Marine fuels in the low-sulphur era

The global marine fuel market is steaming towards a major upheaval, as the industry prepares to enter the next phase of the low-sulphur era. From 1 January 2020, new International Maritime Organization (IMO) regulations come into force, designed to slash the amount of sulphur that ships release into the atmosphere.

To understand the impact this change will have on the industry, let's take a closer look at the fuels currently in use, the mix of bunker fuel products likely to emerge in the coming years, and how the expanded range of fuel possibilities will challenge operators.

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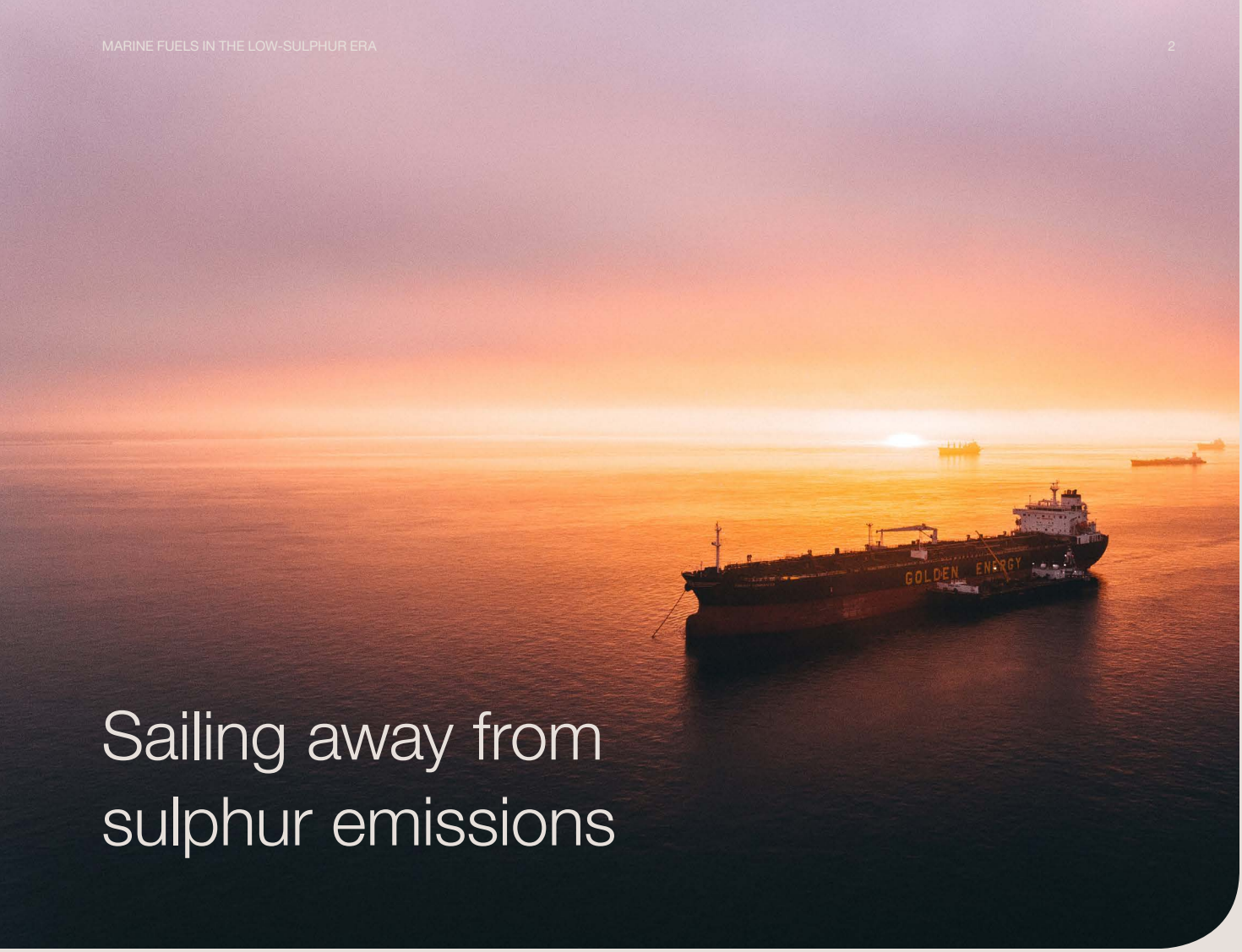


Sailing away from sulphur emissions

It's common to describe the new IMO regulations as ushering in the low-sulphur era, but in fact, post-2020 will be the industry's lower-sulphur era.

Sulphur is a naturally occurring element, present in all fossil fuels. It's essential to life, but its presence in the atmosphere as sulphur oxides (SOx) can, at high concentrations, cause many serious health and environmental problems.

Until now, the shipping industry has been one of the greatest emitters of SOx – in 2007, for example, ships emitted 15 million tonnes of SOx, approximately 5-8% of global emissions. But this is set to change quickly.

The IMO began regulating shipping's environmental impact with MARPOL 73/78 (the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978).

Then, in 2005, Annex VI of the convention came into force, for the first time limiting the sulphur oxide (SOx) and nitrogen oxide (NOx) levels in ships' emissions. In terms of SOx, the first global limit set was 4.50% mass/mass (m/m) sulphur in fuel oil. In addition, Annex VI also established Emission Control Areas (ECA), a small number of limited zones around several major population centres, where the sulphur limit was set much lower.

In 2012, the global limit was dropped to 3.50% m/m. Then in 2015, the ECA zone limit was lowered to 0.10%. In 2020, the ECA limit stays, but the global limit drops to 0.50%.

Despite some concerns that both the shipping and refining industries need more time to prepare for the change, the IMO has recently confirmed that the 0.50% limit will not be delayed, and that all ships will need to comply from 1 January 2020 or face stiff penalties, including being declared unseaworthy.

The fuels of the low-sulphur era

While the changes of the past decade or so have already affected the variety of fuels available around the world, the majority of the fleet still runs on heavy fuel oil.

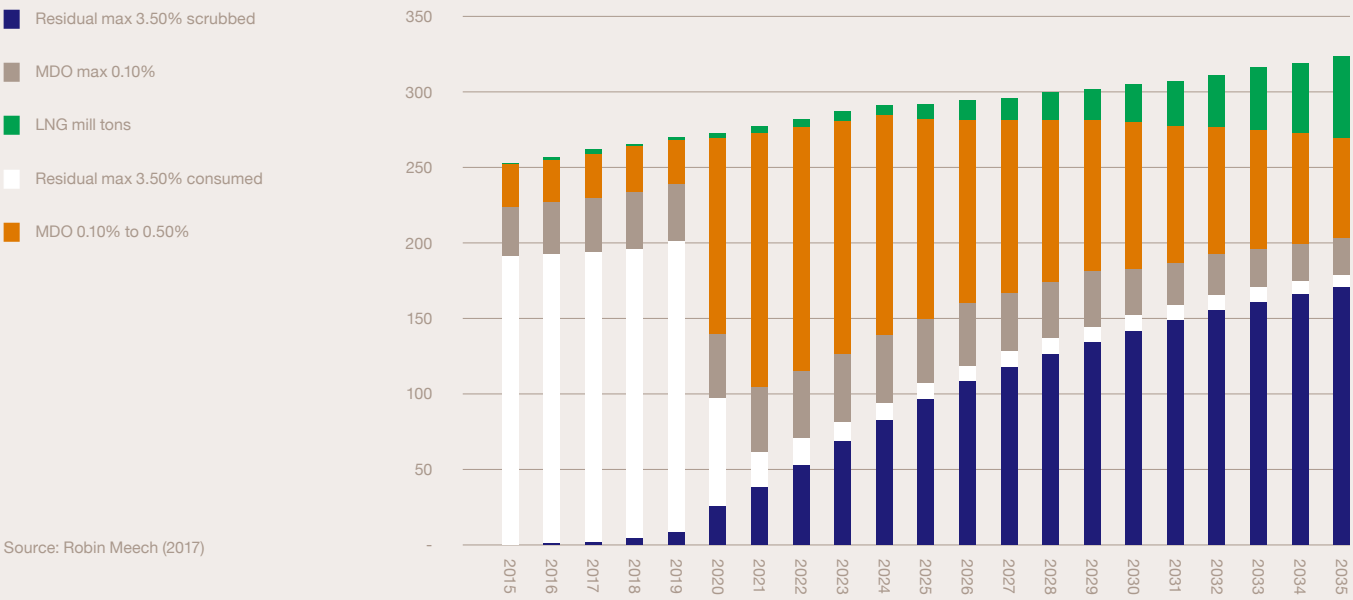
But the new rules, which cut current sulphur content by 85%, will spark more significant changes than the industry has ever seen. Operators without an up-to-date understanding of fuel parameters and associated handling requirements run the risk of major costs and problems.

At a recent Lloyd's List Business Briefing, panellists noted that even though there is no coordinated approach from refiners, it's clear that the industry is headed for a multi-fuel future.

Going deeper, we can expect the post 2020 fuels to fall into five main categories:

- Ultra-low sulphur fuel oil (ULSFO), max 0.10%
- Very-low sulphur fuel oil (VLSFO), max 0.50%
- Heavy fuel oil, max 3.50%
- LNG (liquid natural gas)
- Others

Marine Fuel Demand



Source: Robin Meech (2017)

ULSFO 0.10% S

A range of new fuels that entered the market to meet the 0.10% ECA requirements will continue to be used. These types of fuels are mostly neat distillates. However, they could also be hybrids – gas oil blended with residual oil. In general, these fuels work well with standard engine configurations, though they may require operational changes. For example, the distillates have relatively low viscosity levels, that need careful management. Also, some of the new hybrids use products not traditionally used in marine applications, introducing uncertainty about stability, compatibility, and contamination. Because of the potentially high demand for these fuels, the marine sector may find itself in competition with other industries, and these fuels will be an expensive option.

VLSFO 0.50% S

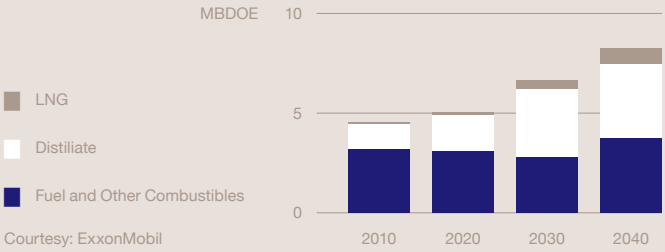
Refineries will always have a need to proactively use up their residues. It is possible to blend suitable residual products with low sulphur distillates to create good quality, compliant fuels. These blends can contain up to 40% residue, yet still be kept below the 0.50% sulphur cap. However, they come with a high risk of instability and can potentially be hypersensitive to mixing with other fuels on board.

Heavy fuel oil (HFO) with scrubbers

Although the IMO regulations are expressed in terms of sulphur levels in the fuel, ships are considered compliant if they have abatement technology fitted to “scrub” the sulphur from their exhaust gases. Scrubbers already in operation have proven themselves capable of handling high levels of sulphur in fuel. They allow operators to continue using the cheap, abundant residual fuels they already know well. Although not suitable for all ships, this will be an attractive option for many.

LNG

The sulphur content of LNG is well below the regulatory limit, and its clean burning properties make it an appealing choice. In practice, though, the cost of refit, manufacture, transport, and storage (both on shore and onboard) rule it out as a viable option for most operators. LNG is mostly methane – a powerful greenhouse gas – so leakage is a significant environmental concern. And burning LNG does still release more carbon dioxide than many people realize. Currently, there are only around 200 LNG ships in operation or on order. This number will grow steadily in new builds, and ExxonMobil estimates 12% of the fuel used in 2040 will be gas. In other words, LNG may become the main shipping fuel of the future, but that future remains decades away.



Courtesy: ExxonMobil

Others

A range of other types of fuels have also started entering the mix. These include biofuels – also known as FAME (fatty acid methyl ether) – fuels extracted from waste plastic, methanol, and other new types not yet on the market. Some of these fuels exhibit properties that are problematic for marine use, such as a high risk of microbial growth. Nevertheless, biodiesel is sulphur free, and has relatively high lubricity. These types of fuels remain too expensive to be an attractive choice on their own, but they can be useful for blending with other fuels to cut the sulphur content.

The challenge for shipping

In the cutover to the 0.50% era, there is no smooth transition – as noted above, strict compliance will be required from day one. In that sense, the biggest initial challenge will be not so much at sea, but in the supply chain, where bunker barges will need to be cleaned and ready, and tanks filled with compliant fuel.

Nevertheless, for ship owners, availability of low-sulphur fuels is not expected to be the biggest problem. Their real headache will be anticipating the different types of fuels available and understanding how to use them, individually and in combination with other fuels. As Lloyd's Register fuel specialist Tim Wilson explains:

> ***"the ship owner needs to realise the risk if they do not prepare in a way where their fuel management is very clearly defined to take into consideration the tremendous diversity and range of formulations of fuels that is going to be facing them from one bunker to the next. They could run huge operational risks on board ship".***

Instability

A fuel is considered stable if it tends to retain its material properties over time. Unstable fuels undergo chemical changes in the short term that can cause severe operational problems.

In unstable distillates, unsaturated hydrocarbons become oxidized, producing resins, gums, and varnishes.

In unstable residual fuels, asphaltenes and other aromatic, polar, hydrocarbon molecules tend to clump together, forming thick sludges in storage tanks. These sludges are sticky and highly viscous.

A ship using unstable fuels can suffer clogged filters, separators, and pipes. If its fuel pumps become overloaded, there can be problems with ignition and combustion and a risk of permanent damage to pistons, piston rings, and cylinder liners. Extreme cases can even stop the main and auxiliary engines, presenting a serious danger to the ship and its crew.

Incompatibility

Even though two or more fuels may be stable in their own right, mixing them together can produce an unstable blend. This is called incompatibility.

For example, blending HFO and VLSFO is likely to create an unstable oil. Likewise, ULSFOs can have compatibility problems with HFO, VLSFO, and even other ULSFOs. As 2020 brings a wider-than-ever variety of fuels onto the market, we can expect incompatibility to become a more widespread and complex problem for the industry.

The importance of testing fuels and cleaning tanks

The stability and compatibility problems we have been experiencing since the creation of ECA zones can be expected to become more widespread from 2020, as suppliers create blends to use up existing stocks at the bunker, or as ships take on new fuels into tanks with remnant fuels.

Stability testing of new fuels is absolutely essential. To this end, ISO WG6 (ISO 8217) and CIMAC WG7 are currently working on methods to better understand stability and compatibility issues. Cooperation between the refineries and testing laboratories can also help ensure the new products are well understood.

Furthermore, operators should ensure that different fuels are segregated on board and that their tanks and fuel treatment lines are designed to work independently, to mitigate risks of clogging. If fuel blending is unavoidable, compatibility tests should first be carried out. Simple onboard tests are possible, but in-depth laboratory testing can provide greater levels of assurance.

As a matter of best practice, tanks should be cleaned regularly to lower the chance of sludge forming at sea. Likewise, crews will need to be particularly watchful for signs of incompatibility when switching from one fuel to another.

Other considerations

The new mix of marine fuels will increase complexity in other aspects of fuel handling and conditioning. Briefly, some of other challenges will include:

- **Temperature** – Different fuels will have different viscosities and flash points. Therefore, operating temperatures must be carefully managed both to ensure consistent fuel flow without causing thermal shock in pumps and other equipment and to avoid the risk of fire.
- **Lubricity** – Crews will need to be aware of how much lubrication each fuel provides, and make adjustments as necessary to protect their engines.
- **Cat fines** – Removing sulphur from fuel requires catalysts, which leave behind small, hard particles that can damage engines and other equipment if not effectively separated from the fuel. Also, low-sulphur fuels can have higher cat fine levels.
- **Water contamination** – Some fuels types attract water more than others, which can reduce fuel economy and corrode engines and other components if not effectively removed.
- **Microbial contamination** – Biofuels, in particular, can be prone to microbial blooms, which can cause blockages and corrosion.

Staying ahead of the knowledge curve

Because the marine industry will change so much and so fast – and because so many aspects of the post 2020 fuel situation remain uncertain – it's vital to stay engaged, especially as we transition to the new era.

Knowledge and awareness will be the keys to success, so it's up to all responsible stakeholders to share knowledge, seek out expert opinions, and be a part of the conversation. The Alfa Laval Fuel Line site, and other emerging sites, seek to inform and focus the dialogue. Working together as an industry – from ship owners and operators, yards, insurers, refiners, equipment and engine makes, and suppliers – provides the best chance to safely navigate the uncharted waters ahead.

The Fuel Line by Alfa Laval is here to inform and offer solutions.
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