatures .. bottom fermenting yeasts are performed between 4-12 &degC, whereas top fermenting yeasts use 14-25 &degC.*

Jack writes ..

> *It's very easy to clarify in the primary fermentor - just fine it with some bentonite or some Sparkalloid. Dropping the temperature also helps- say, down into the 50-60F (10-15C) range. The larger yeast volume in the mash may also (if you're lucky) may cause the yeast to re-absorb some of the esters they produced during the ferment as they go dormant- just like in beer brewing with a long lagering phase.*

AuntyEthyl describes his technique ...

> *The process i use for my turbos at the moment is that I ferment only in the primary fermentor. When the spec. gravity hits .990. I rack the wash from the sediment, into a clean fermentor. I then clean my first fermentor and over the period of the next 3 -4 hours. (depending on how lazy I feel) I continuously pour the wash from one fermentor to the*

> *other for 3 or 4 times then let it sit for 30mins, and repeat.*
>
> *This degasses the wash and aids clearing. I then follow the directions for Turbo Clear and add the first of the two part clearing agent let stand for an hour then add second part leave 24hrs. Result, nice clear wash*

If you have to split the wash (say you've made more than the still can hold), just pour the remaining wash into a container that will hold the remains and be full. That is, ensure that the air in the container is minimalised. By eliminating the air in your container you will lessen the oxygen thereby lessening the chance of oxidation. This way you will be able to do the remains in a second run any time. The wash should be quite safe for weeks. Keep it sealed.
Ian writes ...

> *Please don't "run" your wash while it is still cloudy - when I started this gratifying hobby I did just that. The result of distilling all that yeast is you get a lot of nasties that you could avoid by clearing the wash! Yes, the carbon polishing removed all the nasties over a period of time - but as we are striving for excellence - please clarify your wash! I have found a tremendous difference in the result since I started clarifying my wash. Filtering it is NOT the way to go - I use Sparkeloid - it clears the whole batch in 24 hours. Also, just placing the wash in a carboy in a cool place will do the same job over a longer period of time. When your wash is in a carboy - preferably glass - you can see the yeast settle to the bottom . After it has settled, siphon it off - you don't want to suck up the stuff at the bottom - so put the tip of your siphon hose an inch or two above the crud at the bottom. You will have a crystal clear wash. With the stuff remaining in the carboy - I pour or siphon all the loose crap above the almost firm layer of expired yeast into clear 2 litre soda pop bottles - let it settle, and use it in the next batch - the clear stuff of course - not the crud in the bottom.*

You should be able to keep your wash happily for weeks or months after its settled, before distilling it. Mike writes ..

> *The question was recently raised about storing sugar washes. Almost any alcohol solution over about 5% ABV can be stored for long times if oxygen is kept away from them. This means store it in glass or stainless steel; plastic fermenters will allow oxygen to get in and your wash will turn into vinegar! The higher the alcohol content, the easier storage is because the solution will be self sanitizing from the alcohol.*

For longer term storage, the yeast present in the wash may present a problem. After the sugar is used up in a wash, the yeast initially will start to process some of the higher molecular weight compounds that it made during the primary fermentation, and the brew will actually get cleaner! Both beers and wines often benefit from some period of "sur lees" (on the yeast)storage. If you are planning a pot distillation for a flavored beverage, this may be a good step to take. Experiment and find out!

As time goes on, the yeast do die and split open, changing the flavor strongly for the worse. For storage longer than a few weeks, the wash should be "racked" (siphoned)off of the yeast cake that will have settled out in the bottom and sealed in an air tight glass or stainless container.It can then be stored for months without problems.

Plastics are not 'impermeable to anything'. They may be considered so for liquids that don't attack them, but their structure makes them relatively porous to gases compared to the dense, amorphous structure of glass. Even steel is very porous to hydrogen! Plastics may therefore be used for long-term storage of chemicals that are not adversely affected by oxidation, but not for sugar washes, where even very small amounts of oxygen can have significant impact. Commercial PET in pop bottle thickness transmits 1.5 to 8 ml of oxygen per square meter per day at room temperature. 'Artificial' corks are made out of carefully selected plastics to have uniform oxygen transmission rates, and are being used because they are more uniform than 'natural' corks, not because they don't allow oxygen in. They have the further advantage of being moisture repellent, unlike 'natural' corks which can soak up wine and so provide a nutrient-rich path for fly or airborne bacteria.

The most common bacterium responsible for production of acetic acid from ethanol is not a member of the lactobacillus family, but is mycoderma aceti, commonly known as Mother of Vinegar. When present in wines, members of the lactobacillus family are responsible for malolactic fermentation, which produces many flavorsome by-products. Far from 'being held in check by the alcohol content', they are responsible for secondary fermentation of new wines that are naturally too high in malic acid, as in Germany, or when particular nuances of taste and flavor are desired, as in the red wines of Burgundy and Bordeaux in France. When

> *present in milk, they produce yoghurt. In contrast, mycoderma aceti, which may be bought in any good brewing shop by those wanting to make their own vinegars, primarily produces acetic acid. In the presence of oxygen, this bacterium oxidises ethanol to acetaldehyde and then to acetic acid. This process can and does occur over long storage times in the best of wines should mycoderma aceti permeate 'natural' corks, in which they can find sustenance and so thrive, resulting in the common complaint that a particularly expensive wine has been 'corked'.*

Alcohol Content of the Wash

You can easily calculate the strength of your wash, if you know your starting & final specific gravities (SG) - measure these with a hydrometer. The % alcohol is (Starting - Final) x 129. eg: if your sugar/water mix of SG=1.120 drops to 0.980, then you have a wash with (1.120-0.980)x129=18.1%.

If the SG started at 1.120	and finished at 0.980
Your wash is % alcohol	

Some winemakers use the Ebulliometer degree table for their wines - it estimates the difference between the boiling point of their wine & distilled water (eg if your distilled water boils at 100C, and the wine boils at 93C, then it has 8.8% alcohol). I've created the following calc based on data from Churchward (ACI Jnrl & Proc, Jan 1940), supplied by Duncan. Note that some correction may required if there is still residual sugar present. This calc is only good for % alcohol less than 25%.

If the alcohol content is 8.8 %	
Your wash should boil degrees Celcius below that of distilled water	

Reusing Yeast

It is possible to reuse the yeast several time. Ted Palmer advises :

> *You can "re-pitch" yeast more than 10 times in most cases, the biggest factor in determining if the yeast is still healthy would be its viability. Viability is the percentage of live cells in a given sample. To test for this you will need a microscope, a hemocytometer and some methylene blue stain. Here is a good link written by a friend of mine that explains this method in detail http://www.brewingtechniques.com/library/backissues/issue2.4/allen.html.*
>
> *Another important factor is the genetic strength of the yeast, some yeasts are very stable genetically others aren't. What this means is that genetic mutations change the profile of the cells to the point that they no longer resemble the parent strain. Some yeast strains mutate in less than 4 generations where others are stable for hundreds. Turbo yeast being a highly hybridized yeast falls into the former, I can't tell you how well it will perform or for how many generations, you will have to figure that one out on your own through experimentation. Many packaged yeasts are mixtures of 2, 3 even 4 different yeasts, so if one doesn't crop yeast at the right moment during a ferment one or more of the strains could wind up missing in action. Also be aware that the pitching rate or the number of cells added per ml is an important factor in any ferment . The right # is 10 X 10^6 cells per ml up to 12 degree Plato and you must add 1 x 10^6 per degree Plato above 12. That can be allot of yeast in a high gravity wort. The caveat in yeast pitching is more is better than less.*

See also The Microbrewery Laboratory Manual:

- Part 1: Yeast Management
- Part II: Bacteria Detection, Enumeration, and Identification
- Part III: Wild Yeast Detection and Remediation

Jack comments ....

> *I've been doing some fermentation speed/alcohol-sugar tolerance experiments. The Canadian wine yeast called Lalvin EC-1118 (champagne-saccharomyces bayanus), when pitched at a massive rate (I made up a starter of 10 lbs of sugar, 5 teaspoons of yeast nutrient, in 5 gal of water, then when this was done fermenting, I repitched the thick yeast cake at the bottom of the carboy into only 2.5 gallons of 15% potential alcohol sugar water), with what seems like excessive yeast nutrients, it acted the same as the Turbo yeasts I hear you guys in NZ talk about,*

> *plus, with the competative factor (it's a "killer" yeast strain) no boiling or campden tablets had to be used. Anyone who can't get a turbo yeast can make one by "overpitching " this wine yeast! Fun experiment, but I tested every wine yeast in the store, and I went through over 120 lbs of sugar. EC-1118 was the clear winner by a long shot. Hope this can help someone. (by the way, fermentation took less than a week)*

David Lamotte writes (to CraftBrewing@egroups.com (a brewing group for Australians/Kiwis at YahooGroups)) ...

> *Now repitching is a great way to get huge amounts of yeast working for you quickly, but you can also get the same amount of bugs doing nasty things. Bacteria grow much more quickly than yeast, but are usually killed off as the yeast get going making alcohol and lowering the pH (both are kryptonite to bacteria). But the few that survive from the first brew quickly grow to millions in the second and trillions in the third .... So it can often take a few batches before you have to dump one down the drain.*
>
> *You can just save some of the slurry from the bottom of the fermenter, but it can only be repitched a few times as the 'gunk' builds up and coats the yeast. The information that you were looking for comes from Wyeast's home page (http://wyeastlab.com/hbrew/hbyewash.htm) and tells you how to wash and store your slurry. You can replace the plain water with an Acid wash which will kill any bacteria (but not wild yeast).*

Donald advises ...

> *For yeast re-pitching & yeast washing applications the alcohol should not go above 6%. This is so the yeast will not become stressed and start to reproduce sexually (causing off flavors & mutations) rather than asexually.*
>
> *Please note that at the end of primary fermentation there is enough yeast for four re-pitches. So, one can harvest 1/4 for re-pitch unstressed yeast before stepping up with the remaining 3/4. Also if you want to change your yeast strain by harvesting: Repitch of the bottom 1/3 will be more flocculent, repitch of the middle will be moderate 1/3 and re-pitch of the top 1/3 will be hardley flocculent. It is suggested to take 1/3 top, 1/3 middle & 1/3 bottom to assure yeast character. What you want the yeast to do now is up to you.*

Turbo yeasts are not recommended to be reused. Mike explains "ul> *You can easily re-use beer yeast for two reasons - beer generally is not fermented to high alcohol levels, so most of the yeast in the cake at the bottom is still alive, and beer wort is a nearly perfect growth medium to make more new yeast cells.*

Turbos are designed with a LOT of live yeast cells and enough nutrients to grow more - but by the end of a fermentation, the nutrients (should be)nearly all gone, and most of the yeast in the cake is dead - from the combined effects of heat and high alcohol levels.

If you pitched a new sugar wash onto a turbo yeast cake, I would expect it to ferment - but MUCH more slowly than when the turbo was new, and would not expect it to reach the same alcohol levels. Jack divulges his method for preserving yeast cultures...

> *Most home brew shops sell syringes (about 10cc sizes) without needles- these can be used to collect yeast in a perfectly clean manner. Fill up a measuring cup full of hot water and microwave it until it's boiling, then stick the tip of the syringe into the water and fill the syringe totally with boiling water, wait one minute, then repeat twice more with boiling water. On the last draw-up of the boiling water, instead of squirting it out, leave it in the syringe, put the cap on and allow the syringe/water to cool in a draft free place. When you brew your next batch of whatever, pour off all of the beer/wine/mash until you just have the yeast layer covered with liquid (the yeast layer sould never have been exposed to open air). Un cap the syringe and wipe down the tip with alcohol, then stick it under the surface of the fermented liquid near what looks like a healthy yeast colony, squirt out the water into the general area to stir the yeast up a little bit (don't wash it away, just unpack it from it's settled state- squirt the rest of the water away from the yeast you are aiming for to prevent from scattering it to the wind-the amount of water needed to blast the yeast loose depends on what kind of settling properties it has)- then draw back the syringe plunger to collect the 10cc of yeast slurry. The inside of the syringe has not been exposed to the contaminating air, neither has the yeast (due to the protective blanket of beer/wine/mash that you did not pour off), using standard beer "yeast starter" techniques you can use the syringe to make ten "sub-cultures" (about 50 to 100ml), which can then be used to make a one litre starter for your next batch- This technique will not work well for the Turbo yeasts designed for nothing but sugar- but for expensive (liquid) yeast cultures*

> *for fancy styles of beer/ wine/ whiskey mash- this system works wonders - I store my syringes in the 'fridge- no acid washing no HEPA filter no extra food- they last at least a month this way. Just make sure that if your mom house-sits for you while your on holiday, that you show her what they are so she doesn't think your a junkie and pours your trappist ale culture down the toilet. By the way- special blends of various beer and bread yeasts work great for fermenting whiskey mashes.*
>
> *Magnetic Stirrers*
>
> *You can make a magnetic stirrir out of an old tape player- epoxy a bar magnet to the spindle that turns when you push play and fast forward, mount a piece of thin aluminum above it, buy the stir bars at a science shop, or make one by sealing another bar magnet in a length of tubing cut out of the stem inside a Windex spray bottle, then seal it with the hot edge of a knife- very handy for yeast propagation*

Sloppin' Back

Re-use of yeast is an old moonshiners trick also known as "sloppin' back". This refers to adding the mash that was strained out of the wash just prior to distilling, or the sludge left in the bottom of the fermentor, to the next batch of mash.

As Sam explains ..

> *I did't strain mine so to speak. I pumped out beer from the barrel and left the grain. I used about half old and half new grain. NO YEAST. It is already there. I added water and the same amount of sugar as when I would start a fresh batch. Stir like crazy and you only have to wait for 3 days max for the cap to form and fall and you are ready for a good run. Like I mentioned, third time is the best as far as taste and quantity in my opinion.*

This can be a good source of infection for the next batch, but if it goes well, it will help boost the yeast count heaps, act as a bit of a source of nutrients (though its still best to add more of the real stuff like ammonia), and should help buffer the pH a touch (dropping it a few 10 ths). The yeast that you're reusing by this technique are those that have already shown themselves to be quite happy in that type of mash, and are ready to go for the next lot.

It appears that the "Turbo" yeasts are only designed to be used once, and not reused. Ola Norrman writes ...

> *Turbo Yeast (a mixture of yeast and nutrients) - shall never be reused. There are 2 main reasons for this:*
>
> 1. *Yeast condition. During the manufacture of dried yeast, very high levels of phospholipids are accumulated within the plasma membrane because the yeast is grown aerobically (with oxygen). The yeast population which exists at the end of fermentation has depleted levels making yeast cells more sensitive during subsequent fermentations and fermentation more likely to stick.*
>
>   *So the yeast produce and accumulates lipids during its growth in the yeast factory. Then, during anaerobic fermentation (without oxygen) in the wash, each new generation of yeast contains less and less lipids. Lipids are needed for alcohol tolerance which make this important to 14% Turbos and far more important to 18% Turbos. If to many generations have passed (because of reuse of yeast or to little yeast to start with) the yeast have low "lipid protection" and alcohol tolerance decrease.*
>
>   *Dried yeast also contains typically 15% Trehalose which is a "protectant sugar". It gives the yeast cell internal strength and also is an excellent "start sugar" for the yeast to use at the start of fermentation. Cells at the end of fermentation will typically contain only 2 or 3% Trehalose. Trehalose protect against the shock when the yeast are mixed in the wash.*
>
> 2. *Nutrient depletion. Not relevant for beer, partly relevant for wine but totally relevant for Turbo. So for Turbo, because the sugar offers no nutritional value, re-using the yeast a second time will result in a stuck.*
>
>   *Turbos also contains pH-buffer to give the yeast perfect pH conditions. Nutrients not only work as nutrients, they also keep the production of volatiles down to a minimum. Nutrients are consumed by the yeast. Re-use of a Good Turbo yeast will also result in a lot more volatiles in the wash. pH-buffer will not work in the second batch. There are other ingredients making the CO2 leave faster, giving the yeast cells something to claim to and move around in the fermentation, assist clearing after fermentation etc. Those functions will also be spoiled as they are a part of the*

> *nutrients.*
>
> *Nutrient composition are the manufacturers secrets. One can not simply add some DAP (diammoniumphosphate) or similar and expect it to work the same. The first Turbo in the world was made in Sweden. They are sold under the name Prestige and are extremely good. At http://www.turbo-yeast.com/intro.html there is a lot of info about quality Turbos including a "recipe" telling how "Bad Turbos" are made.*
>
> *There is also info about yeast strains at: http://www.lallemand.com/ It is a bit surprising that they not have some never information here, only old basics.*
>
> *One could talk about genetic drift and bacterial risks too, but it is not so important.*

Freezing Yeast Cultures

Matt reports

> *Noonan's book does mention freezing as a viable way of culture storage. It seems that yeast cultures that have been refrigerated are allowed to warm up to around 50F/10C for about a week. This causes a sedimentation and the liquid above the yeast layer is decanted off and the bottom layer is harvested. This layer is squeezed of excess water and then tightly rolled into a ball, stored in plastic wrap and then moved to a freezer. It apparently can be stored for several months. To re-animate this yeast, it needs to be thrown into a starter culture of aerated wort before pitching.*

High Gravity Ferments

If you want to use high concentrations of sugar, in order to realise final high alcohol, you need to take special steps.
From the Whitelabs site, the instructions for using their WLP099 Super High Gravity Yeast are as follows ....

- *Aerate very heavily, 4 times as much as with a normal gravity beer. Less oxygen dissolves into solution at high gravity.*
- *Pitch 3-4 times as much yeast as normal.*
- *Consider aerating intermittently during the first 5 days of fermentation. This will help yeast cells during a very difficult*

fermentation. Aerate with oxygen for 30 seconds or air for 5-10 minutes.

- *Higher nutrient levels can allow yeast to tolerate higher alcohol levels. Use 2 times the normal nutrient level. This is especially important when using WLP099 to make wine and mead, which have almost no nutrient level to begin with.*
- *Do not start with the entire wort sugar at once. Begin fermentation with a wort that would produce a 6-8% beer, and add wort (it can be concentrated) each day during the first 5 days. This can be done together with aeration. This is mandatory if the reported 25% ABV is to be achieved.*

Dr Clayton Cone writes..

> *Here is a brief protocol for the production of high alcohol fermentations. You can down size to your needs. EC 1118 is a good choice up to 16 - 18 % alcohol. K1 and L2226 seem to work better at 18 - 20+% alcohol. The key to the success of fermenting to these high levels of alcohol is management of the yeast: lots of nutrients, pH control, small amount of aeration and occasional stirring to keep the yeast in suspension.*

High Alcohol Fermentation 15-20 +% v/w	
K-1or L 2226 Yeast Strain	6# / 1000 gallons
Vi-A-Dry Inactive Yeast 2133	2# / 1000 gallons
Fermaid K	2# / 1000 gallons
Di Ammonium Phosphate (DAP)	4# / 1000 gallons

Sprinkle the 6# K1 or L2226 yeast into 6 gallons of 105 F. water. While gently stirring ,to prevent lumping. Allow to set for a maximum of 30 minutes. Stir to disperse.

To minimize cold temperature shock, cool the warm rehydrated yeast slowly , in stages, by adding equal volumes of juice to the slurry. The attemperating stage is important to prevent the formation of unhealthy yeast cells (petite mutants) which form when the yeast is suddenly exposed to greater than 20 F drop.

Add the yeast inoculum to the bottom of the fermenter after a few *gallons of the juice has been pumped in. This allows the yeast added time to get through its lag phase and exposes it to the necessary oxygen that it requires for healthy , alcohol resistant cells after the growth phase.*

Divide the nutrients into several portions and add in increments throughout the first 72 - 96 hours.

Start the fermentation in juice that is below 24 brix, preferably 16-20 brix. The lower the initial brix the better the yeast will grow to achieve the necessary population required to complete the last stage of the high alcohol production.

- *Aerate or circulate gently for the first 24-48 hours. Do not put air cap on for first 48 hours. Oxygen during the yeast growth phase is necessary to produce the cell wall protection that is required towards the end of the fermentation.*

  Monitor the pH carefully during the first 24 hours. Do not let it drop below 3.4. Adjust with potassium carbonate or other suitable alkaline material.

  Monitor the fermentation closely. When the sugar drops to 4 brix, add fermentable sugars to bring it back to 6 brix. Repeat this 4-6 brix. cycle until you reach the desired alcohol level, allowing the last cycle to go to completion (dry).

  Comments:
  The temperature should be 80 - 85F. for the first 48 hours and 70 - 80F. for the remainder of the fermentation.

  pH below 3.1 places an added stress on the yeast cell as the % alcohol increases. It is best to maintain a 3.4+ pH. Use carbonates such as potassium carbonate to keep the pH above 3.4. It is especially important to monitor the pH during the early hours of fermentation when you are using sugar, honey and some concentrates to increase the alcohol level. There is little or no buffering capacity in these sources of sugar.

  High levels of nutrients are absolutely essential for the yeast to produce high levels alcohol.

  100% fructose sugar is not recommended as a source of added fermentable sugars. Most wine yeast ferment fructose at a slower rate and often times have trouble fermenting to dryness.

You can expect 0.58 - 0.60 % alcohol by volume for each 1% sugar. Thus the total brix or % sugar should be 33 -35.

With experience you may be able to adjust the brix between 4 and 10 rather than 4 and 6 to minimize the number of sugar additions.

Every juice ferments differently You may have to increase the yeast and nutrient levels or you may even be able to decrease one or more of them. If you are using sugar, honey or concentrate to increase the alcohol level, there are little to no nutrients present in these so you will have to add all that the yeast need for a healthy fermentation. .

You should obtain a Clinitest Kit from your local drug store and use it to monitor the sugar level near the end of the fermentation. It cost about $0.10 per test. It is an ultra simple test normally used to test your urine for sugar. 3 drops fermenting wine + 10 drops water in a test tube + 1 tablet, wait about thirty seconds. Read color compared to a chart.

One step, high gravity , 25-40 brix, fermentation:
High nutrient and yeast inoculum levels are necessary..
3-5X the above recommended yeast and nutrients are required.

- *Sugar is just as toxic to yeast as alcohol. Yeast growth decreases as the brix increases. Above 25 brix the growth drops dramatically and has to be compensated by increasing the inoculum. A general rule of thumb-1x10 6th yeast cells / ml./degree brix; 1/2 # K-1 / degree brix/1000 gallons juice; i.e., 1000 gallons of 30 brix juice would require 15# K-1 yeast.*

  There is usually very little suspended matter in the high gravity juice and as a result the yeast tends to settle rapidly. The yeast on the bottom of the fermenter participate very little in the sugar to alcohol process. Therefore, stirring and or circulating constantly or frequently throughout the fermentation is recommended.

Stuck Ferments

If your fermentation peters out early in the story, it could be due to a couple of reasons.

- Nutrients. This will be the biggie. These are necessary if just using sugar/water. If this is why its become "stuck", then there will be little chance of reviving it (sorry). See the discussion above for more details.

- I sometimes suspect that I haven't diligently rinsed all the bleach from my fermenter, and that this has killed the yeast. Repitching with more yeast gets it going again (and remember to rinse better next time).
- Sometimes you haven't added enough yeast (there almost is no such thing as "too much" yeast). Use a couple of packets if you are using those little 5-7g sachets.
- Temperature problems - too hot will kill the yeast, to cold will make it dormant. Keep the temperature between 26-34 &degC, and keep it constant - varying the temperature will jepardise its run.

Do not add more sugar to a stuck ferment. It won't help.

You can still distill a wash which hasn't fully fermented out, but be prepared for some fun. It is likely to foam up heaps, and possibly block the column if you don't give it enough headspace, or use the "anti-foaming" silicon emulsions (wash conditioner) available in brewshops. Also, because not all the sugar has fermented, you're likely to get less alcohol out, and you may caramelise a bit of it on the element or the base of the pot (clean it well afterwards).

Heres a couple of emails between Steve & Dr Clayton Cone that are hugely informative ..

> *Below is the reply to my enquiry re turbo yeasts and stuck ferments. Dr. Clayton Cone is a microbiologist and consultant at Lallemand which is the manufacturer of the Lallevin EC1118 yeast which is good for up to 18% alc/vol. He provides a protocol for the production of high alc wines/washes below. You may wish to put the following links on your site, www.lallemand.com and www.redstaryeast.com The latter has an interesting text on the history of yeasts.*
>
> *Regards, Steve*
>
> *Steve,*
> *I hope that you had a chance to read my articles in the Lalvin Home Wine Making section of the Lallemand.com. I try to cover the role of yeast rehydration, nutrients, oxygen, stirring, pH and other factors that are involved in a healthy fermentation that should assure you of a complete fermentation.*
>
> *Most stuck fermentations today are caused by:*

1. *Mishandling at rehydration. Follow instructions very carefully.*
2. *Allow the temperature to rise too high.*
3. *No oxygen (aeration) during the first 36 - 48 hours.*
4. *No stirring or agitation during the first days of the fermentation and near the end. The yeast settle out and are not up in the must where all the sugar is.*
5. *Lack of yeast nutrients.*
6. *Too low pH*
7. *Toxic effect of Octanoic and decanoic fatty acids*

I would first try to reactivate the yeast by adding Vi A Dry yeast residue and stirring, allowing a little air to get into the must. Stir several times for several days. If no activity is observed then you need to do one of the following:

8. *There will be no yeast growth with all of the alcohol present so you must add a large number of live yeast to finish the job. Add 10lbs of properly rehydrated EC 1118, K1 or L2226 directly to the stuck wine and aerate and stir.*
   or
9. *Calculate the right amount of EC 1118, K1 or L2226 required for the total volume of stuck wine at 5lbs/1000 gallons. Rehydrate the yeast in 10 time its weight in 105F tap water. Add the dry yeast slowly to the water while stirring to avoid lumping and allow to stand for a maximum of 30 minutes.*

   Add the rehydrated yeast to the following initial mixture which is 5% of the total stuck wine volume:
   - *2.5% of volume of stuck wine (25 gallons/1000 gallons)*
   - *2.5 % of volume as water (25 gals./1000 gal.)*
   - *2.0 lbs. Fermaid K & 2 lbs DAP /1000 gals. Of wine/water mix*

   Adjust sugar level of this mixture to 5% with juice concentrate or sugar (40 lbs sugar/100 gals)

   Maintain temperature at 70 - 75F

   When the sugar level has dropped by 1/2 (<2.5%), begin to add the stuck wine to this starter. Add 2lbs Vi A Dry yeast residue/1000 gallons of stuck wine before starting to add to the starter. Add* *in batches of 20% of stuck wine volume. When the sugar has again reduced half add the next batch. Continue untill the fermentation has completed.*

** This will adsorb the octonic and decanoic fatty acids that might be present and also furnish nutrients for the yeast.*

Distilling the Wash

Summary
Once the still is up to temperature, and the distillate has started dripping, make sure you throw away the first 50 mL per 20 L of wash, as this may contain any methanol that is present. You should expect to collect the equivalent of approx 1L of 40% alcohol per kg of sugar used; the actual % purity will depend on the type of still you are using. Stop collecting the distillate once you notice them containing some fusels, or if the temperature gets above about 94 °C (it doesn't become "dangerous" or "deadly", just that it tastes foul). If you collect the distillate in small amounts (say 1/2 L or so), you can segregate the drinkable spirit from that with fusels in; the latter can be added to the next wash, and be collected cleanly then. "Genuine" whiskey can be made by passing a grain wash through a pot still twice.

The alcohols in the wash begin to vapourise from the wash around specific temperatures. If by themselves they would be ...

- Acetone 56.5C (134F)
- Methanol (wood alcohol) 64C (147F)
- Ethyl acetate 77.1C (171F)
- **Ethanol 78C** (172F)
- 2-Propanol (rubbing alcohol) 82C (180F)
- 1-Propanol 97C (207F)
- Water 100C (212F)
- Butanol 116C (241F)
- Amyl alcohol 137.8C (280F)
- Furfural 161C (322F)

Once together, a mixture of several of them will be slightly different however. You no longer get them coming off seperately, but always as a mixture. Fortunately for us though, each of the species will tend to dominate around its boiling point temperature, thus we know whats "mostly" coming off at that point. By tracking the temperature of the vapour, you have a fairly good idea when you're collecting the Ethanol your after (78-82 &degC), vs when it is starting to get lean and you're into the higher alcohols.

Note that you may also need to adjust the temperature if you are distilling at altitude - the higher above sea level you are, the lower boiling temperatures become because of the reduced air pressure.

Mark writes

> *Here is what I found. I'm at 7000 foot, i did a test run and water boils at 199 here. Thats 93% of 212. so i cut my tables by that. Maybe this will help others. http://www.hi-tm.com/Documents/Calib-boil.html*

Jack adds though ..

> *Actually, % of alcohol is a more reliable method of measuring cutoff points than temperature is. Thermometer placement in a still can cause a major difference in how the temp is read. Everyone's still is different- the % is more likely to give predictable results, where the temp can be off by more than 10F either high or low- giving the wrong results when duplication of anothers' run is being tried.*

Sometimes with the tails though, even the % isn't accurate enough, with smelly tails sneaking through with little apparent notice. This is when you should also let your nose guide you - collect a few drops on the back of a spoon every so often, and check what they smell like, on a regular basis.

Filling the Boiler

When filling the boiler, make sure you leave enough headspace above the liquid, so that if it foams up a bit, that the foam won't get pushed up the column. Typically it should only be around 3/4 full.

You also want to ensure that there will be enough liquid at all times to completely cover the elements. This is particularly relevent when you've already done some "stripping" runs first, and you're now starting with something quite high in purity (eg 45%) and the reduction in volume will be greater.

If starting with 20 L of wash at 9 % alcohol

through a still that collects its distillate at 92 %

should result in ☐ L water left in the boiler when finished

Some washes may tend to foam up a bit & get pushed out through the column & condenser, contaminating the clean spirit. This sometimes means that for some washes you may have to leave your boiler 1/3 to 1/2 empty at times, in order to accomodate that foaming. Hogan writes about how to deal with this ...

> *someone was descibing the use of malt extract for making whiskey and commenting that it foamed a lot in the distiller. The extract will contain a lot of proteins and when boiled it will foam a good bit. You need to let it foam as much as possible (without boiling over, of course). If you have a big pot, that helps. But you can remove the pot from heat or turn it down (if a gas heat source) let it sttle a bit and fire it back up. You are looking to achieve something called hot break. The foam will soon stop rising. This process coagulates the protiens so that they are larger and will settle out, producing a clearer liquid.*

Removing the Methanol

Be ruthless about tossing the first 50 mL (off a 20L wash) that you collect, as this contains any methanol (causer of hangovers - small quantities, or blindness - larger quantities). Even though I'm pretty sure I only collect less than 10mL at the methanol stage, I still discard 50mL, just to make sure. No need for penny-pinching when you're making 3L of the stuff, for less than $5. If you're using a potstill, you may need to increase this amount you toss up to 100-200 mL.

Jack writes ..*I have tasted potstill alcohol that has been made both ways- when only 50ml (per 20L) was thrown out, the stuff was very sharp tasting. It became alot smoother when a full 100ml was thrown out at the start of the run.*

This first portion is often called the "**foreshots**". They are different from the "**heads**". Ian Smiley (http://www.home-distilling.com/) describes foreshots as "the low boiling point compounds that come out of the still first. They contain acetone, methanol, various esters and aldehydes, and other volitiles. Foreshots are to be considered poisonous and should be discarded." Whereas heads "come out after the foreshots, and are almost pure alcohol, except that they are contaminated with trace amounts of unwanted cogeners ..." To get a really clean distinction between the foreshots and the heads, first ensure that you've let your column equilbriate under total reflux, then hold the reflux ratio high, such that you remove the foreshots only very slowly (eg 1 drip per second), thus allowing an equilbirium to be maintained at the top of the column, encouraging the methanol to collect there.

If you're after making pure neutral spirit for vodkas or gin you may choose to keep the heads (eg the next 250 mL-1L of spirits) separate from the following couple of litres (**middle run**) on the basis of their taste. These heads can still be used to make liqueurs, whisky, rums, etc, or redistilled later if desired totally neutral. The only problem with heads is their non-neutral taste.

The distinction between the various phases depends on what sort of still you have. They will all tend to merge from one to the other. This is particularly the case with a pot still, where you notice the temperatures always slowly changing as the distilling run progresses. Using a reflux still or fractionating column will allow the various stages to appear more distinct, as the temperature will be more stable, due to the more distinct seperation of each compound.

Running the Still

For neutral spirits. there are many different ways of running a still to achieving the same results.

To get high purity, you require your column to be doing many redistillations. To get enough redistillations happening, your packing must offer sufficient "theoretical plates". The HETP that you get from packing depends on many factors, but includes the surface area, the thickness of the liquid spread out over it, and the ratio of liquid to gas. As the alcohol in the pot depletes, in order to keep the same purity, you need more redistillations happening. The usual way to do this is to improve the HETP by increasing the ratio of liquid to vapour (eg the reflux ratio)

As its a ratio, you can do it either by increasing the amount of liquid being returned (eg increase the amount of cooling water to through tubes/top condensors, or closing the offtake in a Nixon-Stone), or by reducing the amount of vapour (by reducing the power input to the boiler). Both will have the same result.

Just how much action is required depends on what the column is like to begin with. If its a tall column, packed with something with heaps of surface area (scrubbers), etc, it may already have enough redistillations happening in it to satisfactorily cope with very low alcohol input. Thus there would be no need to adjust it much during the course of the run. You'd basically turn it on, set it and leave it (though you still need to catch it right at the end).

If however the column isn't quite so great, you might need to do some serious readjusting of the reflux ratio right through the run in order to keep it doing what you desire.

Likewise, with the tall column, maybe you elect to run it heaps faster at the start (and not suffer any ill consequences), but then progressively turn it back down as things progress. Eg - do you run it the whole run at say 10 mL/min offtake, and never touch it, or say start at 50 mL/min and then slowly wind it back to 10 mL/min over the following hours.

None of these are wrong or right, just different. So when you hear of guys doing 17hr runs, thats fine if it suits them. I prefer the latter of fiddling to get the shortest time. Each to their own. With rushing, I have more "oops" happening - finding that I haven't been checking it quite routinely enough, and that its just spent the last 10-15min at too high a temp. But I'm still happy with the final taste, so thats fine for me. Others may shun my juice.

Choose for youself - try a run at a really slow offtake & little control needed, and compare against a "hands on, push it fast" approach. Maybe choose the middle ground.

Likewise as to go to electronic control or not - its just a personal choice, based on if the smoother control is worth the cost, if whether it will work for your style of operation & still design, if you dabble in that sort of thing, or if you prefer the hands on and driving.

When to Finish

This really depends on what your still is like - they can all be different. The general rule is to finish distilling when the vapour temperature near the condensor is around 92-94 ° C. Depending on how much of the "**tails**" you collect, your spirits will aquire a different flavour. If making a neutral spirit, you wouldn't want any tails present, so you'd finish sooner (around 82 C?), however if making a flavoured spirit, you'd want a trace of them present. Note that you can always collect the tails seperately from the "middle run", and redistill them at a later date to get the ethanol from them.

If your column is a very high purity one, you may infact find yourself finishing before 82 C, with only a small amount left to collect as tails after that.

If you're doing a flavoured spirit, eg a schnapps or whisky, often the "cut" to finish will be based on taste rather than by temperature alone.

One clue that you've gone too far is if the distillate takes on a white/milky appearance. This is because the fusels (propyls, amyls & butyls) are partialy/totally insoluble with the higher %alcohols. You won't spot them if you keep your tails separate, as they are soluble within their own family in a weak ethanol solution. You may spot them though by seeing if a drop on the end of your finger gives a sun glint, and/or feels well lubricated (the old moonshiners trick). You may also see a slight film/slick on the surface of the distillate if using a clear container. If you can see them, then you can probably smell them too.

Another indication that its time to finish is when the temperature begins to fluctuate a bit. Tarvus writes :

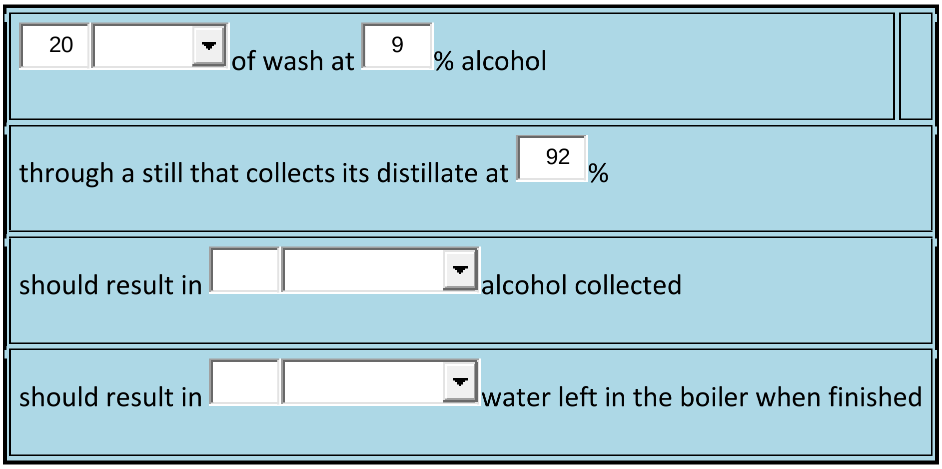
> *...with my Stillmaker type reflux still, I notice that the temperature holds steady until near the end of a cut. I should note that I use a digital thermometer that registers to the nearest 1/10th of a degree fahrenheit and refreshes itself every 10 seconds.*
>
> *For example, near the end of the time the foreshots are exhausted and the ethanol begins running, the temp will fluctuate dramatically after having held rock steady until then. The same seems to happen at the end of the ethanol run. When I see the temp starting to get squirrely, I stop the run. Maybe I leave a bit of usable ethanol in the wash, but it's worth knowing the stuff I collect is pure! :)*

Let the distillate drop cleanly into the recieving vessel, so that it splashes. This will help it lose any fusels that may be present. For the same reason, it is better that the distillate is still warm to the touch, not cold. Don't put the end of the tubing under the level of the liquid, as this will cause any fusels that might be coming out as vapours to condense (and taint the flavour).

Greed is a bad thing. This is what gets your mates saying that your spirits taste "off" (you stopped noticing a while back, but everyone else still comments). You are either trying to rush things (good distillate requires time & patience), or you're wringing the neck of the beast and taking the run too far. You can't get ALL the available alcohol out of the wash. The better your still (eg the more "theoretical plates" / smaller HETP it has) the better your chances, but you still run the risk of contaminating your clean spirit with the tails, and having it smell & taste bad. But heres a few things to try ..

- Segregate your distillate into 1L (or pint) bottles as you collect it. Work out which of them are OK, and which aren't; eg the first 2-3L might be fine, but you start noticing the tails in the last couple. Only keep the first ones for drinking, but put the other bottles aside. Either toss these in with the next wash as you go to distill it, or keep them from several runs, dilute 50/50 with water, and give them a run through the still on their own (see - you're not wasting it, just delaying when you get to keep it). This will allow you to really push the end of the run, as you won't be allowing it to contaminate your good drinking spirit (but don't get silly - stop when you can notice the fusels !).
- Get a better still (eg more packing, taller column, with greater reflux) The tails won't appear until quite late in the run (eg may only have to put the last 0.5L aside, not the last 2-3 L).
- Be patient - take the time & run the still with a higher reflux ratio (collect less, return more back down over the packing). Use more cooling water in the reflux condensor section.
- The still needs to run smoothly, with even temperatures. Stop it surging - the distillate should be coming out nice & steady - either a thin dribble or separate drops. Somethings wrong if its coming in spurts ; more even temperature control needed, keep the packing clean (back-flush it after every run), make sure the packing isn't too tight, have the right column size for the amount of power you're putting it (not a real skinny column with heaps of vapour going up it), don't have cool breezes blowing on the outside of the column giving spot cooling (keep the column insulated)
- Take the time to polish neutral spirits well. Get a batch ahead of yourself, and always have one sitting on carbon, until you need to use it.

A 20L wash (at 12%) should produce approx 3L of 75% ethanol via a basic reflux still, or 2.3L of 95% ethanol via a fractionating reflux still.



20 of wash at 9 % alcohol

through a still that collects its distillate at 92 %

should result in alcohol collected

should result in water left in the boiler when finished

Note: this assumes 95% collection efficiency

Donald advises ..

> *Residual tails should be cut by hydrometer in pot stills then redistilled with the next batch. Column still tails should be redistilled in process, as much as possible then pumped though an activated charcoal filer. A drinking water type filter cartrige is best, pump it through several times for vodka results. Chilling the distillate will improve filtration.*
>
> *Neutral spirits require little to no age (0-30 days). Using refined raw materials helps produce more neutral distillate and reduces tails.*
>
> *Tails are always volitle, oily and rancid. Once they come over they will dominate/spoil the flavor of the entire batch. I suggest having 3 recieving containers on the output side: center cut, orgaoliptics, heads/tails. That way if tails start on the oganoliptics the entire batch is not at risk. The danger/fun is that the organoliptic range changes with the raw material. In general tails are: Early- tequila, Armagnac, Cognac. Moderate- Brandy, Irish style (3x) whiskey, Corn whiskey, Rye whiskey, Bourbon, American whiskey. Late- Malt whiskey and distilled spirit specialties.*
>
> *Each style and flavor profile has it's own target cuts for optimun results. The cuts differ a few points between companies and account for "house flavors" & "regional traditions". The shape and composition of each still (or addition) effects the reading of cuts as well. A short pot still will give a stronger and hearty spirit with early oily tails, whereas a taller onion dome pot still will give a lighter spirit with a later tails. This means that with good hydrometers, anybody with any still, can produce the target flavor with the proper cut. Much money is spent on still improvement, before tool improvement.*
>
> *Save money by using good tools and accurate measuring equipment.*

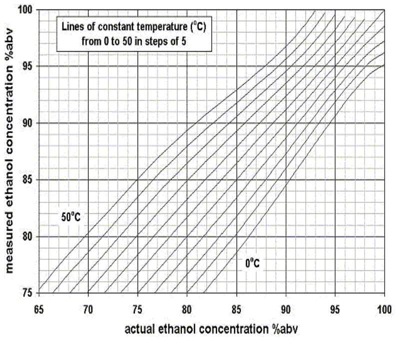
Mark has built a really neat device to allow him to monitor the alcohol purity during the course of the distillation. It floats a hydrometer in the distillate as it is received. Just remember to correct the readings for the higher temperature ....

You may be interested in something that I built so that I could monitor the quality of the output from my still. The device basically takes the output from the condenser and runs it past a hydrometer. I built this from a 6" length of 3/4 copper tube with a 1" tube flanged down and silver soldered at the top. I then connected a piece of 3/16 copper tube to the bottom of the 3/4 copper (input) and at the other end silver soldered on a funnel I then connected another piece of 3/16 copper to the 1" copper tube that collects the overflow from the 3/4 tube (Output tube). This connection was a little difficult as the 3/16 tube will not fit in between the 3/4 and 1" tube. To do this I drilled a small 1/8" hole into the side of the 1" tube and but welded it on. You could probably increase the 1" tube to 1.1/2" tube to make this easier The reason that the tube sizes are small is to ensure that the hydrometer can quickly follow any changes in output. A down side to the 3/4" tube is that if you have a high flow rate the hydrometer will give higher reading as flow of alcohol causes the hydrometer to rise. So if you are considering construction and you have high output rates you may need to increase the size of the tubes. This will of course decrease the sensitivity. I would also suggest to make sure that you hydrometer will fit inside of the 3/4" tube with some clearance for the output to flow past(My hydrometer is 1/2' diameter).

To keep aware of the temperature getting too high at any stage, theres several digital thermometers coupled with alarms available. See http://www.kitchenkapers.com/36290.html Brian wrote: ...

> *If you get a Polder type electric thermometer they can be programmed at set temp to alarm. They also have a nice timer feature...helpful in charting your temps/time and the probe is 1/8 in Stainless which fits easily in a compression fitting at the top of the column.*

When measuring the density of the distillate, you need to correct the reading for temperatures higher or lower than than which your hydrometer was designed for. Most are happy at 20C. Geoff has calculated the corrections required at different temperatures; download his Temperature correction table, an example of which is the following graph :



Jack advises ...

> *Collecting spirit by temps alone is really unreliable- everyone has the thermometer set in the still in a different point- for some it could give false high readings- low for others- practice helps you figure out how to read your specific thermometer- going by the strength of the alcohol is far more reliable- and repeatable.*
>
> *Now, for the good stuff: Most pot stills that are run commercially are run until one-third of the mash volume has been collected (3 gallons of wine gets reduced down to 1 gallon of "low wines"). The second run has the spirit collected when it starts coming out of the still at 75%abv, and you stop collecting at 55%abv. The stuff that came out stronger than 75%abv is thrown out as heads. The stuff that comes out lower than 55%abv is saved as feints, and added to the next run. The feints are added to the next beer stripping run if a lighter, more neutral spirit is wanted- common in Cognac distilleries, not with whisky, though. If the feints are added to the next spirit run, the resulting spirit is a bit more flavorfull- this is how whiskey is distilled. The total spirit collected tends to average somewhere in the mid-60%abv when collected in this style.*
>
> *The 75% to 55% cutoff points are known as a "middle-third cut" among distillers, and is the industry standard for most (except Glenmorangie, which collects only from 75% to 65%abv- this is called a "middle-fifth cut").*

Details from "Increasing Direct Marketing for Fruit Farmers by Connecting Producer to Producer through Research and Development of a Value-Added Product" at http://www.ams.usda.gov/tmd/FSMIP/FY2001/MO0341.pdf include some details about the cuts made when making brandy from apples:

- each cut done by "sensory analysis" - diluting to 40% with distilled water first
- cut from heads to heart when no longer sensed ethyl acetate present
- cut from heart to tails when aroma changed from fruity to musty/rancid
- no pattern for when to make the cut - varied for each different fruit, and from batch to batch. Using set amounts etc would have resulted in lower quality brandy.
- fruits only fermented out to 5-7% alcohol
- lower quality fruit had more heads/tails

Salt

Maurice advises ..

> *..put a teaspoonful of ordinary table salt into the wash ..the spirit comes over much better..*

Salts are sometimes used during extractive distillation (eg when trying to distill past the 95.6% azeotrope) so as to depress the volatility of the water (eg effectively increase its boiling point, so you get a greater % of ethanol off compared to normal). Because the salt is non-volitile, it will always remain in the pot, and not turn up in the distillate.

The "Household Cyclopedia" recommends ...

> *Table-salt thrown into the still, in the proportion of 6 oz. (180 g) to 10 galls. (38 L) of any liquid to be distilled, will greatly improve the flavor, taste, and strength of the spirit. The viscid matter will be fixed by the salt, whilst the volatile matter ascends in a state of great purity.*

David cautions though ..

> *make sure you use ordinary non-iodised salt not iodised. Virtually all salt sold in NZ in containers for domestic consumption is iodised. Also be aware that salt is sodium chloride and that chlorides attack stainless steel and can bad pit it. It can also and will generally shorten your element life.*

Bokakob advises ..

> *The best time to introduce salt in the distillate is when distilling second time. The first distillation, stripping, is used to reduce the amount of liquid and some of impurities. The second run is the place where this salt helps in separating boiling point of water. I always add regular salt for the second distillation in proportion of about two heaping table spoons for about 8-10 liters of 65% abv.*

Ken recommends using Sodium Carbonate to reduce the amount of fusel oils present ..

> *.. try sodium carbonate @ 4.5 grams/ litre, add it when the wash temperatire is at 35-40 degrees C, add slowly then continue with your distillation in the normal manner. Sodium Carbonate is used in the production of soap and it combines with the oils to form a compound that does not evaporate at the normal distillation temperatures that we are using. Voila, cleaner spirit, less carbon treatment needed and more happy faces.*

Alex finds

> *... that adding baking soda delineates the border between the good and the bad stuff very sharply. In regular distillation tails presence increases gradually and it is very difficult to decide when to start separating it from the good collection. In presence of baking soda this division is much more defined. (I added 3 full heaped table spoon of regular baking soda per liter of pure alcohol.)*

Rob details the bicarb advantage too:

> *Assumptions and facts:*
> *1. A well run column distillation will separate a mixture into fractions based on the boiling points of the components.*
> *2. There will be some overlap in most real-life stills.*
> *3. ethyl acetate can be smelled at very low concentrations*
> *4. acetic acid cannot (it has a higher flavour threshold)*
> *5. under neutral or acidic conditions acetic acid will esterify to some extent in the presence of ethanol.*

6. sodium acetate is not volatile
7. sodium bicarbonate will neutralise acetic acid.
8. sodium bicarbonate may hydrolyse ethyl acetate to a greater or lesser extent.
9. Adding sodium bicarbonate at some point between a stripping run and final distillation has the effect of decreasing the volume of fractions collected which smell of ethyl acetate.
10. Adding sodium bicarbonate at some point between a stripping run and final distillation has the effect of making the main fraction "cleaner smelling"
11. without bicarb the main fraction _can_ smell of ethyl acetate (ymmv)
12. Sodium acetate is not esterified by ethanol.

Questions:
1. Why is there ethyl acetate in the fractions after the heads? (no NaHCO3)
2. What does NaHCO3 addition do?
3. How do we best (read easiest) use it?

Rob's Answers/Opinions (currently!):
1. During distillation (after column stabilization) ethyl acetate is being formed in the boiler/column. This is why it continues to be present even after heads removal. (see assumptions 1, 5, 11)
2. Bicarb addition neuralises acetic acid, preventing ethyl acetate formation, distillation of acetic acid, and hence future esterification. (see assumptions 6, 7, 9, 10, 12)
3. Bicarb addition can hydrolyse ethyl acetate, thus decreasing it's quantity (see assumptions 8, 9)
4. There is actually a tiny amount of ethyl acetate about, but it is highly noticable (assumption 3). Using bicarb (as opposed to hydroxides) actually has a rather small effect on the amount of esters in the mix. What it does (primarily) is to prevent further formation, and hence allowing the still to do its job without the moving target of continually increasing ester concentrations in the boiler.
5. Based on this lot, adding bicarb at the start of the final distillation is sufficient, as neutralisation of acetic acid is instantaneous.

Mike warns though ..

> *It's OK to add baking soda or other alkali to a STRIPPED wash, but NEVER put it in the primary ferment and then distill. If you do, and your still contains ANY copper, you will severely corrode the copper, and get blue, ammonia-smelling distillate. Not fun!*
>
> *Why? Yeast and yeast nutrient both contain lots of ammonium salts (like DAP), which are very stable under acidic conditions, but which release lots of ammonia as the approach neutral conditions. Actually, you will start getting ammonia at about pH 5! Ammonia gas is very corrosive to copper, and you will find your condenser coil packed up with blue crystals after such a run (and blue alcohol too !)*
>
> *Schweitzer's reagent is cuprammonium hydroxide, and is formed when copper hydroxide dissolves in a dilute ammonia solution). It is a deep blue colour, and is particularly known for its ability to dissolve cotton. The chemist who first discovered this property was Eduard Mathias Schweizer (1818 -1860), so it seems that it should really be called Schweizer's reagent.*
>
> *It forms in stills when ammonia released from alkaline washes (nitrogen source may be plant material or yeasts) reacts with copper hydroxide formed by the action of steam on copper oxides coating the inside of copper columns or components. It may be avoided by ensuring that the liquid in the boiler is slightly acid (pH less than 7).*

Boiling Chips

If you're heating your still over an external heat source, then you should have a couple of boiling chips inside it to help break the boil. These are any rough-surfaced, inert object - like bits of broken pottery (unglazed so as to avoid lead based glazes), broken glass, or even a couple of marbles.

The rough surface acts as a site where the bubbles can start to form easier. If your pot is nice and smooth on the inside, then its difficult for the bubbles to form, and you can end up super-heating the liquid. When it does boil, it might be quite violent, and give surges of vapour up the column, ruining that nice equilibrium you're trying to create. Boiling chips, although making the job a little noisier (rattle like hell!), do help give a smoother simmer.

Cloudy Spirit

Sometimes your spirit may turn a bit cloudy when its been left by itself. This can be due to a couple of reasons ..

- **Fusel oils** : you've got some tails in there. They may be tend to form a slight "oil slick" on the surface. You may have some sucess in carefull decanting off from underneath it and then passing it through a coffee filter to try and capture it. Obviously the way to avoid it is not to collect the tails in the first place - see above.
- **Mineral precipitates** : your drinking water may have a high limestone content (calcium carbonate) , that has somehow come over with the distillate. Haven't heard how to fix this one, other than softening your water before you use it, or going to the trouble of using distilled water in the first place.
- **Dirty carbon** : Johan advises .. activiated carbon is normally not perfectly clean it contains diffrent kind of salts. Before you mix activated carbon and alcohol clean the activated carbon by boling it in a saucepan and then discard the water, taste it to see if there is any impurity. This will make your activated carbon much more effective as well!

Blue Spirit

Sometimes the spirit may get a slight blue tinge to it. This is usually a sign that you've used too much nutrient in the wash. Mike explains ...

> *I [previously] replied, saying it was probably due to copper salts coming from acid wash. I WAS WRONG!!!!*
>
> *In fact, I've learned that it is just the opposite! Acid washes do not corrode the condenser (unless, perhaps, they've been allowed to sit far to long and have gone acetic), but neutral to alkaline ones DO. Heating an ALKALINE wash, particularly one with lots of nitrogen-containing compounds that have been put in as nutrients, liberates ammonia, which corrodes the heck out of reflux coils and dyes the distillate a distinct greenish blue.*
>
> *The Upshot: if the WASH is turning blue, it's probably due to acid wash corroding a copper sheathed element or a copper boiler, but if the collected DISTILLATE is blue, (and probably ammoniacal, but not always), the wash should be acidified!*

> *Turbos contain a lot of nitrogen-containing compounds, and at neutral to high pH, these can liberate free ammonia. At low pH, they are bound up with the acid as salts, and do not liberate ammonia. So, by adding nutrients to an already nutrient rich turbo, you can inadvertently push the mix over the line and get ammonia with your distillate.*

Using a Pot Still

A pot still is fairly straight forward to use. Turn it on. Once the temperature is up to about 60 &degC turn on the cooling water to the condensor. Make sure you throw away the first 100 mL per 20L wash, as this will contain any methanol that might be present. Segregate the distillate into 500 mL lots as it comes off. Only keep (for drinking) that which doesn't contain fusels (smell off) - probably below about 92 ° C, however you should keep distilling past here, untill about 96 ° C, as this fraction, although high in tails and not good for drinking this time, can be added back to the next wash and cleaned up OK then.

Graham describes using his ...

> *I single distill as I have no need to purify my spirits. The concentration at the top of the tower can be controlled with how much heat i apply at the bottom. If I want a pure spirit, I apply a low heat and can run it off at over 90%. with a bit of a twig I have hit the magical 97.5%. But you get utterly no flavours. I apply more heat, so I get a run at about 70 to 80% and get the flavours I need. Its true people, about about 80% you start to lose flavours.*
>
> *I normally cut my runs when the alcohol drops to about 40%. The heat put in compared to what I get isn't worth it.*
>
> >How do you judge the "cut points" for foreshots and feints ?
>
> *Ah the terms they use for this "firsts and lasts", "Heads, Hearts and tails". for those who dont know, The flavour of any spirit come from a wealth of compounds, alderhydes, amy alcohols (fusal oils), esters, acids and even methanol. The desirable ones are commonly called congeners. The art of any distiller is knowing when to start collecting the heart and stop it again. Start it too late and stop it too early, and you collect mostly pure ethanol and no flavours. Start too early and stop too late, well you make something that will have a lot of flavour, but will give you ripper*

> *hangovers, could even kill you.*
>
> *The art is to collect enough of the congeners in the last of the head and beginning of the tails to get the flavours, but not enough to make it undrinkable. You do this by watching the thermometer at the top of the still. When the firsts start, it will sit at 65C-70C. This is mostly methanol coming off. This you dont want. Then it will suddenly rise as all the methanol is removed. It will rise to 78-low 80s (depending on heat and what you want).*
>
> *This is the heart. Now for a good rum, you want lots of flavour (and the headache with it) so you start collecting as soon as it starts to rise. For a whiskey, I tend to collect when the temperature hits 78C. For clean spirits, I wait till the temperature stabilises. The same occurs at the tails. The temperature suddenly heads for the 90's, and thats agian when you decide to cut it as the higher alcohol start to evaporate and collect. This I do by the the highly accurate method of tasting it.*

The Omnipresent Mecakyrios advises how he uses a Doubler with a pot still ...

> *Here is what I have done in the past when using a doubler:*
>
> *I would fill the boiler to the normal capacity with my wash. I would fill the doubler 1/3 full with wash as well (sometimes I would put in 50/50 wash and neutral spirit in the doubler). I would run my batch. If I still had another run to do that day I would throw our the spent wash in the boiler, fill the boiler with the new wash to be ran, add the liquid that was in the doubler into the boiler with the new wash, fill the doubler with new wash adding to it the tails of the run that I had just finished, and start the run. I keep doing this until I have no more wash to be ran.*
>
> *At the end of a day's run, I toss out the boiler and doubler liquids. I keep the tails until my next run. Sometimes, if I have patience enough, I will store the distillates of that days run and add them to a previous run's distillate. In other words, let's say that a month ago I did a run and had collected one unit of distillate from the first run of the day, a second unit from the second run of the day and a third unit from the last run of the day. I will combine all of the units together and mix them up real good. I will then take one unit worth of distillate and set it aside. I will*

> *take the remaining distillate and put it into a container and label it with the date. The unit that I had put aside is for me to drink while I wait for a whole month to go by. Then let's say I did a run today and had collected three units of distillate. I will combine these, put one unit worth aside and add the rest to last months run. I will continue to do this until I have a month of down time.*
>
> *During the down time I clean out the still real good and take the bottle of several months worth of distillate and draw of one unit worth for me to drink, the rest of the several month collection is bottled, sealed, labeled and stored away and forget about it until a special occasion happens when a good aged product is called for.*

Jack writes ...

> *I use an enlarged ice water/wok type of still, so a thermometer cannot be used- I just go by volume. With a mash starting at about 5 to 10%abv, do the first run, and collect 1/3 of the total mash volume (I.e. Put 3 gallons of mash in the still, keep collecting until you get one gallon out of it). On the second run, I collect one fourth of the total I put in. I.e. distill 2 gallons (8 liters) of low wines, keep collecting until I get 1/2 gallon (2 liters). I also collect heads on the second run at a rate of 150ml to 200ml per each five gallons of (starting) mash volume. Making sure a thermometer is reading the same every time I do a run was too much of a hassle.*

Scrounge adds ...

> *I don't bother with temperature - I used to but after a couple of runs I discovered that relying on the thermometer lead to rather unpleasant off notes.*
>
> *My still is 6l, I usualy put in a 3l wash (or 1.5l if it's a lumpy fruit wash), I discard the first 10ml and then put a jug under the outlet, every 50ml I swap jugs and transfer the spirit to a bottle. I sit there with a shot glass, a spit bucket and a glass of water and every so often I collect a few drops from the outlet and taste. It's up to my tongue where I stop collecting.*
>
> *Big tip - before mixing fractions try mixing a small quantity separately - some fo the later fractions have a bad habit of suddenly clouding when*

> *added to the earlier.*
>
> *My final ABV - using a set of volumetrics in the lab is 60% on the first run, for Eau de vie I don't often do a second run but sometimes I will add all fractions from previous runs to last was and collect that with a lot of care.*
>
> *If it's relevant my lyne arm is 1m long and has a slight upward incline.*

Jack uses a combination of freezing and his potstill, to maximise the flavour ...

> *I found by trial and error the flavor on "double run" whiskey wasn't as good as single run whiskey (although I got less whiskey doing it that way-tighter middle cut). Instead of running my still twice, I now use the technique that was/is used to make apple jack.*
>
> *I take my 5 gallon batch of mash/wine, and I fill 10, one gallon milk jugs half-full (one half gallon being 2 quarts) of the liquid. I then put these jugs into the freezer for two or three days, until they freeze into a solid block of ice. I then set the jugs upside down on a one quart canning jar. The alcohol will drip out as the ice melts (don't add any heat- let it go at it's own pace). When the one quart jar is full, I put the liquid (in the jar) into my carboy to let the yeast, etc settle out overnight. The block of ice in the jug is washed down the drain with hot water- there is no alcohol in it. Since the alcohol melts faster than the water, it tends to come out first- so instead of 5 gallons of 7-10% mash/wine, I now have 2.5 gallons of 17-20% mash/wine.*
>
> *It takes no real effort on my part, but gives the same results as a beer stripping run, roughly doubling the alcohol content by cutting the volume in half. It doesn't stale the flavor like distilling can do at all, quite the contrary, it makes it stronger- this same method is used by some winemakers to make fortified wines at home (like port, sherry, etc.), without using distilled spirits. By cutting the volume in half, and doing it by freezing, not distilling, the flavor is preserved a little better, but the alcohol is high enough that a spirit run can be done. It typically takes one to four hours for the quart jars to fill up- it depends on the starting alcohol content- the lower it was at the start the longer it takes to melt out. It saves a lot of time for me, since I have a lot of freezer space.*

> *When I make my malt whiskey, it used to always foam over in the still- by freezing it like this, then diluting the mash back to 5 gallons with water when I put it in the still- the starches causing my foaming problem have been diluted to the point that they can't lace together and foam up in the still. In the potstill, it just saves me 4 hours of work on an extra run. While the stuff is melting, I check my e-mail, work out, read, or whatever I feel like doing that I can't do when running a still, because that requires all my attention.*

Bill writes ...

> *I have clear tubing from pot to worm and can see the vapors forming, so I know when to start cutting back on the heat, as soon as it starts to run I toss the first 100ml or so then just fine tune the heat so that I get a slow steady stream, run it down to 40% collect the bottoms for the second run, dump the lees and start another run.*
>
> *I usually run it through at least twice and usually three times to get it as refined as possible. No hint of fusel oils at all, as proved by drinking it in massive quantities all one night with absolutely no hang over the next day. I use a propane camp stove to heat the pot as i find it has greater control capabilities.*
>
> *I have been trying the hyper yeast from Gert Strand, am not impressed with the results, a little too yeasty in the aftertaste, could be something i've done wrong, but tried three batches with basically the same result. I will probably go back to using my old receipe for base whiskey, 2 cans of frozen orange juice, 2pkts champagne yeast, 4kilos white sugar and water to 25 litres; you can then feed the resulting mash as the gravity drops till saturation.*
>
> *Tried a rum with fancy molasses 1 gallon 2 yeast water to specific gravity that appeals to you and your yeast, had a friend that works for a distillery, he went on a junket to pourto rico, where they have a distillery, he brought back a bottle of their finest, we did a blind taste test and couldnt tell the difference. Of course after several more taste tests, we couldnt have told the difference from dish water, needless to say I didnt let him drive home as he would have blown the ass off a breathalizer.*

John gives his views ...

A potstill is a direct descendant from the medieval alembic still favored by alchemists, and often shown in old woodcuts. The alembic still was a cooker or boiler with a small conical lid with a sideways protruding tube. Its curving form causes it to be named "swan's neck". The latter led into the cooling coil which sat in a waterfilled vat. The modern potstill has a column (variable length) inserted between the cooker and the swan's neck.

In terms of the modern reflux column which, even in our amateur hands, can consistently deliver 95-96% pure spirit, the pot still is very inefficient. It delivers only impure mixtures of ethanol, water, and congeners. For that reason one usually double-distills (redistill) the wash - the first time delivering a distillate at ca. 30-40% abv, and when re-distilled raises this to 70-80%abv. Even then the product still contains congeners in addition to the ethanol. However, it are the congeners that impart the flavour of the grain or fruit. And most of these come from the 'tails'. As Ian Smiley puts it, the tails 'bleed' into the middle cut. While the reflux still can produce mind-stomping purity, the pot still must be run with a sense of art.

> Why double distill? The abv would be right on from the first run (35-40%). Is the first run still too harsh to drink?

One double distils to increase the alcohol content, but more so to concentrate the congeners. Note that in pot stilling the focus is on the 'also-rans', the congeners, and not on the alcohol!! The pot still is all about flavour. The first distillate from say a malt / barley run is insipid, but better than the wash was. However, when that distillate is run through again, and more water is discarded, the congeners are further concentrated. The final taste of a single malt whisky is likely about 70% congeners from the wash, and 30% from the cask wood.

The art lies in knowing how much of the congeners to allow into the middle cut.

Cut-off point? That depends on one's sense of taste, and on what sort of whisky or brandy one wants - highly flavourful, just right, or overwhelming. Ian Smiley devotes several fine pages on this point - viz. pp. 72-74. (Making Pure Corn Whiskey. 1999. ISBN 0-9686292-0-2;

> *http://www.home-distilling.com/) . It is a matter of deciding how much of the tails one collects into that middle run.*
>
> >What are your feelings on the notion of increasing the sugar content in a berry based wash by adding sugar ?
>
> *I suppose that depends on which is desired - fruit flavour or ethanol strength. One could argue that blended scotch whisky is in fact sugar based, as a blended whisky is a mix of single malt whisky and grain alcohol, where the latter is highly purified grain distillate, devoid of grain taste. Just the opposite, in eastern Europe slivovitz (plum eau de vie) is double distilled from soft ripened plums, often weeks old, left to ferment in tubs with natural yeasts. Now, that distillate should be plenty flavourfull but in some regions more ripened plums are added to the distillate to further enhance the plum flavour.For me, it is all about flavour, so I go for the fruit or grain.*

Michael writes about distilling a wash made from beer kits, to make whisky ..

> *Coopers Lager comes out very much like a scotch whisky.... There are also malt extracts available at any home brew shop that can be added. Both liquid and crystalline form. These are for use in beer brews, but will make the transition to distilling just as well. Putting two beer kits into the brew keg makes for a stronger flavour too.*
>
> *I do a stripping run first. Reflux down as low as possible. I have a still spirits still which I have modified into a compound still. I have the original head and a second lid so that I can use this as a basic pot still. The short column originally had a cooling jacket and a marble. I have disconnected the jacket and removed the marble.*
>
> *Final cut point is a matter of taste and flavour. I am generous with it at this stage since I am going to do a second distillation and can be more picky there.*
>
> *I don't seperate out any heads from the stripping run. The reason for this is that I then stick it into my compound head, water it down and bring the still to full reflux. I let this stay for an hour, and then take off my heads as normal. Once I have got the heads out of it, I turn the still off and let it cool. Then I run it through the pot still again, taking more*

> *care that the final cut point tastes good. Water back to 50% and oak. Voila!*

Stripping

Pot stills can be used to "strip" the wash, prior to a reflux distillation. By passing the wash once through a pot still, it will be increased in purity from say 10-15% up to 40-60%, reducing it in volume by 4/5th. This way, you can strip say 100L of wash down to 20L of semi-clean spirit to then load into the reflux still for a single pass (rather than having to do 5 reflux passes of 20L of wash). This will not only save you plenty of time, but it will also help result in a somewhat cleaner spirit, as any yeast, etc get removed during the stripping run. You could also use a reflux still to do the stripping in, by simply not making it reflux any of the liquid.

When you do your stripping run, it can be beneficial to add some sodium bicarbonate (baking soda) to the first-run alcohol, prior to the second ru n. As explained up in adding salt this will help clean up the taste greatly.

Mike explains the chemistry ...

> *Has anyone stopped to wonder where all that sodium in that baking soda goes when it's done its job of turning ethyl acetate into booze? Indeed, where all that ethyl acetate has come from in the first place?? Have those who advocate boiling right after adding baking soda stopped to wonder what happens to the stuff when it is boiled in water???*
>
> *Taking the last first, if an aqueous solution of sodium bicarbonate (baking soda) is warmed then it starts to decompose with the formation of sodium carbonate, water and carbon dioxide, the decomposition being complete on boiling. Good grief . that's why Granny uses it for her soda bread. The carbon dioxide leavens it! The reaction is: 2Na.HCO3 = Na2.CO3 + H2.CO3 [and H2CO3 -> CO2 + H20] [water + sodium bicarbonate = sodium carbonate + carbonic acid + lye] and the carbonic acid further disassociates to form carbon dioxide and water, particularly when heated [H2.CO3 = CO2 + H20]. Add tartaric acid and you have a quicker reaction with more CO2, and you then call the stuff baking powder which Granny uses to make her nice light scones.*
>
> *Working back a bit, where did all that ethyl acetate come from? Well, we all know about vinegar (acetic acid, a fatty acid), and that a 'dirty'*

ferment or a bruiser of a fast yeast can result in quite a bit of that. What may not be generally known is that fatty acids react with alcohols to form esters, and acetic acid and ethanol get together to form ethyl acetate which is . you've guessed it . an ester with the composition C2H5.COOH

So now we add baking soda (sodium bicarbonate) to try turn all that that ethyl acetate, which started out as vinegar, into booze. Why bicarb? Well, although it's an acid salt of carbonic acid, it turns out that in an aqueous solution it's alkaline, due to hydrolysis. The Na.HCO3 disassociates to form Na+ and HCO3- ions, and the H+ ions from the water (H.OH) combine with the HCO3- ions to form undisassociated carbonic acid H2CO3. This leaves heaps of Na+ and OH- (hydroxyl) ions mooching around . and those two together spell sodium hydroxide . a strong base. So what happens when these ions bump into ethyl acetate? The sodium ion grabs hold of the COOH bit to form NA.COOH, sodium acetate, and the hydroxyl ion grabs the C2H5 bit to form good old C2H5.OH, booze!

But hang around a bit! What happens to all that sodium carbonate [NaCO3] that was left behind when the baking soda disassociated? Well, it's quite handy because it too disassociates in an aqueous solution to form more carbonic acid and lye, with an excess of hydroxyl ions floating around [Na.CO3 + 2H.OH = H2CO3 + Na.OH + 2OH-]. Now this deals to any excess acidity you might have, the OH- ions grabbing acid H+ ions to form water. Not only do you get more Na.OH for conversion of acetate to booze, but the solution is buffered to a pH of just over neutral 7.

This gives us the clue that oyster shells or chalk [CaCO3] will do the same thing, and will also work to convert ethyl acetate to booze as the stuff disassociates in the same way [Ca.CO3 + 2.H.OH = H2CO3 +Ca.OH + 2OH-]. In this case it's the Ca+ ion that grabs the COOH bit of the ethyl acetate to form calcium acetate [Ca.COOH] and the hydroxyl ion grabs the C2H5 bit to form what we're after . C2H5.OH, booze. The only thing to consider is the relative solubility of baking soda compared to chalk, but those who use hard water to dilute their strippate may be on a winner!

Now those who haven't fallen asleep already will be wondering why they

> *can't just add a good dose of lye (Na.OH) to the brew and be done with it. Snag is, how do you know when enough is enough? Put too much in and you have a surplus of lye in the brew, and nothing to counter that. Keeps the boiler clean, but corrodes the hell out of it. In contrast, by using baking soda or oyster shells/chalk you end up with sodium/calcium acetate, and that is also a pretty good buffer, like the sodium/calcium carbonates.*
>
> *Much too has been made about how long this treatment takes. What has to be borne in mind is that it is a relatively slow reaction compared with inorganic reactions that go at the speed of zip. So all it comes down to is how impatient you are. Some might argue that heating the solution up will speed the reaction as it will hasten the formation of the carbonate. Well, they may have a point . up to a degree. However, just remember what happens when you boil hard water . the carbonates are precipitated out, as anyone in a hard water district will know from scaled pipes and kettles. Chuck the bicarb or shells/chalk in and boil immediately and you will get very little conversion, leave it for a couple of months and can be sure you've done the job fully. Similarly, chuck citric acid in and you will stop the reaction dead in its tracks as it will neutralise the bicarb/carbonate treated solution (each citric acid molecule has no less than three H+ ions to give up . hence its use in scented "bath bombs" to get all that luxurious, soft water that keeps the bubble bath foaming). My money is in listening to those who have achieved very good conversion of the bulk if the ethyl acetate by giving it a week or so to work before distilling.*

Mike lists three advantages for stripping runs:

> *a) Rapidly boiling the wash and condensing everything that is vaporized, without bothering to separate the heads and tails, is an easy way of reducing the volume of liquid you will subsequently process with care, saving a lot of time overall*
> *b) The reduced volume of liquid you get from a stripping run is clear of all solids, salts and dissolved gases.*
> *c) The liquid you get has a very much higher concentration of volatiles, enabling far better separation in the subsequent rectification run as you start out in the middle of the equilibrium chart (the one that plots the concentration of volatiles in the vapor against their concentration in the*

> *liquid the vapor came from ... the one that looks like a fat cigar leaning at 45 degrees)*
>
> *In essence, it is much easier to clean a muddy kid after a football game if you first give the brat a quick hose-down to get rid of most of the mud, and then then shove him in a clean, hot bath with a cake of soap with instructions to wash behind his ears, than it is to try and do it all in a bath full of muddy water. Whiskey distillers, who have to tackle the difficult job of dealing with a mash full of solids, first concentrate on separating the low wines from the mash in a big still, where the only problem is to prevent burning, and then move on to a smaller still where they concentrate on getting the right cut from the clean low wines. Experience has taught them that this is a very effective and efficient procedure that results in a much better product than if they tried to do the whole job in one go. It is definitely well worthwhile.*

Peter adds ..

- *You can save up many batches and dedicate a whole day to run the whole lot properly in a reflux still. if you collect 4x25 litre batches you will only have to collect a bit more heads and tails than if you ran just a single 25litre wash. but you collect much more of the middle "drinkable" cut. also if you save up the batches you probably wont need to dilute it back down to prevent elment burn out.*
- *You dont need much care and attention when doing stripping runs. i leave the still running and check it every 15mins or so. i collect everything.*
- *If you dont have time for a reflux run you can strip a wash. this is useful if you dont want an uncleared wash hanging about for a month or so waiting to be contaminated.*
- *You dont have to worry about foaming or nasty smells getting into your prized reflux column. since the stripped wash is relatively pure you wont have to clean the column as often/carefully. i leave my stripped wash sitting on carbon.*
- *For me, electricity is cheaper than finings*

So, to do a stripping run, either use a pot still, or a reflux (but with no reflux generated). Fire it up, and run it as hard & fast as possible. No finesse required. Quit collecting the spirit once the vapour temperature reaches 96C. When you go to redistill this product, properly, you only need to add water if there will not be enough liquid left at the end of the run to safely cover any internal elements.

DP writes more on this, and how it can be used to clear up heads ...

Carbon and methanol (snore) have had more than their share of posts in this newsgroup. Esters, on the other hand, are a subject that gets far less attention than it should. I feel there is too much focus on ethanol and water, and not the properties of the impurities we are really trying to remove. My still already removes more than enough water - I have to add water back before I use it's output so clearly removing water is not my main objective. Everything seems to hinge on the assumption that if your still is good at separating alcohol and water then it must be good at removing everything else. This assumption is loose at best and ignores the fact that with a little encouragement some of the worst impurities will remove themselves.

Esters are flavour compounds responsible for many of the characteristic tastes we know very well:

Propyl acetate (Pears)
Octyl acetate (Oranges)
Isoamyl acetate (Banana)
Ethyl butyrate (Pineapple)
Butyl acetate (Apple)
Methyl trans-cinnamate (Strawberry)
Ethyl cinnamate(Cinnamon)

(See http://www.leffingwell.com/esters.htm. There are many others and a web search will turn up many more if you're interested.)

Esters are the product of a reaction between an organic acid and an alcohol. Read the back of a wine bottle you'll see wine described as tasting of all sorts of different fruit (except grapes, of course because any fool can do that). Yeast, by its very nature, produces a range of organic acids and a range of alcohols during the fermentation process. These combine to form a range of esters responsible (along with other chemicals) for the flavours in wine that aren't in the original grape juice. This is where the interests of a winemaker differ from someone trying to make clean neutral spirits - winemakers see ester formation as desirable. Yeast makers even advertise their yeasts on how good they are at producing damn esters.

The problem with esters is that a little goes such a long way. Most have detection thresholds measured in parts per billion (ppb). Ethyl butyrate – the fruity pineapple ester listed above - has an odour detection threshold in water of 1ppb. As a comparison, ethanol in air has an odour detection threshold of about 50 parts per million (ppm). In other words, it's odour is 50,000 times more powerful than ethanol. For those of you obsessed by percentages, your distillate could be 99.9999999% ethyl butyrate free and you'd still be able to smell the damn stuff. Great if that's what you want, bad if you don't.

The ester of the most relevance to home distilling is ethyl acetate. Ethanol oxidises to form acetic acid. Acetic acid and ethanol react to form ethyl acetate. It's no real surprise that you are going to end up with some of this stuff in your brew - yeast puts it there. The good news is its odour detection level is a relatively high for an ester at 5000 ppb (or 0.0005%); the bad news is it has a nasty solvent-like smell you're probably already familiar with. And there's more bad news…

By itself, it boils at 77 degrees, which is pretty close to the boiling point of ethanol. It forms azeotropes with both ethanol and water, and another when all three of them are mixed together (although all at mixture ratios you are never likely to see). I have heard many claims that ethyl acetate can be effectively removed by a still. It's more correct to say that using a still, a good operator can separate the ethanol that contains ethyl acetate (the heads, etc) from the ethanol that doesn't. To me this is not "effective" as the heads contain far more ethanol than anything else and I make ethanol to drink and not tip down the drain. As I said, stills are great for separating alcohol from water, but that doesn't make them the best tool for every job. Removing ester-related flavours with a still has all the finesse of opening walnuts with a sledgehammer. The secret is knowing your enemy:

Food is acidic. Just about everything we eat has a pH less than 7 (See http://www.phsciences.com/about_ph/ph_foods.asp). Acid inhibits bacteria growth and is the environment in which esters are formed. The chemical reaction that produces esters, however, can be reversed – when taken out of an acidic environment esters hydrolise back into the acid and alcohol from which they were originally formed. This is why food acids are so often added to preserved food – it helps preserve the *flavour as well as preventing spoilage.*

Ethyl acetate is formed during fermentation. After distillation it's no longer in and acidic environment and starts to decompose back to ethanol and acetic acid. Acetic acid gives vinegar its characteristic taste and although pungent, it's far less detectable than ethyl acetate – not great, but less bad. As decompostion produces an acid it tends to slow the rate of further decomposition, but eventually it does happen. If you have the time, people have been getting good results from sticking alcohol in barrels and waiting a decade.

If you don't have the time then don't worry lots of things can be used to speed up the process: agitation/aeration, light (called photodecomposition) do this. The resulting acetic acid has a boiling point of 118 degrees C so it's much easier than ethyl acetate to separate from ethanol in a subsequent distillation. If you add some mild alkali (sodium bicarbonate, sodium carbonate or calcium carbonate) into the mix you can speed up the decomposition time and also precipitate out the acetic acid. By adding a couple of teaspoons of sodium bicarb to your nastiest smelling heads and aerating them with an aquarium pump and air-stone for a week you will end up with something that smells OK. Not quite good enough to drink, but more than good enough to redistil.

This is the real way to solve the ethyl acetate problem – not by pouring your (mostly ethanol) heads down the drain. You get to recover all the ethanol that the ethyl acetate had spoiled and (the really elegant part) some of the ethyl acetate is actually turned back into ethanol. The point to remember is the same process will reduce all ester-related flavours, and not just ethyl acetate, including the ones that exist in immeasurable, but still detectable quantities. You don't even need to know what esters they are!! They all breakdown into different components, which you may not particularly want either but will all have less impact on overall flavour than the original ester.

Once I learned this I changed my process to double distil everything. After the first distillation I throw in some sodium carbonate and aerate for a week before distilling again. I don't separate the heads from the second distillation because there's nothing to separate and the result doesn't need carbon filtration. More importantly, nothing I boil off ever

> *goes down the drain - not a single drop. My end-to- end efficiency from sugar to drinkable spirit is 90% with the cost of consumables and wastage very low. Plenty depends on your ingredients, equipment and process, but you get the basic idea.*

Alex adds more information:

> *Chemical Cleansing Fresh Home Made Alcohol*
>
> *This is a free type translation/interpretation of a freely available material found on web pages dedicated to production of alcohol at home. There are no claims of any kind for this data.*
>
> *The first chemical reaction of saponification binds fusel oils and makes it insoluble. In order for this reaction to work, alcohol must be tested for pH. If reaction shows that home made alcohol does contain dissolved acids then regular baking soda should neutralize the reaction. The proportion is 5g~8g of baking soda per each liter of alcohol.*
>
> *After adding baking soda and stirring it well, potassium permanganate is added. Potassium permanganate should be dissolved in small quantity of clean water beforehand. The ratio is 2g of potassium permanganate dissolved in 50 mL of clean water per each liter of home made alcohol. The mix of alcohol, baking soda and potassium permanganate is stirred well and left alone for 15~20 minutes for reaction to finish.*
>
> *After this stage is complete, additional baking soda is added to the mix in the same proportion as above, stirred and left alone for 8~12 hours for precipitation of solids.*
>
> *Next day any sediment is filtered and alcohol goes through the second distillation. This method of removing fusel oils is rather efficient and removes up to 95% of its content.*
>
> *After the second distillation, home made alcohol is slowly filtered through activated charcoal.*

Double Distilling for Whiskey etc

Here we try to replicate the traditional style as used in commercial distilleries world wide. See Making Whiskey - A Personal Experience by Roger Dowker for a detailed description of the commercial process, including when the various cutoff points are.

The trick to this appears to be the stuff legends are made of, and closely guarded by those who know. It's the matter of how much of the first condensate, or foreshots, to discard and how much of the middle cut to keep before discarding the last runnings, or feints.

Steve writes that its difficult to do this by temperature alone, nor to have a single set of guidelines ...

> *The cut points have to be determined either organoleptically (by taste or smell) which takes experience, or by vapor temperature. The wash itself varies too much (say between brandy and whisky) in levels of fusels, esters methanol and other volatiles to make any simple volume rules across such a wide range.*

For the various %'s at which to do the "cut", Donald advises to use a great hydrometer with 0.5% or greater calibrations for best results, and suggests ...

Mash	**First Distillation**	**Second Distillation**
Grains	to 18% (98 &degC)	85%-58% (80.5 &degC - 92 &degC)
Fruit	to 25% (97.5 &degC)	85%-60% (80.5 &degC - 91.5 &degC)

When about 2/3 - 3/4 of the way through the middle run, and approaching these cut points, start collecting the spirits in smaller collection containers, and smell each of them seperately. The flavour will change from that of the neutral spirit, to more and more of the flavour coming through. This will intensify, but then start to become bitter. You need to work out when to make your "cut" during this period, but do so before it gets to the bitter stage. After making the cut, keep collecting (seperately) the feints up to about 92 &degC, and add these to future runs.

For a reasonable whisky without the long term maturation try this :

- Brew an all grain or malt extract wash using a good yeast like turbo, hyper or one of the wyeast family. Go for no hops and don't add sugar.
- When attenuated, load the wash into your POT still or DE-REFLUXED reflux still with the feints (see later).

- Run out about one third of what you loaded in, as "low wines". Different distilleries tend to get between 18-25% on these.

Repeat the whole exercise several times until you have enough of the low wines to fill your still. (Commercial distilleries get around this by using a smaller still for the low wines).

Load the still with the low wines and set it going.

- Throw away the first 200 mL. These are the "foreshots", containing methanol as well as other low boiling point compounds. You need to discard more than the usual 50 mL, as pot stills are less discriminating then reflux stills. Watch this run with more care than before - it will proceed quite a bit faster !
- The next 5 litres is the good bit that you're after (approx 75%, stop when getting below 60% ? - this is the trade secret of distilleries, as it determines the taste of the distillate). Update ! - see Donalds recommendation above of 58% for grains and 60% for fruit.
- The following 10 litres (the "feints") - save and put back into wash run next time.

It's this re-cycling of the feints each time that does the magic, as they contain the higher alcohols (fusel oils), and esters.

You can now take the 5 litres, flavour it a little bit, put it in a small keg or flavour it with some oak essence. If kegging cut with water to around 40% or the angel's share will get too much. Don't charcoal filter or polish this spirit, as all the tasty bits you've just worked so hard to obtain will go too.

In theory, lets say I was the distiller at Ardberg with one wash still and one spirit still, I would run all the spirit out of the washstill as low wines, load this into the spirit still and run foreshots, high wines, with a cut at betwixt 65/60% then the rest as feints down to X %. The feints could then go back to the wash still or spirit still for the next batch. If I were at Ardberg, I would probably run them back to the wash still.

In order to get congeners, as opposed to a neutral profile it is important not to have a definitive reflux device in the steam path - enough refluxing will occur within the headroom, the "roof" of the still body, the lyne arm or equivalent. Make sure the still is only filled to about the three quarter mark.

As the weather becomes hotter and hotter in the southern hemisphere pot distillers put less wash in the body of the vessel thereby allowing more head for particulates of the solid variety to not be entrained [carried over] into the distillate. If you have variable control throttle back a bit.

Jack adds regarding the tossing of heads...

> *Typically, you only throw away the first 50 to 100ml on the second distillation, not the first. Because of the higher alcohol concentration, the methanol will be more concentrated as well. This makes getting rid of all of it more likely on the second run.*

Jack compares the cuts ...

> *The "middle cut" proportions that are listed in Ian Smiley's corn whiskey book mathmatically conform (almost exactly) to the yield data I sent you out of that Japanese Scotch book - About a 57% middle cut.*
>
> *I also learned that these "middle cut" numbers are good for any volume, and any still- I have made a corn whiskey and have "made the cut" according to Ian Smiley's numbers- but I did this with an ice-water-wok still, and only 2-liters of freeze-concentrated mash (equal to 4 liters unfrozen). It comes out to:*

Foreshots	23 ml	(3.1%)
Heads	130 ml	(17.4%)
Middle Run	428 ml	(57.1%)
Tails	168 ml	(22.4%)

> *all adding up to the 750ml bottle I normally get of pretty rough stuff out of this still. Just by applying the middle cut numbers, I get just over half as much- but it is a LOT better.*

Jack adds ...

> *[for typical scotch] ... The beer still is loaded with 100 volumes of wash at 8%abv, this is distilled until you get 35 volumes of low wines at 20-23%abv. You will then mix 22 volumes of feints (from a previous distillation) at 28-30%abv, giving you 57 volumes at 23-25%abv, which you load into the spirit still. You then distill the low wines, collecting the fraction coming over at 75%abv (methanol is thrown out, anything from*

> *the initial starting % down to 76%abv is tossed into the feints tank), and you stop collecting at 55%abv, giving you 11 volumes of spirit at 68-70%abv. Anything that comes out of the still at below 55%abv is saved, and thrown into the feints tank. In the first distillation you should be left with 65 volumes of "pot ale" at the bottom of the still with less than 0.1%abv to be sold as high protien animal feed. In the second distillation, you should be left with 23.5-24.5 of spent lees at less than 0.1%abv, that is diverted to waste water treatment.*
>
> *By the way, even the Scotch distilleries are now admitting that yeast strain makes a difference in the spirits' final flavor. They figured this out after a couple of research chemists at a distillery made a batch, then filtered ALL the yeast out, and distilled it. After comparing the resulting spirit with regular (unfiltered mash) spirit, they found (under liquid chromatography), that the yeast has a BIG influence on flavor due to the long chain fatty acid esters that are found in yeast do distill over into the spirit- this is, in fact, the cause of cloudiness in spirit thats been run through a potstill only once, not the heavy alcohols as was once thought.*

Jack also adds about Glenmorangie...

> *They take only 1/5 of the second run as middle cut spirit- the numbers I posted are for the more common 1/3 middle cut- sorry, all of those wanting Glenmorangie should work just like [above], but only collect 6.6 volumes of spirit, after the heads are thrown out, and the >76% fraction has been sent to the feints tank, other than that, it's the same. This should average a final spirit strength of about 70%abv, and your Glenmorangie cutoff point should be when the spirit coming out of the still drops to below 65%abv.*

Using a Water Distiller as a Pot Still

If you want, you can use the commercial water distillers as pot stills, though they're not really the best for it. But it can be done. Make sure that you turn it off before collecting the tails - dont just let it distill all the brew you put in there, or else you'll simply end up collecting it all again. (The Kenmore still is a water purification unit marketed by Sears. It is complete and self-contained, with its own carbon filter. The brief description can be found at http://www.sears.com)

Steve explains his technique :

He uses the Kenmore water distiller : http://www.kenmorewater.com/productlist/no-plumbing-drinking-water-systems/34480.html

I'm not sure how accurate this method is, but what I do is discard the first 50 mls of heads.. Then I collect enough total liquid such that I stop when my spirit hydrometer indicates it has reached about 48%. Probably could go down to 45% but I don't want much tails at all so I stop a bit early at around 48%. Basically I collected the first 500 ml, and then the next 50 ml thereafter and found that the tails and taste started to get bad at about 850 ml, so I stop at around 600 ml, which in this case came out to be around 48%. Not exactly precise, and possibly leaving some good stuff behind, and may differ depending on the alcohol percentage of what I'm distilling, but on the whole once you've got it figured out for the first time for a particular mash it is totally painless to use. Since the quantity of fluid I put in there is also very known, it is easy to get it down to a science and just use a timer.. Like 35 minutes to the point where the heads start coming out of the distiller, and then 47 minutes of collecting the spirit, which then yields a known quantity of liquid. After you figure this out the process becomes very easy and reproducable.

There are a few different models of having different sizes so these numbers won't be the same for every Sears/Kenmore water distiller.

Since the quantity of liquid is small, and you're not using an open flame, it's probably a bit safer too than operating some stills.

Still Spirits also has some instructions on how to use it.. Called distilling with the Sears Water Purifier. They just suggest to collect certain quantities of liquid based on using their known alcohol percentages of their yeast/nutrient/sugar combinations.http://www.stillspirits.com/instructions.htm

Tom writes ..

I discard the 1st 50 to 75 mL each time and then monitor the ABV closely. I seperate tails at about 48% and have begun collecting them for a seperate run when I get enough. After I've collected all my "hearts", I run them again together to a higher %, cutting this time at about 60%. If I'm doing a sugar wash, I'll then carbon filter.

The product seems fine. It may not be as excellent as the 90+% you get with a more extensive set up, but it works for me. I've produced a drinkable Brandy from wine, I've added essences to sugar washes with good result, and even done my own alchol extractions creating a nice Ouzo/Anisette. It does take many runs to do a 5Gallon batch, but it requires little monitoring once you get the timing down.

A couple of pointers for those interested:

Watch the amount of wash you try to run. My unit is supposed to take 3 quarts, but the most I can really do is closer to 2.5 because of boilovers. The amount of residual sugar in your wash has a great effect. I tried to run a failed beer, and it would boil over (boil up into the condeser) at any thing over 1quart! I ended up dumping 8 gallons of beer into the garden...)

I added a small amount of copper to the vapor path by attaching a copper pipe "elbow" stuffed with copper scrubber to the rubber/vinyl inlet hose on the lid of the unit. I don't know if it helps, but I figure it can't hurt.

Using a Reflux Still

The alcohol coming off a reflux still will be more distinctive / occur in steps. Rather than a gradual increase in temperature over the coarse of the run, it will get up to certain temperatures (near those listed above for pure fractions), then tend to sit there. The alcohol coming off will be of a fairly steady purity right through, only dropping off late towards the end. You'll probably finish a reflux run at a lower temperature (say 92-94 ° C) than a pot still (say 96 ° C.

For example, my StillSpirits 20L reflux still takes about 1 hour to heat up, then once it gets to about 40 ° C, it then heats up pretty quick to 65-70 ° C. It will then sit there for around 5 minutes, and the first liquid (distillate) starts condensing. After about 5 mL of distillate have collected, the temperature then starts climbing again, up to 80-90 ° C.(Note that these temperatures aren't exactly as in the table above. The water & ethanol form an mixture that boils at a higher temperature - as shown in the graph way back in the Theory section). It will then sit there for the next 2.5-3 hours, and I collect the distillate at the rate of approx 1L/hour. *(with my improved reflux still, it now sits steady on 78.2-78.4C for most of this period - eg 95% purity)* Slowly towards the end of this period, the temperature slowly starts increasing up towards 90-94 ° C. By this stage, my hydrometer shows me that the alcohol is only about 40%, and I've usually had enough, so I then turn it off. Total time 4 hours. *(with the new reflux still, I finish collecting at around 82C, as past there it deteriorates fast towards the rubbish - still 4 hours though)*

Likewise, finish distilling at 92-94 ° C, as you've basically got all the easy ethanol, and you're starting to collect the higher ends, heavy in fusel oils (the wet cardboard smell).

Rob has the following advice running a reflux still :

> *At the moment I'm trying to make wodka with a modified stillmaker still. I have just returned from the Czech Republic, where I have bought a bottle of Jelinek wodka which I am using as a reference w.r.t. taste and smell.*
>
> *To make it easier to achieve maximum purity I strip the beer first and I remove the first 100 ml to be sure the methanol is out. I stop distilling when the temperature reaches 95 Celsius regardless of the %.*
>
> *The low wines I have now are approx. 55% and I dilute this to 40% max. for the fractioning distillation. I slowly bring the low wines to the boil and keep the cooling water running at a high rate for maximum reflux at the top of the column. After a while I tune the cooling water until I get a steady drip from the condenser outlet; I keep the boiler at the lowest boiling rate possible.*
>
> *Every 100 ml I check the % and I put a few ml in a noser (glass) and I add the same amount of water; as soon as I detect a distinct smell of wet cardboard, I know I have to stop collecting the middle cut; the alcohol that comes after this point (not much if the fractioning was going well) is collected, and after a series of distillations I fill the boiler with these faints to collect the remaining ethanol. When checking the alcohol for wet cardboard smell, it is important to dilute the alcohol first to 30-40%, because the undiluted alcohol will not release the smell, and you will notice it too late when you are preparing your wodka, liqueur etc...*
>
> *You will notice, that the off smell will start to occur as soon as the temperature in the top of the column starts tending to rise above 78,5 celsius or the drip from the outlet starts to diminish and you need to increase the heat to keep the boiler going. Also the % goes down to less*

> *than say 92%. Don't waste your vodka now by trying to collect that little bit more !!! After a few runs, you'll get the hang of it; there is nothing better than experience.*

Ian Smiley's book "Making pure corn whiskey" http://www.home-distilling.com/ has very detailed instructions for using a reflux still or fractionating column for making whisky, by closely following recommended cut points (similar to those above); they can likewise be used for rums.

Using a Fractionating Still

The difference here is the need to really equilibriate the column at the start of the run, so that the methanol gets to accumulate at the top of the column, and to get all the packing in the column up to its equilibrium temperature so that it will work its best. This can take from 1-4 hours.

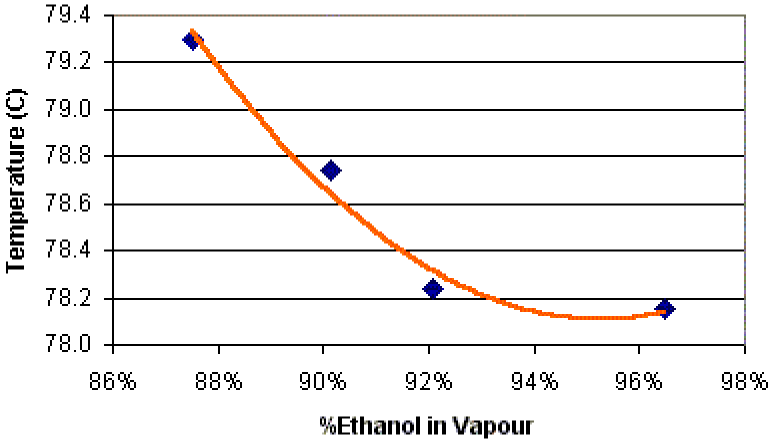
To get a fractionating still to work at its best also requires quite a high reflux ratio - returning 8-12 times back to the column vs that which is kept. To do this means knowing what the total rate is, then trimming the offtake valve to only take a portion of it. Do this by opening the valve fully and measuring how fast it is coming out, then closing down to only take what you should. Once you know this setting (say 1 drip per second), it will be the same for future runs.

If you have an 1800 W heating element, and you are collecting the distillate at 20 mL/min and at 95 %

the distillate flowrate would be mL per minute if you were to reflux none of it, but you presently have a Reflux ratio of

Using the collection calculator back up the page, you know how much alcohol you have to collect, thus it is easy enough to work out how long its going to take. You may figure that its not worth waiting quite so long, just to gain a couple of 0.? % improvement in purity. Experiment to find a reflux ratio that still gives you a suitable purity, without having to wait forever.

I control my still only by adjusting the reflux ratio. It will happily sit between 78.2 C and 78.4 C for most of the run with a low reflux ratio, but towards the end, the reflux ratio will need increasing more and more to hold it there. As this happens, change the receiving container, and keep the tails seperate.



Randy writes ...

> *The most important aspect of observing temperature is to make sure that you do not save any foreshots as beverage. Anything collected before the still head reaches 172 F (77.8 C) should be discarded or used as charcoal lighter. From there on you would be better off using your nose to detect if the heads are finished or not. Then experience will tell you when the tails start coming over. Some people save more tails into their product than others. This is according to taste. Of course everything I just typed about flavor is assuming that you are using a grain mash. If you are using a sugar wash, then the nasties that make you use carbon treatment are in the cogners.*
>
> *For me I let the still equalize in total reflux for 2 hours and then draw off the foreshots and then let it equalize for another 1/2 hour. Then I draw off the heads until I cant detect a foul smell. These I save and add to a container labled "faints". Then I distill the middle run and a portion of the tails. I run this phase until I reach 75 pct ABV. These are saved in my 'product' containers. Then everything else is distilled out until 65 pct and placed into the feints container. Then I distill everything else out of the wash that I can get. I stop when still head temps reach 205 F (96C) or so. Everything in this portion goes into a container labled 'redistill'. If you 'throw everything away' then you will be sending perfectly good ethanol down the drain. It might not be beverage quality right now, but it will be excellant stock to make a clear vodka from.*

Ken describes his technique ..

> *I usually strip 50ltrs and end up with around 18 ltrs @36-40%,this is from 2 fermenters of sugar wash,I then set up and turn on around 11pm and go to bed.Next morning the tower is in a state of total reflux and I start taking the fore shots off around 6-30 am,by 8am everything is coming over @ top % and I keep an eye on it and change jars every 2 ltrs and know when it is about time to expect the tails to start coming over. If you have unexpected guests arrive during the day I usually just turn the temperature down by 10 degrees or so and wait for them to go then turn it back up again and you are soon back in production,the same thing also if you haven't finished at night and you do not want to leave it running while you are asleep,just turn the temperature down by 10-15 degrees.I know a lot of our members will say I am mad for leaving the unit unattended but I have put a lot of effort into my control systems and am very confident in this setup,the next thing to add is a pressure switch that will turn off the power to the kettle if I have a cooling water failure.*

Rum from a Reflux Still

See the different recipes etc in the sugar based washes page.

Make the wash from diluted molasses. Arroyo recommends to split up the fractions out of a reflux still, and then recombine them. The fractions are collected as per ..

- First fraction - collect between 69-72 &degC at 91% - approx. 5% total distillate, unpleasant aldehydes, organic acids and esters. Discard.
- Second fraction, 72-77 &degC at 93-94% - 10% total distillate, contains ethanol with appreciable amounts of aldehydes and esters.
- Third fraction, at 78 &degC, 95.5%, largest in volume at 55-60% ,mostly ethanol with very small amounts of congeners
- Fourth fraction at 78.5-85 &degC , 90%, most of the higher alcohol's
- Fifth and final fraction at of 85-90 &degC at 25-30% - highest boiling point esters and aldehydes

Mix the fractions together as ...

- **Light rum** = 25% of the second fraction, 50% of the third, 40% of the fourth & 15% of the fifth fraction
- **Dark rum** = whats left (except the first fraction - that was all thrown away)

I don't get that fancy with my rum. I first equilibriate the column, and remove approx 50 mL of foreshots, one drip per second. Then I open it up, so that I'm collecting quite fast, and at around 82-84C (rather than my neutral spirits temp of 78C). I'll collect it all together, until the temp rises to about 90C. Anything after that is relegated to tails. I'm after a big hearty flavoured rum, so if you prefer it lighter, don't take it quite as high in final temperature.

Just like whisky, you can keep the feints, and add them to following batches, to improve the flavour you get. Tom explains ...

> *As for returning feints in rum, I do it all the time. I pretty much follow the same process as is outlined in Ian Smiley's corn whiskey book. I have found it makes a lot of difference. I was fortunate enough to trade the use of the brewery's forklift for 120 x 50# bags of raw sugar (sugar with a high molasses content). I use this with a Wyeast 2112 yeast (our house yeast at the brewery) and ferment it out at about 13%. This is about the limit of the yeast and I use more sugar then will ferment so as to leave a sweet wash. If I don't use the feints I end up with a pedestrian rum, but with the feints I create a deep and complex rum. If aged in oak I find it to be much like a dark, dry Cuban rum, without it is a tasty white.*

Jack disagrees ...

> *It doesn't seem to help the flavor any. It also makes the "middle cut" (if that's what you are trying for) a lot smaller. A no-feints added run gives 2 liters of 95% middle run spirit. With feints added- it becomes one liter of 95%. A better choice is to save the feints in a labeled container and run them on their own. The feints only run does tend have a slightly richer flavor (at least in malt whiskey and peach brandy). Best to save them to re-run on their own than mix them in to an otherwise normal (mash only) run.*

Foreshots & Heads

When making the "flavoured" spirits such as whisky, rums, or schanpps, theres always the question of exactly how much of the heads to keep.

Mike raises some questions ...

> *... commercial whiskey distillers make no distinction between "foreshots" and "heads". To them, these are simply different names for the same*

thing. Similarly, they draw no distinction between "feints" and "tails". Now these guys must surely know what they are doing, as many of them have been distilling whiskey for generations, so I just wondered if we might not be introducing distinctions that really don't matter.

After almost a week of searching through the internet and browsing through the local library, I've also learned that although whiskey washes contain methanol, resulting from the use of grain, not one drop of foreshots/heads or feints/tails is ever thrown away, but is instead frugally stored in the 'low wines' vat for inclusion in the next batch. It was also interesting to learn that the decision on when the foreshot/heads 'ended' and the feints/tails 'began' was entirely up to the still master, and that many distilleries included a fair proportion these 'cuts' in the middle run as they contain a lot of flavour compounds that they want in the final product. What also surprised me was how little of the foreshots/heads were diverted to the low wines vat, some distilleries starting to collect the main body only 10 to 20 minutes into a run. Considering the size of their batches, that's very little indeed! Perhaps they rely on long periods of maturation to modify the compounds they include?

The way the still master judges when the foreshots/heads 'finish' and the feints/tails 'begin was also interesting, as it is all done without the benefit of measuring the temperature of the vapor or being able to smell the product. It's all done begind glass in the still safe, and the traditional methods depend on measuring the density of the product (correcting for temperature of the liquid) and what is termed a 'misting' test. Many distilleries now use more sophisticated methods, but these two tests are still widely used. The temperature corrected density seems fairly obvious, but the 'misting' test was new to me, so I had high hopes that perhaps here was a method we could use. Essentially, the 'misting' test involves mixing a sample of the product with distilled water. The presence of foreshots/heads or feints/tails is indicated by the mixture taking on a faint milky cloudiness. Sadly, when I tried it on some heads and tails that I had set aside, I could detect no 'misting' whatsoever, so I reckon that it must be characteristic of whiskey washes that may contain much higher proportions of oils than we encounter with sugar washes. Any thoughts anyone?

> *Now, I'm NOT suggesting for one moment that anyone drinks either heads or tails! However, we may have been throwing away a lot of good ethanol when pouring the heads down the sink. Whether those first heads contain methanol or not (depending on the ingredients of the wash), it is apparent that they contain a very high percentage of ethanol. If, instead, we set them aside and added both heads and tails to the next batch – all of them, as the whiskey distilleries do – then we would be in no danger of including them in the results of that next batch as we would again set aside the heads and tails of that. The obvious question can be asked ... would this not mean that the amount of 'nasties' builds up over time as they are repeatedly added to successive batches? Logically, the answer must be 'yes', but this doesn't seem to worry the whiskey distillers, and they are dealing with much bigger quantities than we are.*
>
> *As for determining when to start or stop collecting the main body of a run, I believe that the methods we have been using are probably the best there are … measuring the temperature of the vapor and using our sense of smell. They may well be better than the traditional methods used in whiskey distilleries! There is certainly a discernible difference between what we have been calling 'foreshots' and 'heads' … the very first part of the heads is markedly more volatile, so the change to the main body of heads is easily detected by monitoring the vapor temperature. Equally, the slower change in temperature as the main run starts is fairly easily seen if you have a good thermometer in the right place in the column.*

Jack likewise adds …

> *In some reading I was doing, I found a spirit where the heads are not separated out at all; Pre-WW2 German Fruit Schnaps. Some may have made a brandy out of a fruit wine and noticed that the heads they were throwing out had a great fruity smell, and it was a shame to throw them out- old style German distillers didn't bother. This is why it has a reputation as a sharp tasting spirit. The trick is to ferment cool, and use no pectic enzyme, and ferment with added sugar no higher than 12%abv- all these things will dramatically increase methanol production. Then, make a note of how much distilled spirit was made out of how much wine, and only drink the amount of spirit that represents one wineglass of the original fruit wine/mash. For example: you have a gallon (4L) of cherry wine/mash, you get 750ml of spirit out of it at about 50% or so. At this rate of concentration, a 3ounce (90ml) serving of the wine equals a half*

> *ounce (16.875ml) of the distilled spirit. This (rather anemic) 17ml serving is to be considered one glass of wine. Limiting oneself to a "double" (roughly 30ml of spirit) of this "no heads separated" spirit, will give you a nice (but sharp) fruit schnaps, with little chance of a crippling hangover. Again, this requires a very temperate attitude toward drinking- in the above example, an American "shot" of this schnaps (2oz./60ml) would be equal to 4 glasses of the original wine- say hello to a nasty hangover. If this sounds a bit dangerous, then perhaps throwing out only the most minute bit of the heads could be done- say 5 to 10ml per gallon (4l) of wine- this should remove the bulk of the methanol.*

Distilling Water

Do you just want to use your still to make some nice clean water ? Zoran advises ...

> *Put 10 g permanganate in 10 L of tap water. Reflux 30 minutes. Distill from glass or SS. Reject first 200 mL. Collect 8 L very clean water without chlorine or any organic contaminants. Dispose residue*

Flavouring

Summary

There are now many commercial flavourings available, which turn vodka into pretty decent gin or whiskey, or all manor of liqueurs.
If you're looking for essences, contact Brewhaus

Or you can soak it with oak chips and make whiskey, or soak fruits in it to make your own liqueurs.

See the following sections ...

- using wood (oak) for whisky & bourbon,
- flavoured neutral spirits (non-sweet),
- liqueurs (sweet), and
- essential oils,

The liqueurs can be made using

- fruit & berries,
- herbs,
- citrus, or
- spices,
- nuts & seeds,
- emulsions using cream or eggs

Most of the fun comes from trying out different flavours, and making up your own liqueurs. Whiskeys etc usually require a bit of time spent with oak - something like 80% of the flavour is said to come from the wood.

It is quite tricky however to copy exactly the flavour of a favourite spirit. There are many factors which influence the flavour, and we can't easy copy them, nor quickly mature a whisky;

- The two main sources of organoleptically (smell/taste) important compounds are

  - the yeast used during fermentation, and
  - the oak barrels used to mature the spirit in

other factors include

  - the proportions of grains used
  - mashing technique,
  - fermentation environment, and
  - type and operation of the distilling equipment.
- Most manufacturers use a form of S.cerevisia, though some may also use some brewers yeast too.
- Sometimes, bacterial activity is actually encouraged in the wash to some extent. These include lactic acid bacteria, Gram positive & Gram negative bacteria. These will excrete compounds that add to the organoleptic qualities. These bacteria need to be really carefully controlled and managed, kept well below certain levels. (This would be a real fine balancing act, by experienced brewers - don't try it at home kids)
- Most wash is fermented out to around 10-12% alcohol, though some may be 8% (quite different to the 23% we're targetting - thus get a different concentration of the flavours)
- The use of copper in the still to fix some of the sulfur containing compounds (hmmm... go the guys with an all-stainless setup - though I've heard of copper strips being hung in the headspace)
- Maturation involves three different actions ...
  - extraction of compounds out of the oak, including lignin, tannins, oak lactones, sugars, glycerol, and fructose. This can be affected by the % of the alcohol, and even how the wood was dried. Around 25-30% of the colour is developed in the first 6 months.
  - modification of the compounds, to form aldehydes (particularly acetaldehyde), acetic acid, and esters (ethyl acetate) - this takes time
  - subtraction of volitile compounds by evaporation and absorbtion into the charred surfaces - this takes time, and needs to be quite selective
- the flavours which add to the taste/smell can be present in very small concentrations - only one volitile compound (isoamyl alcohol) exceeds 0.01%, whereas most of the others present are less than 50 parts per million (ppm). Some importants ones are there in parts-per-billion . Heaps of different ones are listed in the books. You're not going to find all these in the essences, nor in the exact right proportions.

I haven't listed all this to discourage us, but rather just to point out the difficulties if trying to match an old favourite. The best option is to experiment around with the different flavours, techniques etc, and see what works for you.

If you catch onto something good, please share it with the rest of us. Although I've made some fairly quaffable spirit from neutral alcohol, I still haven't quite cracked how to make something comparable with any of the decent traditional single malts. But, I've only just begun !

For a huge description of all the different styles of spirits, their production, etc, see the educational material from the University of Nevada Las Vegas Hotel Administration Course : (local index)

Using an Essence or Flavour still

One great tool to have is a small stove-top pot still that you can use to make your own essences in. Mine is simply a 1L glass coffee pot, with a large cork in the top, through which a condensor sits. Total cost < $20.

With this, you can either do

- "alcohol extractions", where you macerate your flavours in alcohol for a while, then distill them off;
- "water extractions", where you use water instead, or
- "steam extractions", where you hang the herbs etc in a wee wire basket above the boiling water, for steam to pass through before you collect & condense it.

One great sucess I've had is making my own "smokey peat" flavour for trying to imitate those strong Islay Scotch whiskies like Laguvulin. To make my "essence of compost", all I did was get a handfull of peat (sold at gardening shops as compost - yeah - they look at you strange when you only ask for a handful, not a trailor load, then explain why), put it a a can with a lid, then heat up the can over a flame for 15 minutes. Don't have the lid tight (or else the whole thing can blow up), but just sitting lightly in place. It may smoke a little, so have the fume extraction on, or do it outside. Leave the lid on while it cools, so that the smoke will cool & collect on the peat. Once cool, soak it in some 75%+ alcohol. Distil it off sometime later, to make a fantastic smokey peat essence.

For more about peat, see
http://www.ucmp.berkeley.edu/plants/bryophyta/sphagnointro.html

Motie elaborates ...

> *The stuff you want is Peat potting soil. Don't try it in a small container. It will explode. Think of it as a very crude distilation. Your still won't run without a venting of pressure. It's more like the creosote from a very smokey wood fire. If you are familiar with gasification, you will understand the explosion part. When heated in the absence of air, it will give off Carbon Monoxide and Hydrogen Gas, along with the smokey stuff and water vapor. These are very poisonous gases to breath, and explosive besides. I'm not experienced at what you are attempting to do, but I do smoke fish and make jerky in a smokehouse.*
>
> *If I were to attempt to make a liquid smoke flavoring, I would definitely do it outside. I would build a small enclosed fire in a bucket or something similar, using charcoal or wood. Burn it to a bed of coals. The very damp Peat potting soil would go on top of the coals. A container of some type would go on top of the Peat, and a roundbottom pot full of very cold water suspended just above that. The wet Peat smoke and steam would pass by the container, up to the cold round bottom of the pot above, and condense on it. Hopefully, the drops would follow the bottom of the condenser pot, and drop into the container below. I can't guarantee the method, but that is how I would make my first attempt. This gets away from the pressure issues of a closed, heated container, and away from the production of Carbon Monoxide Gas. Any Hydrogen Gas produced can burn in the fire and be eliminated.*
>
> *The moss you have is NOT Peat. If you can't get Peat potting soil,*

> *sometimes planting pots are made of compressed Peat. Dry cowpies are what it looks like. Brown, slightly fibrous. Moisture content can vary widely, and is adjustable by you. If you make a slurry, it looks like fresh cowpie without the odor.(Or bits of corn! LOL)*

Yield of Essential Oils

Wal writes ...

> *The http://www.benzalco.com/herb_distil_info.html dealing with essential oil distillations appears to be defunct now for some reason. It had a list of botanicals and their percentage oil yield, which luckily I downloaded. Another still cuurent site with some similar information is from the 'Food & Technology Course' at Ohio State University - http://class.fst.ohio-state.edu/fst621/Lectures/flavors.htm Since botanicals are used to flavor alcohol, I think it is useful to combine the information that is relevant to Distillers. There is divergence in some botanicals in these 2 sources - I will put the Ohio State Uni. figures in brackets. It is apparent that there is a wide range which depends on geographical source and climatic conditions. That is why gin distillers to have a consistent quality have to test their purchases and use essential oil quantity as a basis of their formulation.*

Name	%Yield
Almond (kernel)	(0.5-2.0)
Allspice/Pimento (seed)	4.5 (5.0)
Allspice/Pimento (leaves)	(0.5-0.7)
Angelica (root)	0.3-1.0
Angelica (seed)	0.6-1.5
Anise (seed)	1.5-4.0 (2.5-3.0)
Arnica (root)	1.0
Arnica (flowers)	1.0
Basil,sweet (leaves & tops)	0.5-1.0 (0.2)

Bay (leaves)	3.0 (1.0-3.5)
Calamus (root)	1.5
Caraway (seed)	3.2-7.4 (3-6)
Cardamon (seed)	8.0 (3.5-7)
Cascarilla (bark)	3.0
Cassia (bark)	1.5
Celery (seed)	3.0 (2.0-2.5)
Chamomile (flowers)	0.3-1.0
Cinnamon (bark)	0.1
Clove (buds)	14-21 (15-20)
Coffee (roasted beans)	0.12
Coriander (seed)	1.0 (0.4-1.0)
Cumin (seed)	(2.0-3.0)
Dill (seed)	2.5-4.0 (2.0-3.5)
Eucalyptus (leaves)	1.0-7.0
Fennel (seed)	4.0-6.0
Geranium ssp. (leaves)	0.3-2.0
Ginger (root)	3.0 (1.5-3.0)
Grapefruit (peel)	(0.3)
Hops (flowers)	1.0
Hyssop (leaves)	1.0
Iris/Orris (root)	0.2
Juniper (berries)	1.5

Lavender (flowers)	0.5-1.0
Lemon (peel)	2.0 (0.3-0.4)!
Lemon Balm/Melissa (leaves)	0.015
Lemongrass (leaves)	1.0
Lemon verbena (leaves)	1.5
Mace (aril)	17-20
Majoram (leaves)	0.9
Mustard (seed)	1.5 (1.0)
Nutmeg (seed)	15-25 (6-18)
Orange (peel)	1.5-2.0 (0.3)!
Orange (flowers	0.1
Organo (leaves)	1.2
Parsley (seeds)	6.0
Pepper, black (seed)	2.5 (1-3)
Pepper, white (seed)	1.5
Pepper, cubeb (seeds)	2.0
Peppermint (leaves)	1.0-2.5 (0.3-0.5)!
Pettigrain,citrus (young shoots)	0.5
Pine, needles (leaves)	0.5-3.0
Pine, sap (resin)	15-35
Poplar (spring buds)	0.5
Rose (flowers)	0.006
Rosemary (leaves)	2.0 (0.5-0.7)!

Sage (leaves) The major constituent is Thujone	2.5 (0.7-2.0)
Savory, summer (leaves)	0.1 (0.5-1.5)
Spearmint (leaves)	2.0 (0.7)!
Star anise (seeds & pods)	3.0
Tangerine/Mandarin (peel)	0.5
Tarragon (leaves)	0.08-1.5
Thyme (leaves) 2.5	(0.7)!
Tumeric (root)	5.0
Valerian (root)	1.0
Wintergreen (leaves)	0.6 (0.7)
Wormwood (leaves & tops)	0.5-2.0
Yarrow (leaves & tops)	0.15
Zeodary (root)	1.5

Making Schnapps

See all the recipes in the Fruit Wash page too.

Jack reports an easy way to make schnapps ...

> *On page 173 of Dave Broom's book: Spirits & Cocktails (1998, Carlton Books Limited) he says that to get around the problem of soft fruits having a low amount of sugar, which prevents them from being made into wine and distilled :"the fruit is macerated in alcohol before it's given a single distillation in order to concentrate the flavored spirit."*
>
> *I decided to test this out. I bought a bottle of pure black cherry juice (no "flavored" apple or grape juice- the real thing at $5US per quart). I mixed the juice with an equal amount of 50% abv sugar spirit and it was redistilled (no soak time, just mix the juice and go) until about 1/2 a quart was collected. after being allowed to cool down it tasted*

> *wonderfull- full black cherry flavor, without making the stuff into wine first.*
>
> *I plan on using bags of frozen berries (rasberries, blueberries, etc) that can be found in the freezer section of the grocery store ($5US for 3/4 a pound)- I'll use one bag per quart of spirit. Since I'll be using the whole fruit, I'll let it soak for 2 weeks first. This should be more than enough to make a bottle of great schnapps, allowing me to catch the perfect flavors of the single fruit, without having to risk it turning sour as it's fermenting into wine (plus- no worries about added sugar ruining the final flavor).*

He then confirms this technique..

> *I've got the Schnaps stuff sorted out- using carbon polished sugar spirit at 40 to 50%abv. Apples seem to have enough of their own sugar to make this route unneeded for them, but for blueberries, cherries, etc, it works great. Mix up by volume- 2 parts of alcohol and one part fruit. Let this soak for one month, then redistill on a water bath still (a heating element is not going to work). Make sure to leave the fruit in the alcohol when you distill it. No sugar is to be added- the end result is a fiery spirit with a great bouquet of whatever fruit you used- this is TRUE schnaps- not the over sugared, watered-down, artificially flavored garbage that passes for schnaps here in the US. Enjoy!*

He also recommends ..

> *The "brewmart" brand french-style apple cider kit (in a can), when mixed with ten pounds of sugar, 5 gallons of water, and a wine yeast (K1V-1116), and distilled twice in a potstill (colect one-third of the 5 gallons on the first run, collect the middle one-fourth to one-third on the second run)- and you get a really good apple schnaps or aged on charred american oak you get a great calvados-type brandy- heck of a lot cheaper, too. The can kit only costs me $20US at my homebrew shop. definately worth every penny.*

Wal writes ...

> ***Maraschino*** *(pronounced Maraskino) is a clear, relatively dry liqueur made from sour or morello cherries (Prunus cerasus marasca), including the crushed pits which give it a subtle bitter almond flavour. Originally made in the region known as Dalmatia (now a part of Croatia). Since 1947 it is*

made in the Veneto region of Italy by the Luxardo company.

First, crushed cherry stones are macerated in alcohol and then redistilled to produce an alcohol with a bitter almond flavor. Marasca cherries are partially fermented and the fermentation is stopped when there is still residual sugar, by the addition of alcohol. This is then pressed out and the free run is used to produce a sweet cherry brandy liqueur (Cherry Brandy). The alcohol which had been redistilled from macerating crushed cherry stones is added to this pressed cherry pomace and macerated for 2 months. Then it is redistilled and aged for 3 years in ash vats. The final alcohol content is 32%.

Kirsch is a clear, non sweet, eau-de-vie made from a sour or morello cherry mash in a similar manner to calvados and slivovitz.

Butterscotch Schnapps

Wal writes ...

Most of the commercial lollypop schnapps probably use artificial flavorings. You could try the baking section in a supermarket to get a low cost butterscotch flavor. Add cream as a thickener to get a 'Baileys' effect. Or you could experiment with a basic butterscotch extract which is really a runny butterscotch sauce, and add this to a neutral alcohol.

Basic Butterscotch Extract

- *200 g unsalted butter*
- *200 g light brown sugar*
- *500 ml light or heavy cream*

Melt and bring to boil.
For a 20% sugar & 20%abv 'Butterscotch schanapps' add the above butterscotch extract to 500 ml of 40%abv neutral spirit.
I appears that one should use the very minimum of butter (say 1 tbsp butter to 1 and 1/4 cups brown sugar) if you want to make your own butterscotch flavoring. Various nut oils (almond, hazel) in nut based liqueurs seem to disperse well in alcohol, but butter is usually solid at room temperature, so would need an emulsifier like lecithin.

Some rethinking. For a butterscotch schnapps you could use less butter - say 1/4 cup or 50 g. Adding lecithin should help to homogenize the *product.*

Butterscotch flavor is a flavor of butter and brown sugar. See articles on Butterscotch: http://www.baking911.com/candy_butterscotch.htm
Butterscotch Sauce (which should work as a flavoring for alcohol)
http://www.baking911recipes.com/other_sauce_butterscotch.htm
What is Butterscotch? http://www.prenzel.com/distilling/index.htm
Butterscotch schnapps http://www.webtender.com/db/ingred/114

Noticed that the Butterscotch Schnapps in the liquor stores do not have cream, so we can make a butterscotch concentrate using brown sugar, unsalted butter and light corn syrup or golden syrup (light molasses). This is then added to neutral alcohol to your desired strength. Most liqueurs are 20-30%abv. Here is an untried suggestion based on www.baking911.com recipe for Butterscotch Sauce:

Butterscotch Schnapps

- *250 g (1 and 1/4 cups) light brown sugar*
- *50 g (1/4 cup) unsalted butter*
- *150 ml (2/3 cup) light corn syrup (or golden syrup)*
- *1 tsp vanilla extract (optional)*
- *750 ml (3 cups) neutral alcohol (20-40%abv)*
- *1 tsp glycerine (smooths the liqueur)*

Combine the sugar, corn syrup, butter in a heavy-bottomed saucepan. Bring to boil, stirring, over medium heat. Turn the heat to medium- low. Boil the sugar, without stirring to soft ball stage (234F). Cool, add vanilla, glycerine and alcohol.

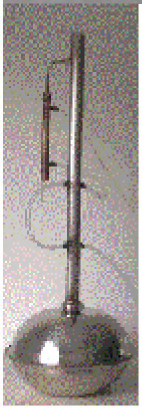
Excessive butter, could be a problem for a butterscotch liqueur/schnapps. Maybe 15 g unsalted butter to 250 g light brown sugar would be more safer. An emulsifier (lecithin?) would help disperse fats. Or maybe use browned sugar (caramel) and an artificial butter flavor that is used in cooking?

Janette wrote ...

Wal, I made very similar butterscotch schnapps the other month. My only problem was with the butter settling on the top. (which is why you suggested the lethicin) I cured it by sitting the liqueur in the fridge in a *bowl with lid, after 30 minutes, I skimmed the hardened butter off the top and what ever is left in there has no problem staying blended with the other ingredients. Even though I took about half the butter out of it, I would still use the same recipe as you do want the butter flavour in it, just not all the fat. Tastes great drizzled over a banana split!*

Photos of Stills Sold Commercially

Brewhaus at http://www.brewhaus.com/



Stainless steel boiler, connector, column, and condenser
Laboratory stopper
Food Grade PVC cooling hoses
Laboratory Thermometer and Raschi Rings included!

The Ultra Pure Still at www.puredistilling.com

From Australias largest manufacturer of stills:

Purity: 95%
Speed: 1.2L / Hour
Capacity: 5L (can be fitted to any boiler)

100% Money Back Guarantee

Using just a 25cm column, this still produces 2 bottles of spirits from its 5L boiler in just 30 minutes, including heatup time!

It uses a 2200W element, and amphora structured copper mesh for smooth, authentic flavour. Comes with a digital thermometer for accurate cuts.

A true reflux still for an excellent price - just $467 delivered anywhere in the world - guaranteed.

Click here now to find out more!

Mile High Distilling at http://www.milehidistilling.com/

Pictured are the Grande! from Mile Hi Distilling, featuring a 41-inch column and 40 & 32 quart boilers, their 43 inch reflux column and 2-in-1 tower, and 26 quart pot still.

Other designs, equipment etc shown on the site, along with prices

Portuguese Copper Alembic and Alquitar Stills

To see a full range of these stills, sold by Destilarias Eau-de-Vie, simply just click on one of the images above. Handcrafted and hand hammered by skilled Portuguese coppersmiths, the sensual curves and natural beauty of copper echo the splendour of the past. Email contact: homedistiller@copper-alembic.com

Bosco Engineerings Reflux Still

email boscoengineering@tpg.com.au

	Stainless steel reflux still, fabricated in Australia , at Bosco Engineering P/L

Haas Copper Still email info@haasdestille.de	
	Traditional Iberican alcohol still, hand hammered in hard copper. Tel. 0049 2261 66115 Fax.0049 2261 64714 Germany

Desti Lab at http://www.desti-lab.com

Also sold at http://www.economystill.com

Outterson, LLC Stills at http://www2.eos.net/beerwine

US supplier for botique distilleries, from 5-1000 gallon (5, 10 & 25 shown)

These Revenoor stills shown can also be seen at http://www.revenoor.com

Daves Still

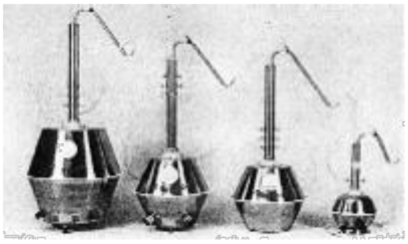
I got it via Outterson (http://ww2.eos.net/beerwine/) , it is made by The Revenoor folks.

It has what I believe is a 3-part rectifying column (I heard it called a splitter, not sure what that means but I assume it's fractional), and the top 1/5 or so is a condensor with cool water regulation to the condensor and the worm. The column seems to have marbles or some other inert media in the condensor and at least the top 1/3 or 2/3 of the column, but that's just a guess!

Completely high quality craftsmanship all around, they really take some pride in their work.

As you can tell, they are from the sour mash tradition, and this is a pretty classic U.S. still design if you ask me.

Euro Stills at http://www.spiritsunlimited.co.nz/



Don't know if these are available yet off their site.

Column diameter = 50 mm
Column height = 600 mm
Packing type = glass beads, with a stainless steel scrubber each end
Distillate purity = 92 %
Distillate flowrate = 1 L/hr
Pot capacity = 25 or 50 L
Heat Input 1500 W + 1000 W (25 L) or 2 x 1500 W (50 L)
Retail price = NZ$550 (25L) and NZ$650 (50L)

Pete at the Brewers Barn (brubarn@xtra.co.nz) sells these, and can send you an email brochure about them.

Modifying the Euro Still

Gaddock wrote about some improvements he made to his Euro60 .. *When I received the item, the first thing I did was to get rid of the glass packing and replaced it with rashig rings, 6mm. I was able to get a 92% product at about 1.2 liter per hour. I was not happy with the 92% and made a few modifications as a result of the information on this site, once again thank you all. I am now able to get just over 96% at 1.2 liters per hour! For those of you with the Euro 30, 60 etc. you may want to try the following.*
1) I turned the column upside down so that the 2 cooling tubes are on the bottom and the three are on the top (there are 5 in total).
2) I then packed the column with copper pot scrubbers in the areas of the column that do not have the through tubes. Around the through tubes I used Rashig rings.
3) I also rerouted the water hoses and started the input on the finger condenser and the output on the lowest tube. This is the reverse order that came with the directions for the still.
4) I cut a slot on the inside of the column where the ring clip goes to hold the packing in. Why they did not do that to begin with is beyond me as with no slot cut the packing could have easily fallen out during distilling, tragedy for sure.

5) I wrap the pot with towels that allow me to regulate temperature by the number of towels to reduce the water flow. I hate to waste good water down the drain.
With these mods I have a still that produces a first rate product fairly rapidly compared to similar sized stills I have read about.

Winesupply at http://winesupply.com/

They offer 5, 10 & 25 Gallon models
Propane, electric or wood fired
Sold in the US

Initially this site raised a few eyebrows - could it be a BATF sting, seeing it was so openly selling within the US ? however Tim reports " Wine Sales and their parent company Dextan are mainly wholesalers. I called them and they informed me that they will not sell distilling set-ups to individuals in the US."

Malt Masterclass at http://www.maltmasterclass.co.uk/

They use this for training sessions in making malt whisky's

No performance details available, but gee it looks pretty !

Lab Master I

either purchase it fully made up from :
http://www.angelfire.com/wi/widder/index.html

or buy the Home Distilling Handbook from Gert Strand (Partyman) for US$5 and build it yourself

Height : 590 mm
Diameter : 50 mm
Performance : 90-95% alcohol

Spirits Unlimited

For sale at http://www.spiritsunlimited.co.nz/

20L Pot stil
Volume : 20L
Performance : 4.5L @ 40% in 6 hours

For sale at http://www.spiritsunlimited.co.nz/

20L Reflux still
Volume : 20L
Column : 350 mm tall x 75 mm diameter
Performance : 80% as is, 90% if stuffed with stainless steel wool pot scrubbers (David Pickles)

	For sale at http://www.spiritsunlimited.co.nz/ 24L Reflux still Volume : 24L Performance :
	For sale at http://www.spiritsunlimited.co.nz/ 5L Export Still Volume : 5L Performance :

Aqua Vita at http://www.aquavitae.co.nz/

Looking at the condensors, these would appear to be Still Spirits stills

	For sale at http://www.aquavitae.co.nz/ 25L Pot still

For sale at http://www.aquavitae.co.nz/

25L Reflux still

Mine is an early version of this 20L Reflux still (it has a plastic body). It puts out about 3.5L of 75% alcohol in 4 hours off 20L of 15% wash, if just used as designed (one marble for packing !) Stuffing half a stainless steel pot scrubber into it, below the marble, has increased the purity to 85%. The small diameter, and extremely short height of this column will never really make it a great "reflux" still, however it is a good step up from just a pot still. Cheap and easy.

Modifying the Still Spirits Reflux Still

Mos writes .. I have cut and shut mine by adding a 600mm*30mm piece of stainless steel tube to the middle.After a trial run this morning I am pleased to report to have collected my ethanol at 91% which is a huge improvement on standard.There seems to be a much improved smell bordering on none.

Wal writes ... I modified mine by adding a 1 metre (3 ft 4 in) 1.5 inch copper column to exg. Took out the marble and put in part of a scourer to act as a vapor trap. I treat the exg. part as a reflux and vapor condenser for the 1 metre column filled with scourers. Attachment via standard plumbing screw-on connectors - no cutting required. See your plumbing supply store.

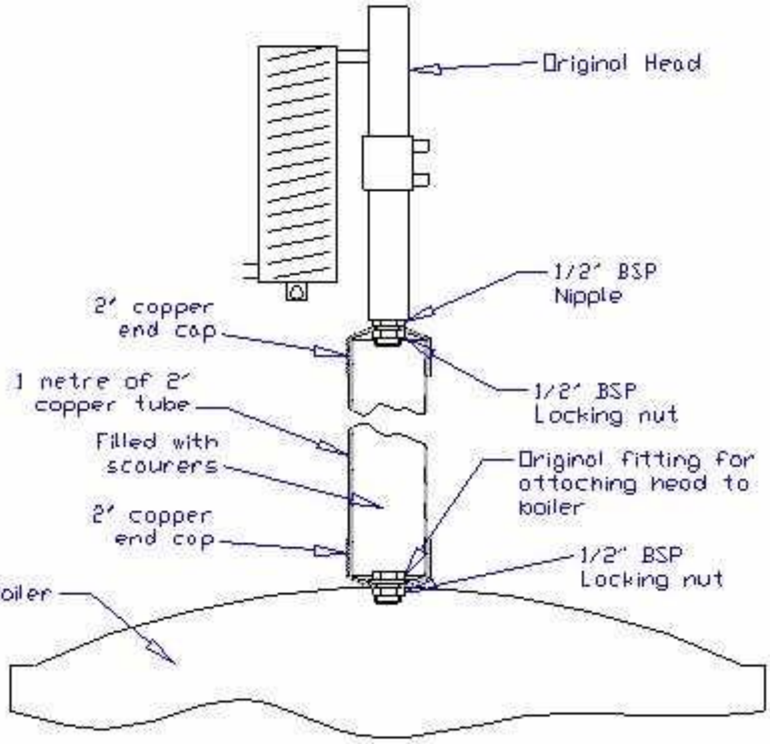
...later..offering more details ...

I decided to .. attach an extension for the actual reflux column. I

 	took out the marble and replaced it with part of a copper scourer - to act as a vapor trap around the reflux jacket condenser area. I also cooled the reflux condenser separately to get more control, rather than having the cooling water from the vapor condenser entering the reflux condenser. My first extension was a 750mm x 25mm diam. copper pipe packed with s.s. scourers. This looked neat as it was the same diameter as the SS Reflux Still, but with my 1380w heater it flooded (See photo No 6). So I made another - 11/2 inch (40mm) diam. x 1000mm (3 ft 4 in) long column packed with copper scourers. Standard adapters at both ends enabled me to attach the SS Reflux Still unit and use it in a similar way. Instead of welding, this time I used an 'epoxy steel' glue - an 'araldite' formulated for metal (See photos No 1, 2, 3, 4 - use horizontal scroll bar). I also made a bigger

boiler using a second-hand heavy duty plastic drum, in which I drilled 2 holes and attached 2 x 1300w replacement hot water jug elements (See photo No 5). I use the drum also for malting grain by heating the water to 75C. For those who like me have minimal workshop skills, this is one way of improving a standard off-the-shelf unit in an economical way. I am getting 85%abv which gives me residual flavors from the mashes I am playing around with (I make my cut at 60%abv which is the practice with brandy and whisky). The reflux condenser seems capable of total reflux now, so I will give it a go soon to find out - can't see why it should be worse than the 'stillmaker' model with its inserted cooling tube acting as the reflux condenser. It was a bit of a 'I can do it too' exercise, and interest in the matter made me post my photos to stimulate others. The plastic drum idea is

	much simpler than beer kegs and only AU$20!.

	Mike writes ...I have a still spirits reflux still. My first mod to it was to seperate the water supplies to the cooling jacket and the condenser. Eventually I found that the cooling jacket is not necessary. The still works just as well without it IMHO. The best mod to make to this still is to extend the column. What I have done is to get myself a metre of 2" copper pipe. To this I have added a copper cap end to each end. I have drilled a hole in each cap, and tapped a 1/2" BSP thread. I bought a 1/2" nipple, and two lock-nuts

to suit. One lock nut I use down the bottom to attach to the boiler, the other to lock the nipple into the cap at the top. The nipple at the top will screw into the original head. You can go further and turn this into a Nixon-Stone style still, but I haven't got to that yet.

Duplast at Des Zine's Code Imports

Performance : 80 - 82%

Dean Watts comments : *My still has a Plastic boiling chamber (basically a brew barrel which you can by the way, see through and see the wash boiling correctly.) This then connects to a plastic reflux tower which is 11cm wide by 30cm tall. Then it connects to a Copper head (another 18cm high) unit which has the reflux condenser inside mounted about 9cm from the top. As the copper head is the last thing to be assembled you can only put media in the 30cm Tower.*

Bob's MoonWater Still at http://www.encode.com/exec

Performance

Flowrate : 1 litre per hour
Purity : 90 to 95%
Cost : US$325
Pot size : 5 US gallons
Column size : 2"
Packing : copper scouring pads

Bob reports that

> *" This is a real proven unit and works very effeciently. The real jouney for fun begins when you run off your first batch. It will change your life forever. It will create great memories that will last a life-time."*

Photos of Pot Stills at Commercial Distilleries

Heres's some of the still heads used at commercial distilleries. Note the range of different sizes, shapes, proportions etc. These should give some indication of what hobby pot stills could be designed as.

Whiskey styles are as quoted by "the Malt Whisky file" by Robin Tucek & John Lamond. I've done this to see what correlation there is between shape/size and resulting flavour.

Bushmills at http://www.bushmills.com	
	Sweetness 7 Peatiness 0

Famous Grouse at http://www.grouse.com	
	Sweetness ? Peatiness ?

<table>
<tr><td colspan="2">**Laphroaig** at http://www.laphroaig.com</td></tr>
<tr><td>
</td><td>Sweetness 1-2
Peatiness 10
Quite a range of different styles in use here !</td></tr>
</table>

<table>
<tr><td colspan="2">**Glenfiddich** at http://www.glenfiddich.co.uk</td></tr>
<tr><td></td><td>Sweetness 8
Peatiness 3-5</td></tr>
</table>

<table>
<tr><td>**Glenmorangie** at http://www.glenmorangie.com</td></tr>
</table>

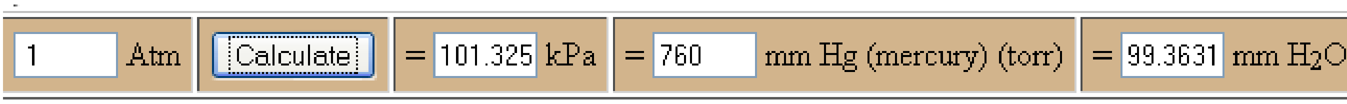
	Size : 17ft tall Sweetness 3-4 Peatiness 3-4

the Macallan at http://www.themacallan-themalt.com

	Sweetness 7 Peatiness 4 Comments from their site: The size and shape of the stills are crucially important. The more contact the wash and low wines have with copper the better, since it acts as a catalyst, removing sulphury impurities (in the wash still) and promoting the creation of esters (in the spirit still) - effectively cleaning and lightening the spirit. Small stills with a broad 'head' (the middle part of the still), such as those at Macallan, are best of all: a narrow head tends to increase the velocity of the ascending vapours and to reduce their contact with the copper walls. Finally, while we are on the question of still design, there is the important matter of the length and angle of the 'lyne arm' - the pipe which connects the top of the still, known as the 'swan neck' to the condenser. Macallan's lyne arms are of average length, but they are acutely angled in a downwards direction. This means that once vapours reach the neck of the still they are more likely to go over and be condensed than to fall back as reflux and be re-distilled. Again, the Macallan is unusual in this: most distillers set out to increase reflux. But then, they may well not achieve such copper contact (with its spirit-enhancing properties) as do Macallan's small stills.

Glengoyne

	Sweetness 5-6 Peatiness 0


1 Atm Calculate = 101.325 kPa = 760 mm Hg (mercury) (torr) = 99.3631 mm H_2O

How to brew your own booze (Formerly "FACTS, FANCY AND OTHERWISE") It is well-known that the making of intoxicating beverages is as old as recorded history, and probably a great deal older. In this treatise, we wish to present the easiest method to make a `produce' that is both safe and pleasant to consume. The goal, naturally, is ethyl alcohol, or C2H5OH; the only base or stock from which good drinking whisky and other liquor is made. In fact, ethyl alcohol rapidly oxidises in the body to carbon dioxide and water, and no cumulative effect occurs. We will attempt in this article to combine the most useful chemical and technological information with `homespun' procedures, as well as trying to keep the data simple and understandable. The text, by the way, is "Chemistry and Technology of Wines and Liquors" by Herstein and Jacobs (excerpts from this book are within quotation marks).

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General Conditions of Alcoholic Fermentation

Fermentable sugar, water, the presence of a ferment (yeast) and a favourable temperature, usually between 75 F - 85 F and NEVER over 90 F, are inescapable requirements. Concentration of sugar (2 lbs in 1 imperial gallon) and yeast and the acidity or pH of the fermentation mash are of great importance. The pH range is

usually 4.0 to 4.5.
page 2

Rate of Fermentation

The rate of fermentation depends chiefly on the temperature and the CONCENTRATION of yeast. The rate of fermentation is twice as fast at 95 F as at 77 F. "However, the antolysis (decomposition of the yeast) is favoured by higher temperatures, and the rate of UNDESIRABLE by-processes increased; hence, it is usual to set 90 F as the upper limit." (In other words, it is definite that the higher we go above 90 F, your probable loss of yield of alcohol will be from about 25% to 50% because yeast cells die, as well as undesirable products increasing at higher temperatures.)

Alcoholic Yield and By-products of Fermentation

[1] The overall chemical equation of the conversion of sugar to alcohol is:

```
     C(6)H(12)O(6)  ->      C(2)H(5)OH      +     CO(2)
     (Hexoco)              (Ethyl alcohol)      (Carbon dioxide)
```

[2] The weight of products from fermentation of one hundred pounds of sugar is as follows :

Alcohol	48.5 lbs
Carbon dioxide	46.7
Glycerol	3.2
Organic acids	0.6
Miscellaneous	1.2
Total	100.2 lbs

The extra 0 2 lbs is due to the fixation of water in the formation of some of the by-products.

[3] In general, the chief products of vinous fermentation are alcohol and carbon dioxide (94% - 95% of the sugar), glycerol (2 5% - 3 6%), acids (0 4% - 0 7%), and appreciable quantities of fusel oils (higher alcohols), acetaldehyde and other aldehydes, and esters. The minor products of fermentation are:

Formic acid Acetic acid Propionic acid Butyric acid Lactic acid Ethyl Butyrate Ethyl Acetate Ethyl caprate

page 3

[4] Very little methyl alcohol is found in grape wine, about 0 15%. Methyl alcohol is NOT produced by the fermentation of pure sugar, its sole source appears to be the

hydrolysis of pectins. Pectins are found in grapes, commercial orange juice and other fruits. The addition of several cans of orange juice is not necessary and may, in fact, increase methyl alcohol content. It is far safer to use a chemical `booster' such as ammonium phosphate-dibasic, or a close substitute containing nitrogen and phosphate. Calgon water softener is also a fair substitute. Perhaps we should explain that the reason for adding an ingredient to the sugar, water and yeast mix is solely for the yeast to have `food' in order to `work' properly. It has been established that yeast needs nitrogen, phosphate and potassium for `food', but only in very small proportions. In other words, the ammonium phosphate-dibasic has the nitrogen and phosphate, and the raw water has the potassium.

The Basic Batch

There are a great many ferments or batches, and trying to catalogue them in all varieties would be a tremendous task; therefore, we will discuss only a `basic' ferment that proves itself reliable and gives optimum results time after time. Keep in mind that it is only possible to produce a certain per cent of alcohol, 9% to 16% by volume, depending on what type of yeast you use (at the right temperatures), regardless of `pet' additions such as molasses, corn sugar, cornmeal, wheat, large quantities of juices, etc. Therefore the `basic' ferment saves money.

[1] Ten pounds refined sugar (always 2 lbs per imperial gallon) dissolved in lukewarm (80 F) RAW WATER before pouring into your container.

[2] One cup of baker's yeast. If this large amount causes raised eyebrows, read over "Rate of Fermentation", page 3, again. Also, according to the text, yeasts multiply most rapidly in the presence of a supply of air; however, by using a large amount of yeast at the start (one cup per five gallon mix) it is not necessary to start a culture of sugar-water-yeast and later add this mixture to the batch.

[3] One teaspoon of ammonium phosphate-dibasic, or, as explained in [4] under "Alcoholic Yield and By-products of Fermentation", page 3, a close substitute. The addition of this chemical booster will shorten the time the batch works.

[4] After the above items have been put into the mash container, fill the container to the 5 gallon mark. THE BEST METHOD OF ELIMINATING UNWANTED OXYGEN AFTER THE REACTION HAS STARTED IS TO STOPPER THE CONTAINER AND LEAD A HOSE OR TUBE FROM THE CONTAINER TO A CAN OR BOTTLE FILLED WITH WATER. This allows the carbon dioxide gas to bubble off through the water, thereby preventing oxygen from entering the container, otherwise, if the ferment stands too long without an adequate `check valve', a vinegar process could start turning the mix sour.

[5] As stated under "General Conditions of Alcoholic Fermentation", page 2, and "Rate of Fermentation", page 3, temperature control of the ferment is very important. Keep your batch within the 75 F - 85 F range and never over 90 F.

[6] Up to now, if the steps have been faithfully followed, your mix will stop working in about 6 to 9 days. Although the ferment might stop working in this time estimate, it takes several days more for the batch to settle. The best practice is to keep two or three batches in the various working stages so that you can allow the ferment to clear up or settle before running. Apparently, although this point is not covered in the text, the longer a stoppered batch `sits' up to a certain time limit, the better the yield. The reason the mix stops working is that the higher the percentage of alcohol in your batch, the more yeast cells die until the alcoholic content is so high that all yeast cells die, and your mix stops working. Baker's yeast yields around 9% to 10% alcohol, wine yeast, on the other hand, yields 14% to 16%, because wine yeast has a greater tolerance for alcohol. Therefore a cup of baker's yeast (dry) for each 10 lbs of refined sugar is about the right concentration of yeast for our purpose. We are also reasonably sure that the distilled product from a sugar-water-yeast-chemical booster ferment will contain only ethyl alcohol, carbon dioxide and distilled water at the end of a four-run process as described in this article.

We make this statement even though it is contrary to the facts as set forth in "Alcoholic Yield and By-products of Fermentation", but keep in mind that we said `reasonably sure', and it only deals with the fermentation process, whereas our statement concerns the product after the four- run distillation process.

Distillation Theory

A simple definition of distillation is: the separation of the components of a mixture by partial vaporisation of a mixture and the separate recovery of the vapour and the residue; i.e. distillation is a method of separation and concentration, based on differences in volatility. The apparatus in which this process is carried on is called a STILL, of which the essential parts are:

[1] The kettle in which vaporisation is effected.
[2] The connecting tube which conveys the vapour to the condenser.
[3] The condenser where the vapours are re-liquified.
[4] The receiver in which the distillate is collected.

Modifications involving the addition of other parts to the still are introduced for various purposes such as conservation of heat and to effect rectification. The condensed vapours, returning to accomplish rectification, are called reflux. In other words, a simple distillation is a means of separating a volatile liquid from a non-volatile residue. A fractional distillation is a means of separating liquids of different volatility. Fractional distillation rests on the fact that no two liquids of different chemical composition have the same vapour pressure at all temperatures, nor very often the same boiling point. However, every liquid has a definite vapour pressure at any given temperature. The various types of stills may be classified as: Pot stills; Coffey or Patent stills; Vat stills; and Continuous stills.

Cleaning the Still

There are too many variations of the four types of still in our interesting hobby to attempt an explanation of each `cooker', but our chief worry, regardless of type, is cleanliness and the prevention of accidents and fires.

Keeping a clean still is only common sense, and is greatly simplified if your cleaning begins immediately after the last run while the metal is warm. Use water to wash out all parts and keep the kettle well-scrubbed. Do not use soap, as it might impart a disagreeable taste to your product. It is necessary to supplement the plain water rinse by establishing the following cleaning practice at least once a month:

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Dissolve cup of salt in about 16 oz of vinegar and pour this solution back and forth through the tubing several times, then rinse thoroughly with water.

This procedure is all that is necessary for the pot still, but the reflux types need special attention to the cleaning of the reflux chamber and the `marbles', helices, etc.

Safety Precautions in Distillation

The home distillation of alcohol CAN be either very hazardous or reasonably safe, depending upon the degree of care taken. Unfortunately, accidents have occurred resulting in burns to people and destruction of property. These accidents can be well summed-up in General "Hap" Arnold's message, in which we have substituted the word `distilling' for `flying'. "DISTILLING IS NOT INHERENTLY DANGEROUS, BUT, LIKE THE SEA, IT IS TERRIBLY UNFORGIVING OF CARELESSNESS, INCAPACITY OR NEGLECT."

In this discussion the unsafe practices which produce the majority of all distilling accidents are described and the proper method of operation to eliminate the hazards is set forth for your safety.

First, we must recognise and accept the fact that for all practical purposes, WHEN DISTILLING ALCOHOL WE MIGHT JUST AS WELL BE DISTILLING GASOLINE. Take a look at the comparable properties, given in the table on the following page:

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Characteristic	Alcohol (160 proof)	Gasoline (Average grade)
Flash point (alcohol from condenser is well above this temperature)	68 F	45 F
Ignition temperature (any flame or electric spark is above temperature)	793 F	536 F
Explosive limits (% by volume -note wide range of vapour/air	4.3% to	1.4% to

mixture which can be ignited)	19%	7.6%
Vapour density (Air = 1) (although there is a tendency for rich alcohol vapours to settle, it should be noted that alcohol/air mixtures in the flammable range have a specific gravity only very little greater than that of air (1 02 - 1 11); therefore, air currents will distribute such mixtures widely)	1.59	3 to 4

IT SHOULD BE OBVIOUS FROM THE ABOVE DATA THAT, FROM THE FIRE POINT OF VIEW, ALCOHOL IS ALMOST AS HAZARDOUS AS GASOLINE.

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[1] IF YOU USE GLASS BOTTLES FOR MASH, BE SURE THAT THE BOTTLES ARE TAPED WITH MASKING TAPE to avoid the hazard of cuts from broken glass. Should the bottle break, there is no fire hazard from the mash, because the alcohol content of the mash is too low to create a flammable mixture at ordinary room temperatures. Never attempt to carry heavy 10-gallon bottles: their structural strength may be insufficient and they have been known to fracture upon the slightest impact. Also, the strength of your back is inadequate in an awkward position. Use a dolly to transport the bottle on or, better yet, siphon into the still. The best bet is to get metal or plastic containers from one of the main mail order houses.

[2] NEVER FILL A STILL ON THE STOVE. Of all the dangerous things to do, the second most hazardous is to fill a still with second or subsequent runs when the still is on the stove. Even though the fire is out, the pilot light or oven may be lit. Any spillage of alcohol at this time can get you into serious trouble. If the vapour flashes, you will probably drop the dispensing container, with the likelihood of splashing flaming alcohol on yourself or others, as well as starting a large fire.

ALWAYS CHARGE THE STILL ON THE FLOOR AWAY FROM THE OVEN and, if it is too heavy for one person to lift, get help. Any of your friends will help in this important endeavour. To form correct habits, this practice should be followed even to charge the still with mash.

[3] NEVER LEAVE A STILL UNATTENDED - THIS IS THE MOST HAZARDOUS ACTION OF ANY AND IS ABSOLUTELY INEXCUSABLE.

First: Condenser water can fail due to -
a. Failure of hose lines.
b. Low water pressure.
c. Shutdown of utilities.
d. Failure of condenser shell.

Without adequate condensing means, alcohol vapours will rapidly spread within the room until a source of ignition is reached. The degree of flash fire will depend upon the accumulation of vapours, but in most cases the fire is immediately beyond control. If the concentration of vapour is sufficiently widespread, an explosion can occur.

Second: The receiver can overflow. This will create a large area from which the alcohol can vaporise. Usually under these conditions the flash point is reached. Flash point is defined as the lowest temperature at which a liquid will give off flammable vapour at or near its surface. This vapour forms an intimate mixture with air, and it is this mixture which ignites.

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[4] LOCATE THE DISTILLED ALCOHOL RECEIVER AT AS LOW A LEVEL AS POSSIBLE and extend the run-down tube from the condenser to the bottom of the receiver.

First: Placing the receiver at a low level will tend to keep any alcohol vapour away from the flames at the top of the stove. Note that any flames (main burners or pilots) in the oven or boiler units are usually lower and tend to draw the air for combustion from a low level; therefore, all flames, including the pilots, in ovens or boilers, should be turned off. In a few of our stoves (older wedgewood models) all pilots are controlled from a single safety shut-off valve that shuts down the entire stove if an oven pilot goes out - on these stoves it is impossible to cut off the oven pilot and keep the top burners operating, therefore, for such cases, the receiver should be located at least 3 feet away from the bottom of the stove and the recommendation in "PLACE THE RECEIVER IN AN AUXILIARY CONTAINER", paragraph [6], must be followed.

Second: When the run-down tube extends to the bottom of the receiver and becomes submerged in the liquid, there are several safety features created:

- a. The alcohol liquid that contacts air is reduced to only the stilled surface in the receiver.
- b. If any alcohol vapour remains uncondensed, it will bubble in the liquid receiver and serve as a warning of insufficient condensing capacity.
- c. If there is abundant condensing capacity, the condenser will establish a partial vacuum in the system and draw up a liquid head that will stand in the run-down tube. This will be proof of adequate condensing capacity.

NOTE: When the still is first started, it contains air above the liquid. This air must be displaced; therefore, the end of the run-down tube may bubble at first.

[5] USE A RECEIVER WITH A SMALL FILLING OPENING. A small opening cuts down on the quantity of vapours escaping into the room and it also saves you alcohol. If a fire does occur at the receiver, it will burn at the small opening and be easily controlled. With a large opening, the fire will be much larger, a lot more heat will be rapidly given off, and the fire will be more difficult to contain. If such should occur, extinguish all sources of flame and follow the suggestions in paragraph 10, "IN CASE OF ACCIDENT, IMMEDIATELY CALL THE FIRE DEPARTMENT".

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[6] PLACE THE RECEIVER IN AN AUXILIARY CONTAINER. If the receiver is placed in a dishpan or other type of auxiliary container, an accidental overflow will be restricted much more than would be the case if it should run out on the floor.

[7] Be sure exhaust fans or other means of ventilation are used to reduce the possibility of alcohol vapour accumulation.

[8] NEVER USE A STILL IF YOU DO NOT HAVE COMPLETE CONFIDENCE IN THE EQUIPMENT. Stills should be of welded or brazed metal construction with metal tubing and tight-fitting slip joints or bolted gasket heads. All joints should be carefully made up to avoid leaks of either vapour or liquid alcohol. CONDENSER CAPACITY SHOULD BE ADEQUATE for the maximum rate of distillation. If you are not qualified to appraise the condition of your equipment or its method of operation, get a qualified friend to make the inspection for you.

[9] DON'T STORE UNCUT ALCOHOL. If a fire should involve this highly flammable liquid, the situation could rapidly become very serious. Cut your alcohol BEFORE you store it. Alcohol cut to 90 proof has a flash point of 77 F, whereas 160 proof alcohol has a flash point of only 68 F.

[10] IN CASE OF ACCIDENT, IMMEDIATELY CALL THE FIRE DEPARTMENT. DO NOT DELAY, OTHER THAN TO GET ALL OCCUPANTS OUT OF THE HOUSE. It is a good practice to have your garden hose attached to the outside faucet and readily available. An alcohol fire can be extinguished with water if the alcohol is sufficiently diluted. However, the heat release is so rapid that, except for very small fires, you will need trained help in handling the situation. DON'T DELAY IN EVACUATING THE HOUSE AND CALLING THE FIRE DEPARTMENT; then do the best you can to control the situation.

[11] Above all else:

- a. DON'T LEAVE A STILL UNATTENDED!
- b. DON'T DRINK AND RUN THE STILL!
- c. DON'T RUN THE STILL IF YOU ARE SLEEPY!!!

Distillation can be interesting and it can be reasonably safe, but don't spoil it through unintelligent operation or plain carelessness. Though you may be a brave soul with lots of luck, don't expose yourself and other people to serious injury or yourself to liability for serious property damages. REMEMBER, IF AN ACCIDENT OCCURS, YOU ARE THE CAUSE AND THE ONE LEGALLY RESPONSIBLE.

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[12] One special word of caution for those who use immersion heaters. These heaters must be completely immersed in liquid all the time. If they are not, they will overheat and be destroyed. If this happens while a flammable mixture of alcohol vapour and air is in the top portion of the still, an explosion will occur. Such an explosion would be extremely dangerous both from a standpoint of flying parts of the still and a very rapid spread of fire.

Common Pot Still

This section deals with the 3 or 4 run system, using a basic sugar-water-yeast-chemical booster ferment, and the common pot still apparatus. Incidentally, the reflux chamber stills are excellent (one run equals four runs in pot stills) but the majority of us use a pot still over a gas flame; therefore, in this section we will concern ourselves with this method. Be sure your thermometer is mounted in the vapour space chamber so that temperatures will be vapour temperatures. Do not mount your thermometer in the liquid; keep it AT LEAST 3 inches above the liquid level.

Running the Still

Using the ferment described in "The Basic Batch", page 4. NOTE: TURN ON EXHAUST FAN FOR ALL RUNS.

First Run: Run to 207 F or 97 2 C

Pour your ferment into the kettle up to the 5-gallon mark and set up the apparatus. Adjust your condenser and turn on the flame or flames FULL BLAST. (This section is based on a one-burner heat source - if you can use two burners, your times will be considerably shorter.)

44 F indicates the start of air moving through the system. Depending on the alcohol and water proportions, as well as the temperature of the mix before heating, the run should start in about one hour between 170 F and 175 F. Approximately two hours later, when 207 F is reached, you will have a good working stock of about one or one and a fifth gallons. BUT if your ferment temperatures were too high, you might be unlucky and get only gallon! (See "Rate of Fermentation," page 3.)

Your first run distillate should amount to about 40% ethyl alcohol and 60% water and by-products. Disconnect the kettle and POUR OUT THE RESIDUE. Be careful while pouring out the hot residue, as splashes might cause you to drop the container resulting in painful burns. A good way to empty a large still is to use a piece of garden hose as a syphon. Put one end in the liquid and fill the hose by turning on the water faucet. As soon as all the air is removed, disconnect the hose from the faucet and let the liquid syphon down the drain. At this point it is a good idea to rinse out the tubing so that any lurking `solids' are flushed away.

We might also add that sometimes one gets anxious and runs before the mix stops working the green or unsettled batch bubbles inside the pot. Consequently, if there is not enough space above the level of the liquid in the kettle, solids will come over and cause the condensate to turn milky in the receiver. This is also caused by running `full blast' or, in other words, there is too much heat applied to the pot.

If this should be the case, keep on running at a REDUCED HEAT and when you finish, be SURE to rinse out the entire apparatus thoroughly before starting the second run. Incidentally, unless you have had lots of experience, it is not a good idea to run at `full blast' for the entire run. Most of us use the high heat only to cut down the heating period of the batch.

Second Run: Run to 204 F or 95 6 C

Pour your first run into the kettle as it is, do NOT add water. Set up the apparatus again and turn on the heat TAKING GREAT CARE THAT THE KETTLE IS BUTTONED UP. This time results come faster. At about 170 F - 180 F (76 7 C - 82 2 C) it starts, and in about one hour the 204 F mark is reached. If you are lucky, you should have about 0 75 gallon of about 70% ethyl alcohol, and the remainder water and by-products. Once again, pour out the waste, and, if you wish, rinse out the tubing. We now have a pretty good stock, but yeast waste and other by-product traces are definitely there, although in very small proportions. At this point, remember, 70% alcohol is 140 proof and has a flash point of 70 F. YOU NOW HAVE A VERY FLAMMABLE PRODUCT.

Note: Multiply % alcohol x TWO to get `proof' i.e. 90 proof whisky is 45% alcohol

Third Run: Save everything from 170 F - 184 F (76 7 C - 84 7 C)

This is the run that counts, the first two runs served to get us a good working stock, now we start to refine it. Pour in your second run without adding water, button up the apparatus, and turn on the heat. Stand by to watch your thermometer. At about 150 F - 160 F the needle or column really moves fast to the 170 F - 172 F mark; this jump is normal, don't let it worry you. Throw away whatever comes off before 170 F (or that which comes off before the trickle steadies into a solid stream), and save the rest up to 184 F. Time for this third run is about hour, and the distillate will amount to about gallon, which will be around 82% to 87% ethyl alcohol and the remainder water and very, very small traces of by-products. Some of us stop here and call it quits. The elapsed time from start to this point is about 4 hours.

Fourth Run: Save everything from 170 F - 180 F (76 7 C - 82 2 C)

Now we are on the home stretch. Pour in your third run without adding water, button up and turn on the heat. As before, the needle will jump to the 170 F to 172 F mark. Throw away whatever comes off before 170 F to 172 F and keep the rest up to 180 F. This time the run will last only about hour and will amount to about gallon consisting of 90% to 95% ethyl alcohol and the remainder distilled water. We are betting our first drink on the fact that the by-products will be negligible. Now you have an excellent base for any type of liquor you care to concoct.

Notice that we have not once run according to proof; now, bring out your hydrometer, and let's cut the fourth run back to about 90 proof. Be sure that you use your hydrometer at the correct temperature, usually 60 F; otherwise, if the product is warmer than prescribed, there will be an error in proof. After cutback, you should now have about 0 8 to 1 5 gallons of the finest raw whisky this side of the Esk (well ...). Here's a thought: don't worry if your ferment didn't start running at the temperature we've indicated; it is rare that two batches are exactly alike in alcoholic content; therefore, there will be differences in initial boiling temperatures as explained in the footnote below.

NOTE: These temperatures are approximate. It is very difficult to run exactly according to the prescribed degree because:

- a. Your thermometer might be off.
- b. Percentage of alcohol vs. water may vary considerably, even though you have followed correct instructions.

Therefore, as you gain experience, you will learn to judge both temperatures and the strength of the first trickle during the third and fourth runs. Usually you throw away that which comes off before the trickle steadies.

Reflux Column Distillation Units

[1] APPARATUS: Essentially there will be a pot (5 to 20 gallons), a packed column (1 to 3 feet) and a condensing system.

The pot requires little comment except to state that operators of gas-heated units should be careful because the produce is nearly pure ethyl alcohol and thus extremely combustible. The top and sides of the pot should be insulated.

The usual packing materials are - stainless steel mesh or turnings, glass beads or rings, and porcelain saddles. When packed normally, one can expect 6 inches of packed column height to be equivalent to one stage. Thus the pot and 1 feet of packed column will be equivalent to the 4-run pot still. The outside of the column will need insulation, otherwise too much internal condensation will occur due to heat loss to atmosphere.

There are two schools of thought on the need of an internal reflux condenser. Certainly if one is used, then careful control must be exercised, otherwise the column may become flooded and thus impair efficiency of separation. There should be a separate needle valve for controlling internal reflux water - do not allow the complete condenser water stream to pass through the internal reflux condenser. One way to decide on the need of internal reflux is the adequacy of the column insulation. If the column is not well- insulated, then the need for internal reflux is lessened.

[2] OPERATION: As in any distillation, the faster the rate of distilling, the lower the efficiency of separation. If a 3 foot column is used, the process can be forced and still yield good product with one run. If a short column (1 foot of packing) is used, a lower rate is desirable in order to get by with one run.

[3] CLEANING: The cleaning operations of a reflux column depend on one's techniques of distilling. After every batch, one should backwash the column, and after 4 or 5 batches, the column packing should be removed and cleaned thoroughly - hot, soapy water, vinegar rinse, raw water and sweet water.

Ageing

It was supposed for a long time that by ageing straight whisky in charred wood a chemical change took place which rid the liquor of fusel oils, and this destroyed the unpleasant taste and odour. It now appears by chemical analysis that this is untrue - that the effect of ageing is only to dissipate the odour and modify the raw, unpleasant flavour, but to leave the fusel oil still in the straight whisky.

It is known that wood absorbs some of the undesirable components while some of the materials in the wood are, in turn, dissolved by the whisky. At the same time, some of the secondary products are changed into acids and esters, so that in matured whisky many of the secondary components are actually present in HIGHER content than in green liquor. The esters increase in matured whisky, but to a lesser extent, while the furfurol and higher alcohols, i.e. fusel oil, remain practically unchanged. There is also the change in proof in whisky stored in wooden barrels, since water diffuses more rapidly through the pores of the wood than does alcohol.

The above paragraph throws a new light on the subject. Apparently it is not true that ageing in charred wood gets rid of the undesirable by-products, but still some of us like the taste of the esters because that's what gives the `whiskey taste' to much Stateside liquor.

It follows, then, that RUNNING ACCORDING TO TEMPERATURES IS ONE OF THE BEST WAYS OF GETTING RID OF UNWANTED BY-PRODUCTS.

In the past, some people have used the technique of accelerated ageing by double-boiler heating of 90 proof alcohol and wood chips. We definitely DO NOT recommend this method because, first, alcohol vapours are released above the flame of the stove, which is hazardous, and second, the method requires a loose-fitting cap on the alcohol container. It is difficult to specify what is loose and what is not. If the cap should accidentally be fastened too tightly, it is possible that pressure can build up inside the container, and it might explode. This is a double hazard because of the shrapnel-like articles of the container and the sudden release of the flammable alcohol vapours.

Endnote

The story is that "The Blue Flame" was written for circulation amongst expatriate Britons in countries where alcohol was difficult or impossible to get. One rumour, and it is probably no more than that, is that it was put together by the staff of one of Her Majesty's representations in the Middle East, the idea being that since people were going to do it anyway, they might as well be provided with instructions for doing it safely. (Cynics might think this too commonsense an attitude for diplomats of any country to adopt.)

Would-be experimenters should be warned that, in the UK at least, a licence is required to manufacture poteen. These are not easy to get. Laws will vary from country to country, as will penalties for breaking them. In some countries the penalties can be violent and painful. In the UK they are merely undignified. In a country where the penalties are severe, you might prefer to let someone else take the risk if you can get a supply at an affordable price. Shabby, but `watching the wall' means you don't get parts cut off you. It seems to be the case in practice that compounds of foreign workers in these countries will have well-established means of getting or making alcohol, and are pretty safe. You just need to get to know someone.

I'm told the title "The Blue Flame" derives from a test for suspect alcohol. I can't vouch for the chemical reliability of the test, but here it is:

> Heat a small amount of the spirit in a pan until it is well warmed. Turn off the heat, then put a flame to the warmed alcohol. If it is `clean' spirit with few impurities, it should burn with a steady blue flame. If the flame is flecked with yellow or orange, or if the flame sputters while burning, do not drink it - use it as an embrocation instead.

If you value your organs, make sure any spirit made in this way is cut. If you don't have a hydrometer, a rule of thumb is equal quantities of tap-water and alcohol. Do this even if you intend to mix it further with tonic or fruit juice. Try cutting a cupful first - taste will guide you to the right proportions of water and firewater.

IMPORTANT NOTE ***

It is a federal felony to actually use this information to build your own still and produce alcohol. The information presented here is simply for informative, educational and game-use only. In no way is this document meant to persuade people to actually produce illegal alcohol. It is ill advised to do so, but if you must there are legal ways to do so. It is possible, in special cases, to get a permit to build an experimental still, work on solar power, or power an alcohol gassed automobile. If you decide you want more information, look in the library under fuel alcohol, distillery, or wine making. Have fun but please use discretion.

The following is a large excerpt from a discussion about distilleries with Jesse Duke, Master Bootlegger. Jesse is considered one of the finest moonshiners in the land. Although he operated illegally, many law enforcers overlooked his operations for just a sip of his elixir while others hunted him down because he was considered the prize catch. Now retired, Jesse lives of the riches of his successful career. His love now is telling tales for all who will listen of his many adventures. Many sages have regarded him as an expert on distillation. Unfortunately, nobody can get Jesse to put his knowledge on paper. At least we can listen to him...

"So you want to know about a still do you? Well, I suppose I'm the expert around these parts. Your not with the law are you? Of course, I'm in retirement now and don't distill, except for medicinal reasons.

A still is a very old, very simple concept. It has been postulated that perhaps the reason that people actually started farming was in order to produce an excess of grain from which to produce alcohol. At any rate beer is made simply from fermenting most any grain starch. Whiskey, hard liquor, or other distilled drinks are made by removing water from the base material. If you distill beer you have whiskey, wine wields brandy, potato mash wields vodka. The technology to do this is available among almost any people's that are capable of speech it seems. All that is required is a source of heat, a cooking vessel, and some sort of cooling element.

The principle of the distillery, or still for short, is that water boils (i.e. becomes vapor) at 100 degrees Celsius (212 Fahrenheit). Alcohol (ethyl alcohol that is) on the other hand boils at about 73 degrees Celsius (170 Fahrenheit). If a liquid contains both water and alcohol and is heated to a temperature somewhere between these boiling points then it is possible to drive off the alcohol and leave the water behind. Now all that is left to do is capture these intoxicating vapors to increase the percentage of joy in the drink.

How is this done? The absolute simplest way is to place a freshly fermented, malted drink (beer in the raw) into a container and heat it. Seal the container except for a single tube/pipe/etc. leading away and into a tub of water. At the other end, allow the tube to empty into a cup or jug that has been set in a bed of ice. This is not the safest, or easiest still to run, it is the simplest. Constant care must be taken of the temperature, as there are no safe guards against overheating the beer (thus boiling off a good bit of water too) or an explosion. This can be caused by the careless who don't clean the equipment properly. A build up in the tubing can cause the pot to build up steam, and the you can say "Good night!"

The basic workings of the still are as follows. The pot is the containment vessel for the crude fermented beverage. A heat source is applied to the bottom of this to drive vapor out of the top vent pipe. This then leads more or less directly to the worm. The worm is a coil of tubing which acts to cool the vapor back into a liquid, which will hopefully be noticeably more intoxicating than the original material. A pressure gauge and/or valve can be added to the pot as a safety measure. A thermometer/rheostat can also be added to the pot to more closely control the temperature for optimum performance. However as hundreds of years of backwoods moonshining can attest, there is no need for such extravagances to produce good quality liquor. The worm can be made from almost anything. At one point car radiators were popular, however due to their less than clean nature, this is HIGHLY unrecommendable. The lead used in soldiering at the manufacturer can also easily react with alcohol to produce lead nitrates and other nasties that can permanently relieve you of the necessity of sight. More common, and safer is a quarter inch diameter copper tube, wound into a coil, and submersed in a barrel or bathtub of cold, slowly running water. A heat source should be diffuse if possible, a common trick was to place the pot on a piece of slate, then use a wood fire to heat the slate. This produced an even, slow heat that tended to prevent scorching of the grain sediment and eventually leaving a burnt taste to the end product.

Improvements are constantly being made to this basic design. One of the most revolutionary, and important additions is that of the thumper keg. When this is added to a still, it halves the distilling time and doubles the final proof of the beverage. The thumper keg is nothing more than a second pot which is not directly heated. Hot vapors from the real pot are piped over into the bottom of the thumper keg. The vapors then percolate through the thumper keg's hold of new crude alcohol. As it cools the vapor, water is drawn from the vapor. As the thumper keg's liquid warms, more alcohol is vaporized. Thus, when the vapors finally leave the top of the thumper keg, they have essentially been processed twice. Before the advent of the thumper keg, the crude mash would first be run for "singlings". These singlings would be run through the still a second time to produce the final whiskey. Now it was possible to produce a high quality, high alcohol content liquor on the very first run.

An additional attachment was invented long before the thumper keg, but is attached after it in the normal sequence of the still. This is the dry box. Simply said, it is a air-sealed box that takes the vapors from the thumper keg (or the pot, if a thumper keg is not used) and sends the vapors out the other side. In the mean time, the vapors have cooled slightly and water has condensed on the inside of the box. (Please note that this box is empty, thus "dry", except for the vapors passing through it.) The box is so angled that any water condensing inside runs through a pipe back to the thumper keg or pot. There should be three pipes attached to this dry box. One leads out of the box towards the worm, one leads out of the box into the thumper keg, and one from the thumper keg to the dry box. The reason there are two pipes between the dry box and thumper keg is to prevent a back log of liquid and a build up of pressure in the dry box. The pipe meant for the return of water to the thumper keg should be visibly lower to gravity than the pipe meant primarily for transportation of steam/alcohol vapor. Water from the dry box can be alternatively bled out onto the ground, or into a nearby stream, but it may still contain some alcohol, and for this reason it is often simply cycled back into the still.

The worm is probably the most important piece of the still, as far as final quality goes. All the careful care in the world can be put into making sure that the pot doesn't get too hot, the still can be clean as a whistle every time you run it, and if the worm is nothing more than gunky, disgusting, rusty piece of metal, your liquor will suck. Besides, that's not how they did it in the good old days, right? They used wooden kegs for the pot and thumper keg, and chances are that they used a can in place of a coil. A can is a sort of sleeve that has an input opening in one side for the vapor, and an output port for the leaving liquor. Basically it looked like a very thick walled can without the top or bottom. This allowed the cooling water to flow over a lot of surface area. It isn't easy to make something like this. It would involve a good bit of soldering with plumbers solder (i.e. no lead) and two large, closely matched cans. Perhaps a better way is to use copper tubing, coiled and submerged in a contained of water. (The can has to be submerged in cold water too by the way.) This coil of copper tubing is what is most commonly referred to as the worm.

That is the basics of the hardware. There are other nifty little adaptations that can be added but each requires a bit more technology than the last, so we'll keep it simple. Next is needed the knowledge of how to actually take field corn and produce drinkable white lightening from it. The true artists will insist that it be done with grain, and grain alone, while the pragmatist will say that adding sugar really doesn't affect taste that much and greatly increases the yield. You can decide for yourself whether sugar should be used or not. First you need starter stock. Take 10% of whatever amount of corn your going to work with and place it in a warm damp spot for about a week. Perhaps you will keep it in jars behind the stoves (don't allow the seeds to become submerged, they can drown believe it or not) in a burlap sack buried in a manure pile (please, please wash them VERY well) or whatever. After they have sprouted with 3-4 inch growths (and preferably before the leaves break free of their casings) grind them up. For small batches a sharp knife and cutting may work. Larger batches may require a meat grinder or something. This will act as an enzyme to start breaking starch down into sugar. Next thing that needs done (and should be down simultaneously with making the starter) is to grind up the other 90% of your corn. You might try buying ready round corn meal, maybe use that meat grinder again, perhaps soak the corn in water then try to grind them up. Whatever works for you. Then mix the ground corn with water to make a mix that won't quite hold a spoon straight up. About a gallon of mashed corn to three gallons of water, or less if you have already soaked the corn in water prior to grinding.

Now heat this grain/water till it is almost boiling, keep it simmering for 10 to 30 minutes. Then let it slowly cool, when you can comfortably put a finger in it, mix in the starter. Stir this around for another 20 to 30 minutes. Keep it warm during this time. If you desire (and it is a good idea to do this) yeast can be added at this point. Best thing to do is get brewer's yeast at a store that sells supplies for making wine, and then culturing the yeast in sugar water as per instructions with the package (if any). Otherwise you can use regular baker's yeast, or not use any, and trust wild yeast to do the work (keep your fingers crossed here). Watch the mix carefully, as without sensitive equipment it is hard to tell when the yeast have stopped working. The yeast will form a foam or crust as they work. As they finish, the foam will break up and disappear. The proper time to run it through the still is when the foam is pretty well gone, but not totally, there should be a film of it left with some holes poking through. Wait to long and you will have wood alcohol rather than grain, it is not possible, no matter who tells you different to return wood alcohol back to grain alcohol. I cannot possibly emphasize enough the number of injuries and fatalities occurring from attempts to "purify" wood alcohol. Run it too early and you won't get a good yield of anything but corn starch and water. It is better to run it too early, trust me.

The next major thing to know is how to know when to stop collecting the distillate. One easy way is to collect a small amount of the end product, splash it on the pot, and light it with a match or lighter. It should burst into blue flame. If it doesn't, there is too much water in it. Either turn down the heat on the pot if you are just starting, or stop collecting if its been going a while. By this time you have as much of the alcohol as you'll be able to get. Another, better way, is too watch the distillate as it pours out of the worm. It will sputter at first, slowly develop into a ready stream (hopefully), then at a certain point it will sputter a bit again, and then the twist to the stream will change very slightly as the content changes from mostly grain alcohol to mostly water. These are very hard changes to catch, and it takes practice to learn. It is however the most accurate means by which to gauge the distillate without high tech equipment.

That is about all there is to it. There are many, many other details that have been discovered in the many years of distilling, but these are the basics needed to build a simple still. Now, don't go off half-cocked kid. Distilling is illegal in this country without an official permit from the High Court. And of course, permits are only issued to the rich merchants that can put some gold pieces in important people's pockets. But of course, you young adventuring types try everything at least once, more until you get a sword in your face."

-- Jesse Duke
Master Bootlegger

Disclaimer from Tony: The following text is not recommended as a guide on how to make a decent still or how to run it. Let it more be a guide as to how much misinformation is around on the net. Please refer to http://homedistiller.org for better information. I only include this text with my notes, as it is already so widespread on the net.

How to make alcohol...

The Guys Six Feet Under Present

Part I of the Getting Homemade Highs File

Alcohol

First you must obtain (steal) a holding tank. I recommend those 6 gallon Alhambra water jugs which are often left on porches and in driveways for refills. Just take it off the porch at 3:00 AM and run it home. Now, put it where you are going to put your still. They need to be kept together. Hide your still even if you don't have parents that will shit when they see it. This is illegal by federal law, and you could get busted pretty well. Make your still so it is collapsible and you can fit it all into a small box. Hide the box in your room. When you are going to use the still, take it out and hide it behind some bushes where a passing state trooper, snoopy neighbor, or phed busting you for pirated games won't see it. Keep the Alhambra jug where the still is going to be, cause they are way too big to hide anywhere.

Also, keep your still somewhere with a good breeze or away from people who will smell it. When you are fermenting the shit, it will smell like puke or even worse. When you are distilling it, your heater might put off smoke. The alcohol will smell like alcohol, and heated mash smells worse than shit.

Now go buy a shitload of fresh or frozen whatever (check the list below). Frozen corn will be easiest to deal with because it is already cut off the cob and is very forgiving with beginners. Besides, it's all part of a great American tradition: Moonshine!

Ingredient	Product
Rye or Potatoes	Vodka
Molasses or Sugar Cane	Rum
Corn	Moonshine
Wheat or Rye	Whiskey
Barley or Rice	Beer
Grapes	Wine
Apple Juice	Hard Cider

```
|   Sake                        |   Rice                    |
 ----------------------------- ---------------------------
```

Put about 10 bags of corn in each jug and no more, because the carbon dioxide being released sometime pushes it up and out and you could get the shit all over the ground. What a waste. Besides, it will start to rot in the ground and smell even worse.

Anyway, add just enough lukewarm water to cover the surface and leave the stuff exposed to air for about 2 weeks at room temperature. After a few days it will bubble and look and smell like puke, but that's no problem. It should do that. Just be sure you've got adequate ventilation.

Installing a small fan in your Alhambra jug is no problem. Drilling holes in the sides of plastic with a sharp drill bit is easy. Drill two holes near the top, where there won't be any corn (fans do tend to heat up and short circuit when exposed to water) and insert two tubes. Make the fan blowing air into your jug, and not out. The mist from the mash will wear it down after a while.

Now, for the still. This is complicated, so bear with us. First, take a big beaker or something like it and put a big tube going out the top. You should glue around this tube, so none of the gas will escape. Now, run a smaller tube into the side of the bigger tube, and connect a valve to it.
Now,
connect the other side of the valve to your huge thing of fermented whatever, but make sure the tube connects at the bottom and goes straight across so the pressure of the water will push it along the pipe (pumps get too messy). I mount my Alhambra jug on bricks, so now the whole thing looks like this:

```
           |            |  |
 Fermented |   __ __    |  |

    Shit   |_____|______|  |
___________/----|_|-----,  |
  |      |     Valve    |--|
  |------|              /  \
  |Bricks|             /    \
  |------|            /Beaker\
  |______|           (________)
```

Now, bend the big pipe around, so it is pointing down at a 45 degree angle. Connect a bigger pipe to it. This will be the condenser. Connect a small pipe leading out of the condenser to a big cup or something that you will catch your 200 proof alcohol in. Also, make a rack to put the beaker on, so you can put a can of sterno or a bunsen burner under it. I would recommend putting a thermometer inside the beaker, so you can leave the temperature just above the boiling point of alcohol. If you don't, you won't get very strong alcohol.

```
                          ________
           |             /   ___  \
 Fermented |   __ __    /  /    \  \/\

    Shit   |_____|______|  |     \    \
___________/----|_|-----,  |     /cond-\
  |      |     Valve    |--|     \ enser>
  |------|              /  \      \    /
  |Bricks|             /    \      \  /
  |------|            /Beaker\      \ \_____________
  |      |           (________)       \-------------,|
  |------|           /   /\    \        ^ Pipe ^   ||
  |      |          |    \/     |              |___________|
  |------|          |  __||__   |              |  Alcohol  |
  |______|          | |Sterno|  |               \_________/
```

Everything should be a little farther apart than depicted in the picture,
but I only wanted to use 60 columns (80 columns with 1 inch margins).
However, the longer the tube leading away from the beaker to the condenser,
the longer the distillation process will take, so keep that quite close.
If you get the alcohol too close to the flame, it might evaporate. Keep that
at the end of a long pipe.

Now, there is only one last step. Take a very long length of surgical
tubing (the stuff they make water weenies out of) and wrap it around the
condenser, leaving almost no space in between coils. I usually wrap some duct
tape around the tubing so it keeps it in place and insulates it a bit. Now,
run one end of the tubing to mom's flower garden and the other end to a
valve. Connect the other end of the valve to a hose or some other cold water
source. Don't do anything stupid like use liquid nitrogen instead of water
cause it won't speed up the distilling process. This is what the finished
still should look like:

```
                         ________
                        /   ___  \  ______
 Fermented |   __ __    /  /    \  \/,----- -=> Heated
    Shit   |_____|______|  |     \  / \   __ __  Water
___________/----|_|-----,  |     / / / \____|__
  |      |     Valve    |--|     \/ / / >--|_|- <=- Cold
  |------|              /  \      \/ / /  Valve     Water
  |Bricks|             /    \      \/ /
  |------|            /Beaker\      \ \_____________
  |      |           (________)       \-------------,|
  |------|           /   /\   \         ^ Pipe ^   ||
  |      |          |    \/    |               |___________|
  |------|          |  __||__  |               |  Alcohol  |
  |______|          | |Sterno| |                \_________/
```

A friend of mine was going to be doing a lot of distilling cause he made a HUGE still. He was going first- class. He lived near a creek that stayed

pretty cool, so he was going to figure out how to use that unlimited supply of water. The creek grew plenty of bushes, so he hid his still in them. He even painted the valves green and stuck them out of the bushes and glued leaves on to them so nobody could tell it was a still. But he still didn't have any water. He couldn't have a small electric pump, cause he didn't have any electricity.

As it turns out, he now has 4 lengths of surgical tubing going down to the water, around his (superhuge) condenser. He made a rock and concrete dam about 3.5 feet high, to get a fast stream of suction. He then ran the tubes down to below the dam, and sucked on them. He siphons the water up and out of the creek, through the condenser, and back into the creek. His still is awesome! That thing can run as much as he wants it too, cause he isn't wasting any water, and it won't show up on any water bill.

If you are going to be distilling a lot of stuff, you better make a tube going out of the bottom of the beaker so you can dump out the water and garbage and every now and then. Of course, connect it to a valve, so you won't loose any precious alcohol that's trying to turn into steam in the beaker. Make sure any tubes (like this one) aren't made out of glass and can melt. It's bad when tubes melt, cause that means you have to rebuild the still almost from scratch.

Now that you've got it all set up and the corn (or whatever) is fermented and hooked up to the beaker, turn the valve on a bit to drip some puke of your Alhambra jug into your beaker. Turn on the sterno or bunsen burner to a high flame so it will heat up the beaker. Turn on the cold-water valve so you have cold water flowing around the condenser at a trickle. If the water coming out of the condenser is cold, turn the valve so even less water is coming out, because you don't want to use too much water. But, if it's warm, it's not doing its job. Keep the water coming out about lukewarm.

As this thing's just starting up, keep a good eye on your thermometer. You want to keep the temperature just above the boiling point of alcohol (which is less than the boiling point of water: 212 degrees). This is so you can separate the water from the alcohol by turning only the alcohol into steam, and you can get better stuff. If you're not sure of the boiling point of alcohol, ask your science teacher, or look it up, cause I don't know either.

Now, watch it, and adjust the valves so the fermented stuff coming out of the Alhambra jug just equals the steam going up the pipe, and it won't fill up or boil dry. Adjust the cold water valve so the water coming out of the surgical tubing is slightly warm. Now, wait. Read a book or download another Six Feet Under production, but always keep an eye on the still. When the Alhambra jug is empty and the beaker is dry, you are done. Don't expect this to go very quick, however.

If you like almost pure alcohol, distill it again. If you do it right, you could have no water at all inside your liquid high. However, even I haven't been able to get a batch that good. All it takes is practice and

getting to know your still. They all have different personalities.

You now have around 198 proof ethyl alcohol in that collecting cup. Pour the alcohol through activated charcoal to remove that nasty shit that makes you retarded and blind. The stuff is now safe to drink, but don't. One swig of 200 proof alcohol will probably kill you. 150 proof is only for experienced drinkers (derelicts). The highest proof I've ever had is 138, and it must have been the worst experience of my life.

Now, mix it in with about 3 parts alcohol and 5 parts Kool-Aid or distilled water or something. The more Kool-Aid or water, the less the proofage. To give you an idea, beer is around 6 proof, wine coolers are around 12, and wine is around 20. I wouldn't recommend more than 100 proof at all. If this is your first time, make sure you have a little bit alcohol and a shitload of Kool-Aid. You probably won't notice the taste or overdose that way.

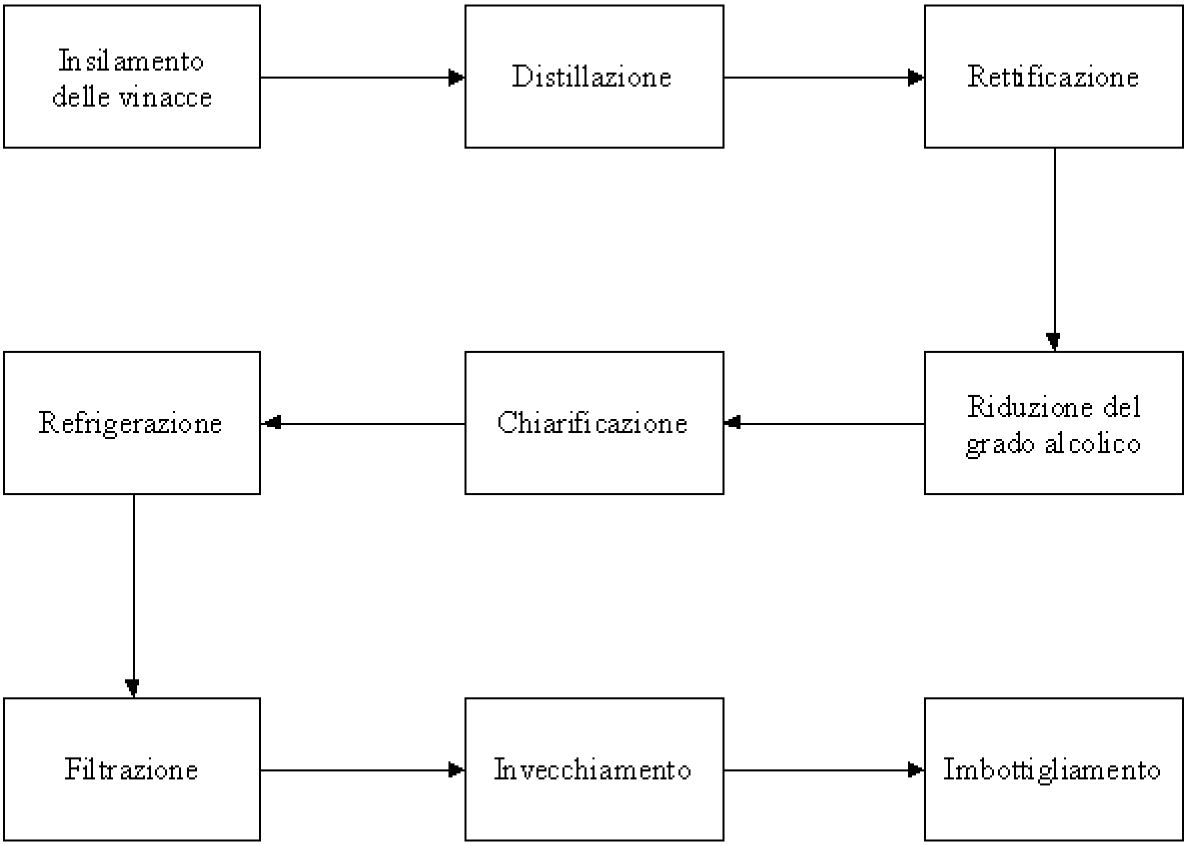
If it goes wrong, keep trying. Usually the first time, the stuff will taste like shit and be almost all water. It just takes some practice. Also, proof is roughly percentage times 2. 50% alcohol is 100 proof alcohol. 100% is way too high to drink. Never go above 75 percent alcohol (3 parts alcohol, 1 part something else), which is 150 proof. That shit could kill you.

Coming soon: Part II of Homemade Highs: How to smoke pot.

Produzione della grappa

La tecnica di produzione della grappa prevede diverse operazioni che vanno dall'insilamento delle vinacce all'imbottigliamento.

Il processo viene qui di seguito schematizzato:



Analisi delle fasi di produzione

Analizzeremo in dettaglio tutte le fasi che portano all'ottenimento della grappa:

Insilamento delle vinacce

La produzione industriale della grappa, negli appositi impianti, avviene per almeno 4 - 5 mesi all'anno, perciò la vinaccia fresca può essere distillata solo per brevi periodi.

Quindi, si rende necessario un insilamento della restante vinaccia per la successiva produzione.

Inoltre, vi sono le vinacce vergini e semifermentate che necessariamente devono essere insilate per consentire agli zuccheri di trasformarsi in alcol.

Tecnicamente la distillazione della vinaccia fresca fornisce una grappa migliore, in quanto con l'insilamento avvengono reazioni biochimiche che producono composti che non sempre sono fattori di qualità.

Le vinacce sono insilate in vasche di cemento, in silos di cemento, in contenitori di ferro rivestiti con resine epossidiche o in tini di legno. Tutti questi contenitori devono essere puliti, indenni da muffe e da sostanze organiche inacetite.

L'insilamento della vinaccia avviene dopo l'operazione di pressatura, perché, già dopo poche ore dalla separazione dal mosto, essa può subire alterazioni tali da compromettere l'ottenimento di buoni risultati.

Nei contenitori la vinaccia deve essere disposta a strati e pressata il più possibile affinchè non rimangano sacche d'aria. Inoltre, gli strati superficiali di vinaccia devono essere protetti dal contatto con l'aria mediante l'uso di teli di materiale plastico.

La distillazione

-

La fase più importante per la produzione della grappa è la distillazione.

Nella vinaccia sono presenti numerosi componenti volatili di cui quantitativamente, i più importanti sono l'acqua e l'alcol.

La distillazione è quell'operazione fisica con la quale si separano alcune sostanze che sono trasformate in vapore per essere poi ricondensate. L'operazione viene compiuta tramite il calore, con il quale si vaporizzano i liquidi, ed il freddo, che li ricondensa.

A pressione atmosferica, l'acqua bolle a 100°C, mentre l'alcol etilico bolle a 78.4°C; la conseguenza è che i vapori sprigionati dalla miscela in ebollizione contengono più alcol della miscela stessa.

Una miscela con circa il 95% di alcol ed il 5% di acqua (miscela azeotropica), bolle a temperatura inferiore a quella dell'alcol. Quindi, saranno i vapori di questa composizione a sprigionarsi per primi con la conseguenza che per distillazione non si può ottenere una gradazione alcolica superiore a 95°C.

Ne deriva che quando tutto l'alcol si sarà trasformato in vapore e sarà ricondensato, nella caldaia ci sarà ancora acqua. Il distillato quindi avrà un grado alcolico superiore a quello della miscela che l'ha originato.

Il punto di ebollizione di una miscela idroalcolica è intermedio rispetto a quello dell'acqua e dell'alcol e sarà tanto più vicino a quello di quest'ultimo quanto maggiore sarà la ricchezza alcolica della miscela. La temperatura di ebollizione di una soluzione idroalcolica a composizione costante, si alzerà man mano che questa perderà alcol.

In questa fase, inoltre, è importante concentrare al massimo i vapori alcolici prima di condensarli, in modo da ridurre il numero delle distillazioni che servono per ottenere un prodotto di una certa gradazione alcolica. Per fare ciò si usa un **deflemmatore**.

Esso, sostanzialmente, è un sistema di raffreddamento posto sulla sommità del distillatore, e storicamente ha avuto svariate forme che vanno dalla lente, alla sfera oppure semplicemente costituito da un serpentino.

Il fenomeno fisico che sfrutta questo apparecchio è la differenza di temperatura di ebollizione tra l'acqua e l'alcol.

In particolare al raggiungimento di una certa temperatura si formano i vapori che iniziano il loro moto ascensionale nella caldaia, e quando arrivano a contatto della parte superiore ancora fredda, si condensano e ricadono nella massa sottostante ;

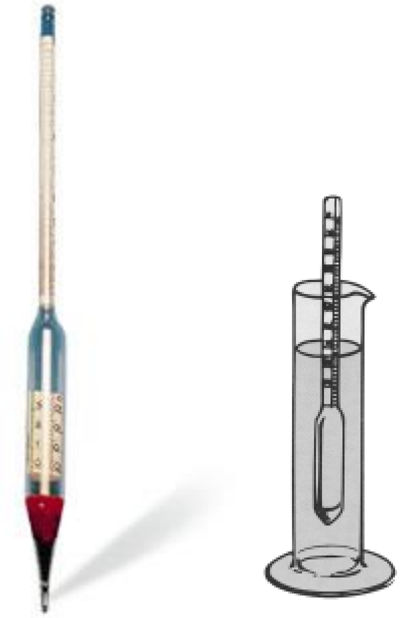
però tra i vapori si condenserà molta più acqua che non alcol, per cui essi quando usciranno dal distillatore avranno una gradazione alcolica superiore ai vapori che si erano formati in caldaia.

Questo fenomeno avverrebbe lo stesso anche senza il deflemmatore, ma solo nei momenti iniziali; poiché, proseguendo nella distillazione, l'elmo della caldaia si riscalderebbe in maniera eccessiva e non si riuscirebbe più a condensare i vapori alcolici come precedentemente.

Quest'apparecchiatura è talmente importante negli impianti industriali, che i vapori che escono dal distillatore raggiungono anche i 95° alcolici, e quindi, non necessitano di una seconda distillazione.

Nelle lavorazioni artigianali invece, non occorre arrivare a queste concentrazioni, poiché l'obiettivo è di arrivare intorno ai 50-60°, e quindi il deflemmatore è semplicemente costituito da una tela umida che va a raffreddare il coperchio della caldaia.

Per misurare il grado alcolico si usa l'alcolometro.



Oltre al **deflemmatore**, l'apparecchiatura per eseguire la distillazione è costituita in generale da:

- la **fonte di calore**, che cede energia al liquido; per un lavorazione artigianale è costituita da un fornello a gas poiché consente di avere una buona regolazione della quantità di calore da erogare.

- la **caldaia**, che contiene il prodotto da distillare; questa dev'essere costruita in rame (con l'esclusione di questo metallo si possono avere gusti solforati) o in acciaio inox. Questo perché materiali quali il ferro e l'alluminio, non sono adatti in quanto sono facilmente aggrediti dagli acidi delle vinacce, e oltre ad avere una vita relativamente breve, correndosi, diventano difficilmente pulibili. Inoltre i residui che rimarrebbero attaccati alla parete potrebbero decomporsi sia durante il periodo di inattività dell'apparecchio sia durante la distillazione, producendo composti che possano alterare le caratteristiche organolettiche della grappa.

- il **coperchio** della caldaia, detto anche *elmo*; esso può essere piano (se su di esso si fa scorrere l'acqua per avere una migliore deflemmazione), a forma troncoconica o di pera. Quando non esiste altra forma di deflemmazione, è bene che l'elmo della caldaia abbia la più grande superficie possibile, in modo che i vapori siano costretti ad incontrarla e per la massima parte. Per la costruzione del coperchio, come per la caldaia è preferibile utilizzare il rame o l'acciaio inox.

- il **collettore** che unisce il coperchio della caldaia al refrigerante, detto anche *collo di cigno*; per costruirlo si utilizza maggiormente il rame, e in caso di assenza di deflemmatore, è opportuno che sia abbastanza sviluppato con un'ampia sezione all'attacco della caldaia, che via via va restringendosi arrivando al serpentino.

- il **refrigerante** che condensa i vapori prodotti; esso è composto dal serpentino e dal recipiente. Il serpentino costruito in rame, ha lunghezza e diametro in funzione della capacità della caldaia e della temperatura dell'acqua. Il recipiente che contiene il serpentino può anche essere di metallo diverso dal rame, ma non è consigliabile il legno poiché disperse male il calore e quindi porta a un maggior consumo di acqua.

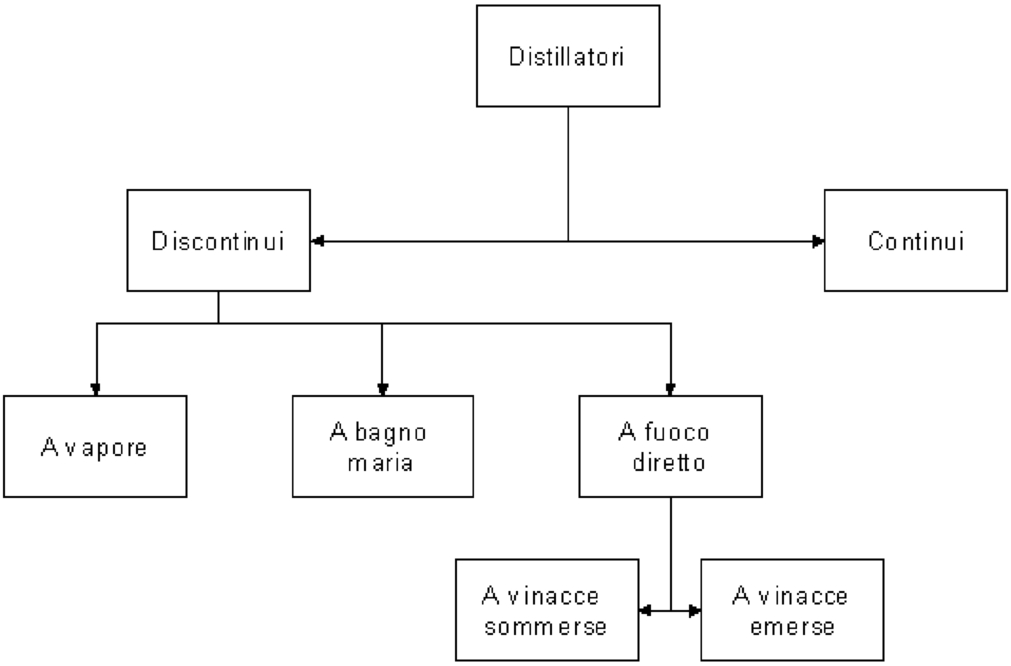
Tutta questa attrezzatura, storicamente, prende il nome di **alambicco**, e si differenzia nettamente tra un tipo di processo continuo e uno discontinuo.

Nel primo caso la vinaccia entra continuamente dall'alto, incontra il vapore che la esaurisce privandola dei componenti volatili, e viene allontanata dall'apparecchio tramite una coclea. Questo tipo di distillatore è prettamente riservato ad una produzione industriale.

I distillatori discontinui, più comuni nelle piccole industrie e nella produzione artigianale, si dividono in :

- **a vapore**

- **a bagno maria**
- **a fuoco diretto**



Nei distillatori **a vapore**, una caldaia esterna all'alambicco produce vapore e lo immettere in delle caldaiette facendo così esaurire la vinaccia.

Il distillatore **a bagno maria** è, invece, caratterizzato da una intercapedine, nella quale è racchiuso un fluido (acqua o olio), tra la fonte di calore e le vinacce.

La particolarità di questo apparecchio è nell'evitare il surriscaldamento della vinaccia, che può portare alla formazione di furfurolo e di altre sostanze dal sapore e l'odore disgustoso.

I distillatori **a fuoco diretto** si differenziano a seconda che le vinacce siano sommerse nella acqua oppure poste su una griglia sopraelevata.

Negli alambicchi *a vinacce sommerse* vi è un cesto che contiene le vinacce e ne impedisce il contatto con il fondo e con le pareti, e quindi evita loro il surriscaldamento.

Nel distillatore *a vinacce emerse*, la caldaia viene divisa in due sezioni da una griglia di rame; in quella inferiore si metterà l'acqua, mentre in quella superiore, vengono

poggiate le vinacce. Inoltre il vapore idroalcolico subisce una parziale deflemmazione, dovendo attraversare la massa spugnosa costituita dalla vinaccia.

Rettificazione

La distillazione non darebbe luogo a molti problemi se nella vinaccia gli elementi volatili fossero esclusivamente acqua ed alcol. Invece questa materia prima contiene una moltitudine di elementi volatili che se passano nella grappa in quantità moderate, conferiscono tipicità e finezza, mentre se superano un certo limite la deprezzano e la rendono fisiologicamente dannosa.

La rettificazione è quell'operazione che permette di separare le sostanze volatili di pregio da quelle meno pregiate.

Mentre negli impianti industriali, formati da colonne a piatti, la rettificazione avviene in modo continuo, nella distillazione di tipo artigianale si esegue, invece, dividendo la grappa, in fase di distillazione, in tre frazioni: *teste, corpo, code*.

Le *teste* sono formate dalle sostanze volatili che hanno un punto di ebollizione inferiore a quello dell'alcol etilico. Nella distillazione discontinua rappresentano la prima frazione di liquido che esce dal refrigerante.

Con l'esatta separazione della frazione di testa si allontanano gran parte dell'alcol metilico e dell'acetato di etile, che in un distillato è il responsabile dell'odore acetoso.

Il *corpo* o *cuore* è formato dai composti che hanno un punto di ebollizione compreso tra 78.4 e 100°C.

Se non vi sono state alterazioni, questi composti non nuociono alla grappa, anzi fanno parte del suo bagaglio tipico.

Il corpo è la frazione centrale del processo di distillazione ed è la più importante perché contiene la maggior quantità di alcol etilico e la minor percentuale di sostanze indesiderate.

Nel corpo, oltre all'alcol etilico, sono presenti altri alcoli, esteri e l'isovaleraldeide.

Le *code* sono formate dai costituenti volatili che bollono oltre i 100°C e che si raccolgono nell'ultima parte del distillato.

Nella distillazione non si raggiungono mai queste temperature, ma molti di questi composti chimici sono abbastanza solubili nei vapori alcolici caldi ed in parte sono trascinati anche se non sono solubili negli stessi vapori.

Gli acidi, soprattutto l'acido acetico che conferisce un sapore pungente alla grappa, devono essere separati con molta attenzione perché sono in grado di arrivare nel distillato anche se nessuno di loro ha un punto di ebollizione inferiore ai 100°C.

Le code, quindi rappresentano la terza frazione di distillato. Già quando la temperatura di processo supera i 90°C, inizia l'inquinamento delle sostanze altobollenti, che sarà tanto più elevato quanto più violenta è l'ebollizione.

Riduzione del grado alcolico

La grappa prodotta può avere una gradazione alcolica di 50- 60°C, e se non è destinata all'invecchiamento o se non la si vuole consumare con tale ricchezza alcolica, si effettua una riduzione del grado alcolico mediante taglio con acqua.

Esistono delle tabelle che indicano quanti litri d'acqua bisogna aggiungere alla grappa in esame per portarla alla gradazione desiderata.

Per esempio, per portare 100 litri di grappa da 40° a 55° si devono aggiungere 38.5 litri d'acqua.

Con la riduzione del grado alcolico, alcuni composti solubili in miscele ricche di alcol si insolubilizzano diventando facilmente separabili con una semplice filtrazione, o con una chiarificazione.

Tutto questo è un vantaggio per la stabilità della grappa nel tempo, perché si eliminano grandi quantità di acidi quali il miristico, il laurico, lo stearico, l'oleico, il linoleico, il linolenico ed i relativi esteri formati con l'alcol etilico, metilico e amilico e di acetale che s'idrolizza.

L'acqua che si aggiunge per ottenere la riduzione del grado alcolico non deve essere dura. Infatti, se contenesse sali poco solubili in ambiente alcolico, questi ne comprometterebbero la stabilità originando con facilità intorbidimenti e depositi.

La legge impone l'impiego di acqua distillata.

Form per la riduzione del grado alcolico

Chiarificazione

Quest'operazione, insieme alla refrigerazione ed alla filtrazione, serve per eliminare quei difetti del distillato, che si sono originati nel tempo per insolubilizzazione di vari componenti, i quali vanno ad intorbidire la grappa. Questa, inoltre, per vari motivi può presentare difetti che devono essere eliminati.

Per la chiarificazione s'impiegano prodotti organici o minerali che, dopo averli sospesi in acqua, s'introducono lentamente nel distillato ed hanno la proprietà di flocculare trascinando sul fondo le impurità presenti.

Il trattamento è molto efficace, ma bisogna tener presente che i prodotti usati asportano anche notevoli quantità di profumi, deprezzando la grappa trattata.

Refrigerazione

Questa fase ha lo scopo di favorire l'insolubilizzazione degli oli di flemma in modo da poterli separare mediante filtrazione.

La grappa viene portata ad una temperatura variabile tra i - 10°C ed i - 20°C per almeno 48 ore e poi si filtra con setti in grado di trattenere gli oli insolubilizzati.

Filtrazione

Serve a rendere la grappa limpida trattenendo i flocculi di chiarificante che non sono precipitati ed altre sostanze sospese che accidentalmente possono essere presenti.

La filtrazione può essere eseguita con filtri a carta o con filtri a pressione che impiegano coadiuvanti di filtrazione oppure con strati filtranti preformati.

Per le piccole e medie produzioni si utilizzano filtri a pressione che impiegano strati filtranti.

In genere, per ottenere una buona qualità del filtrato, occorre utilizzare strati a media e bassa permeabilità.

Invecchiamento

Invecchiare un distillato significa conservarlo per un certo periodo di tempo in fusti di legno che non abbiano subito impermeabilizzazione.

Le grappe invecchiate costituiscono una grande categoria nell'ambito delle grappe, e l'invecchiamento è un mezzo di indiscutibile validità perché il produttore possa esprimere la sua maestria nella produzione di acquaviti di vinaccia di qualità.

Per la grappa possiamo distinguere tra un *breve (piccolo)* ed un *lungo (grande) invecchiamento*.

Nel ***piccolo invecchiamento*** dovremmo parlare più propriamente di un affinamento in legno. Infatti, la durata è limitata a 6 - 12 mesi, le cessioni da parte dei fusti sono minime e questi possono essere di dimensioni notevoli e raggiungere anche i 6000 litri e più di capacità.

In questo modo la grappa raggiunge una tinta appena paglierina o resta bianca, il gusto si armonizza ed i profumi aumentano leggermente in intensità e finezza.

Il ***grande invecchiamento***, invece, consiste nel far soggiornare la grappa in piccoli fusti con capienza è massime di 700 litri, per periodi che vanno dai cinque ai quindici anni. In questo caso la grappa che si ricava è completamente diversa dal distillato che si era introdotto nei fusti;

infatti il colore assume un giallo che va dal "paglierino" al "dorato scarico", il profumo va ad assumere una flagranza più intensa e più armonica, ed il gusto assume un sapore rotondo con una leggera sensazione di vaniglia.

L'invecchiamento produrrà le attese caratteristiche organolettiche esclusivamente se saranno rispettati tre fattori:

- Cessione di sostanze gradevoli da parte del legno.
- Ossigenazione del distillato.
- Giusto tempo di permanenza nel recipiente.

Compito del legno è quello di cedere determinati composti polifenolici quali la *quercina* , *querecitrina* , e altri tannini che conferiscono il tipico colore e la classica struttura organolettica. Il legno inoltre cede emicellulose e lignina che si idrolizzano trasformandosi in zuccheri, ammorbidendo gradevolmente il sapore. Sotto questo aspetto, oltre al **rovere** che è il legno più usato nella costruzione dei fusti, danno ottimi risultati il frassino ed il ciliegio.

Nonostante alcune aziende aggiungono trucioli di legno o particolari sostanze chimiche, il risultato non è mai allo stesso livello di quello ottenuto facendo invecchiare la grappa nelle botti di legno.

Un altro fattore importante dell' invecchiamento della grappa risulta essere l'ossigenazione. L'ossigeno che viene a contatto del distillato è quello proveniente dall'aria tramite gli infiniti pori del legno.

La grappa inoltre tende a fuoriuscire dalla botte e va ad incanalarsi nei pori del legno, risultando quindi finemente suddivisa quando incontra l'ossigeno;

questo fa si che ci sia un'ampia superficie di scambio che facilita le reazioni di ossidazione a carico dell'alcol etilico e degli alcoli superiori .

Questa ossidazione porta alla formazione di acidi organici, che reagendo con gli alcoli da luogo agli esteri che conferiscono delle caratteristiche fondamentali per il bouquet della grappa.

Il terzo fattore, indispensabile per l'invecchiamento, è il tempo che il distillato deve trascorrere nel legno. I fenomeni chimici, che originano nuovi composti qualitativamente importanti, sono molto lenti; è necessario, quindi, attendere per lunghissimi periodi (anche 10 anni) che queste reazioni avvengano.

Si può cercare di ridurre il tempo, utilizzando fusti di capacità inferiore, legni più porosi o più nuovi, che non siano ancora stati esauriti da precedenti partite di distillato. Queste tecniche non sono utilizzabili oltre un certo livello, poichè non possiamo forzare più di tanto senza compromettere l'eleganza, la finezza e l'armonia della grappa invecchiata.

Per la **costruzione delle botti** è necessario attenersi a determinate regole, poichè è indispensabile che i fusti abbiano determinate caratteristiche.

Innanzitutto una volta abbattuti gli alberi (rovere,cilegio o frassino) e ridotti in tavole, è necessario che quest'ultime soggiornino in locali areati per almeno 3-4 anni al fine di seccare il legno; questa operazione è importante affinché buona parte dei polifenoli astringenti e amari si ossidino per trasformarsi in tannini più gradevoli. E' importante inoltre che le doghe per la costruzione dei fusti siano state ricavate spaccando il legno e non segandolo; questo, per evitare una porosità troppo elevata che comporterebbe forti perdite del distillato per evaporazione. Prima di impiegare i fusti nuovi si deve procedere a vaporizzarli o a lavarli accuratamente e con acqua bollente per eliminare le sostanze legnose facilmente solubili, ma poco gradite nel distillato. Sempre per questo motivo è bene riempire i fusti nuovi per quattro o cinque mesi, con una acquavite di minore pregio prima di utilizzarli per un grande invecchiamento di una grappa di qualità. Inoltre, nella costruzione di piccoli fusti, è indispensabile utilizzare doghe molto spesse in modo da evitare le perdite del distillato in volume, e una ossigenazione troppo spinta.

I **locali dell'invecchiamento** devono avere temperature medie intorno agli 20-25°C, e una umidità relativa non inferiore al 70%.

Se sono troppo freddi le reazioni chimiche proprie del invecchiamento vengono rallentate, se troppo caldi, il calo della grappa per evaporazione è rilevante. Così pure se gli ambienti sono troppo secchi si ha una forte perdita in volume.

Contrariamente a quanto si pensa, è nelle cantine umide che il grado alcolico diminuisce più facilmente; questo perché l'alcol è più volatile dell'acqua ed in queste situazioni l'umidità si oppone all'evaporazione dell'acqua ma non dell'alcol.

Imbottigliamento

Dopo aver verificato il giusto grado di invecchiamento, magari tramite degustazione, si confeziona la grappa in bottiglie apposite, che vanno da una capacità di 3 centilitri (mignon) ad una di 2 litri.

Preferibilmente le bottiglie devono essere di vetro, poiché esso conserva nel miglior modo le caratteristiche organolettiche della grappa.

Grappa aromatizzata e metodi di produzione

Le grappe aromatizzate rappresentano una parte molto importante nell'ambito dei distillati di vinaccia; perché le grappe oltre ad assumere delle piacevoli qualità organolettiche, acquistano dall'erba officinale impiegata, le virtù terapeutiche associate a quest'ultima.

Le sostanze chimiche, contenute nelle erbe, che sono in grado di essere solubilizzate dalla miscela idroalcolica, possono essere così suddivise :

- Gli **zuccheri**, che terapeuticamente, oltre ad esercitare una azione energetica sull'organismo, hanno una discreta proprietà regolatrice sull'intestino.

- Gli **acidi organici,** che sono rappresentati per la maggior parte dagli acidi malico, ossalico, citrico, succinico, tartarico.

- I **fenoli**, rappresentati dai tannini, dagli antrachinoni e dai composti floroglucinici; le loro proprietà terapeutiche riguardano una azione astringente, purgante, e tenifuga.

- Le **saponine triterpeniche**, che favoriscono la diuresi, l'espettorazione e la sudorazione

- Gli **steroidi**, che comprendono i glucosidi e le saponine steroidiche. I primi utili negli scompensi cardiacaci, mentre le seconde hanno effetti analoghi a quelli delle saponine triterpeniche.

- Gli **alcaloidi**, che stimolano la respirazione, aumentano la sudorazione e la salivazione, ed agiscono in vario modo sul sistema nervoso, digerente e cardiocircolatorio.

- Le **essenze**, che hanno una grande importanza dal punto di vista organolettico.

- Le **resine**, che svolgono sull'organismo umano funzioni importanti a livello dell'apparato respiratorio e digerente.

La **preparazione delle grappe aromatizzate** può avvenire sostanzialmente in due modi :

- aggiungendo le erbe come tintura alcolica.
- mediante macerazione nella grappa di una pianta officinale (o parte di essa) allo stato fresco o essiccato.

La **tintura alcolica** di un'erba officinale si prepara facendo macerare l'erba in alcol di una determinata gradazione, per un periodo di tempo che oscilla dai cinque ai dieci giorni. In genere si utilizzano cinque parte di alcol per ogni parte di erba officinale. Allo scadere del termine fissato, si separano le parti solide dalla fase liquida mediante filtrazione oppure pressatura, e si ottiene la tintura alcolica che verrà addizionate alla grappa nella quantità voluta; per legge l'alcol aggiunto con la tintura non deve essere superiore al 3% rispetto a quello contenuto nella grappa. Questo tipo di preparazione è comodo perché permette di aromatizzare la grappa di volta in volta, partendo sempre dalla stessa base ed aggiungendo questa o quella tintura alcolica. Inoltre questo tipo di processo consente di scegliere il grado ottimale di aromatizzazione facendo magari delle prove in piccolo.

La **macerazione diretta della pianta officinale** nella grappa si esegue immergendo l'erba, in dovute proporzioni, nella grappa già portata al tenore alcolico che dovrà avere quando verrà consumata. Il tempo di macerazione varia in considerazione della pianta officinale utilizzata, e della gradazione alcolica della grappa (più è elevata, più sarà forte l'effetto solvente, e meno tempo occorrerà).

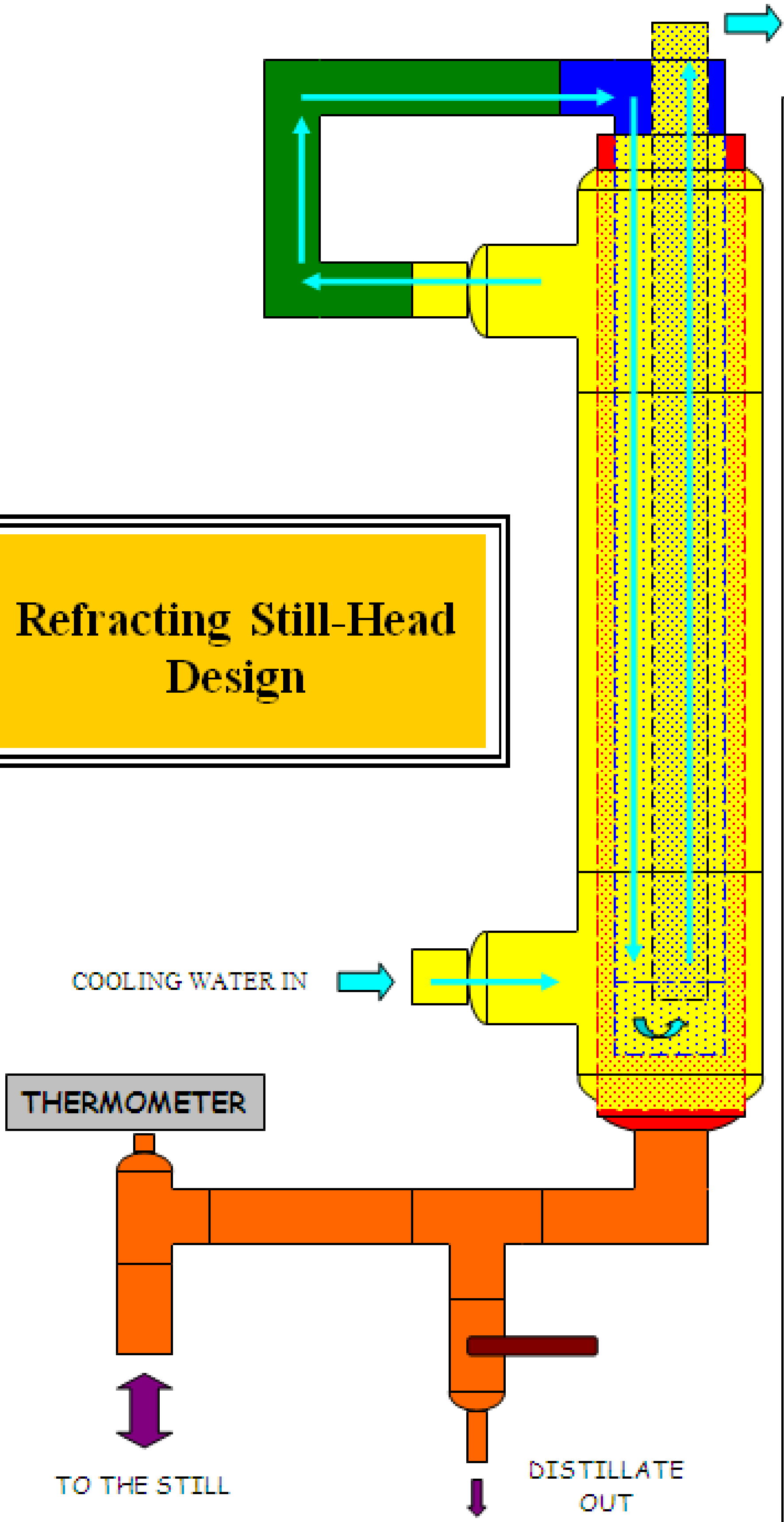
Il periodo di macerazione deve terminare quando l'acquavite ha estratto, nella giusta misura, i principi aromatici buoni e non ancora quelli sgradevoli. Ecco perché non è raccomandabile lasciare le erbe dentro la grappa fino a che essa non sia consumata. Dal punto di vista qualitativo non c'è molta differenza nell'usare una pianta fresca o una essiccata; indubbiamente è più comodo il secondo sistema perché qualsiasi erba è facilmente reperibile in erboristeria.

Nelle grappe aromatizzate viene sempre più o meno aggiunto un quantitativo di zucchero, perché esso migliora il sapore rendendolo più armonico. La legge ne consente un'aggiunta massima del 2%; a livello casalingo se ne può aggiungere anche il 5-6%, ma se si aumenta questo componente ci si avvicina sempre di più al liquore, allontanandosi dalla grappa.

La grappa che si utilizza nelle preparazioni deve essere di buona qualità; infatti, è erroneo utilizzare una grappa scadente pensando che il sapore venga mascherato dall'aromatizzazione. In genere succede il contrario, si formano combinazioni che danno un sapore molto sgradevole. E' da tenere presente, inoltre, che diluire una grappa aromatizzata è rischioso, perché alcuni componenti possono insolubilizzarsi provocando un intorbidimento, e ci possono essere alterazioni nell'armonia del gusto.

Al termine dell'aromatizzazione è sempre bene eseguire una filtrazione per rendere più limpida l'acquavite.

Refracting Still-Head Design



Particulars

This design is based on a Nixon/Stone set-up.

It is made of copper, using five different diameters of tubing in its construction (2", 1.5", 1", .75" and .5").

It consists of a 1.5 inch condensing tube (Red) that is jacketed with a 2 inch cooling tube (yellow) and inserted with an additional 1 inch cooling tube (blue).

The internal (blue) and external (yellow) cooling units are joined together and utilize the same water source. The internal unit in capped on the bottom and has a 1"x.5"x.5" tee at the top. One arm of this tee is the cooling water inlet. The other tee has a length of .5 inch tubing running through it. This outlet tube runs from the bottom of this unit up through the tee where it is soldered to the discharge hose fitting.

A key to the construction of this unit is the alteration of fittings. Normally, these fittings have internal stops that prevent a tube from extended too far into the fitting. In order to allow the tubes to pass through the fittings so as to create the external jacket these stops are filed away.

The upper end of the condensing tube (red) is left open to prevent pressure build up.

Links to Other Sites

This site : Home Distillation of Alcohol

Harry's excellentAlcohol Library

Distillation and Stills

Brewhaus - American supplier of stills & supplies.
A 25cm column that produces 95% at 1.2L /hour! Pure Distilling
Another Aussie distilling site : http://www.users.bigpond.net.au/home_drinkers
A Polish site: http://bimber.prv.pl
The Economy Still - 55% purity for 75 quid.
Distilling Information Archive
U.S. Bureau of Alcohol, Tobacco & Firearms Title 27 relating to Distilled Spirits Plants (DSP) ha a useful FAQ section.
Mike Nixon and Mike McCaw's Amphora Society - home of "The Compleat Distiller" book.
Th Swedish Moonshine at http://www.users.bigpond.com/larborn
StillCookers page at http://us.geocities.com/stillcooker/index.html
StillCooker's site
StillMakers "Build a World Class Distillation Apparatus" site :
Http://www.Moonshine-Still.com for free reflux still plans
ibrew wine & beer making suppliers in Australia - suppliers of oak casks
Ian Smiley's book "Making pure corn whiskey" at http://www.home-distilling.com
Mother Earth Alcohol Fuel manual
http://journeytoforever.org/biofuel_library/ethanol_motherearth/meToC.html
The Manual for the Home and Farm Production of Alcohol Fuel by S.W. Mathewson :
http://journeytoforever.org/biofuel_library/ethanol_manual/manual_ToC.html
Distilleries in your country
Outterson, LLC (US) still & equipment supplier
"Dangerous Laboratories's" Building a Tea Kettle still - with heaps of photos to help too.
Jan Willem's Distilling page - great illustrations and details.
Distillers news group
Thicko's guide to distilling alcohol.
Gert Strand's Partyman Homepage - book, yeasts & fermentation

Aaron Smith's Millenium Moonshine page
A still aboard the Mir spacecraft ?
Australian Distillation Act of 1901
Big Al's page
Fermtech & Still Spirits (New Zealand)- stills, flavours & yeasts.
Spirits Unlimited (New Zealand)- still manufacturer & book.
Aqua Vitae (New Zealand)- homebrew shop.
Brewers World (New Zealand) - lists suppliers of the Fermtech & Still Spirits goodies.
Desti Lab Stainless Alcohol Still/Water Purifier
Malt Masterclass for training in Malt whisky distilling
Secrets of Building an Alcohol Producing Still
See the Virtual Bar for a brief summary of the process
Vendome Copper and Brass works - price list
Polish Vodka - on vodka technology
Schnapsbrennen
Brewhaus (Canada) - essences & yeast
John Stones http://www.gin-vodka.com

Technical/Detail Information

University of Nevada Las Vegas Hotel Administration Course : http://www.unlv.edu./Tourism/362Textbook/ and the slide presentation which goes with the course : http://www.unlv.edu/Tourism/FAB362PowerPointSlides/.
http://www.whiskyschool.com/
UCC's details on ethanol's properties & chemical reactions
Information about alcoholism & the effects of alcohol at Unhooked Alcohol, etc in general.
Distillation when it was known as Alchemy - worth a look !
University of Akron's slide-show on principles of distillation
"The Brewery's" Technical Library for articles on brewing related topics (extremely comprehensive)
AllTech's company homepage (yeast suppliers & Alcohol training)
Info & experiments about yeast and alcohol.
Fun Facts about alcohol
Packed Column Design
Column Internals
'Structured Metal Packing
Distillation, Vapor Pressure, Vapor-Liquid Equilibria

Ethanol as a Fuel

Robert Warrens Running on Alcohol

By far the most comprehensive : Steve Spence's Renewable Energy pages - with a focus on motor fuel, and the USA ATF permitting processes.

Journey to Forever covers it, along with other reneable energies.

Alcohol can be a Gas from the Institute for Ecological Agriculture

Traditional Distillation

David Nathan-Maisters "Virtual Absinthe Museum - an excellent reference for all things pertaining to Absinthe.

Fermented cereals a global perspective at http://www.fao.org/docrep/x2184e/x2184e00.htm#con

History of Vodka - its origin, name and distilling in Poland

Alcohol in East Africa, 1850-1999

The Cognac process, and the Art of Distilling (brief summary)

Whiskies of the World Expo

Indonesian distillation from lontar palm

Making Whiskey - a personal experience by Roger Dowker

Herbal oil extracts

Flavouring

Des Zines (Topkiwi) Code Imports - flavours and essences

Gunther's Liqueur Making - principles and techniques

Alternative site for Gunther's Liqueur Making

French recipes (in French, so use Babel Fish to translate)

Moonshine

Techniques and equipment have improved considerably since..

Greek raki

Moonshine Online

A moonshine story

Moonshining - Everything your Dad didn't tell you, and your Grandpa forgot.

Moonshine - How to Make it.

The View from Here.

Moonshining in the Southern Appalachians

Diana's moonshine recipe.

$15 moonshine book (no idea what its like)