INCREASE IN POWER CARRYING CAPACITY OF TRANSMISSION LINE BY USING HIGH AMPACITY CONDUCTORS.

[1]ANIKET.V.KENGE, [2]SUJAY.S.KULKARNI, [3]SAURABH.S.PATIL

Sandip Institute of Engineering and Management, Nashik.

Abstract:-Now days the ACSR (Aluminium conductor, steel reinforced) conductors are use for transmission of electrical energy. They can withstand temperature up to 85 degree celicus. Their current carrying capacity is also less. So to meet the today's demand new generating stations are constructed but to construct new transmission of lines Right Of Way (ROW) is getting difficult day by day due huge rise in land cost hence construction of line has become difficult. Hence it is necessary to think on enhancing Power handling capacity of existing overhead transmission line or transmits maximum power than conventional conductors and can withstand maximum temperature. So this paper discusses about this new type of high ampacity conductors which can be used for transmission of nearly double electrical power than existing conductors.

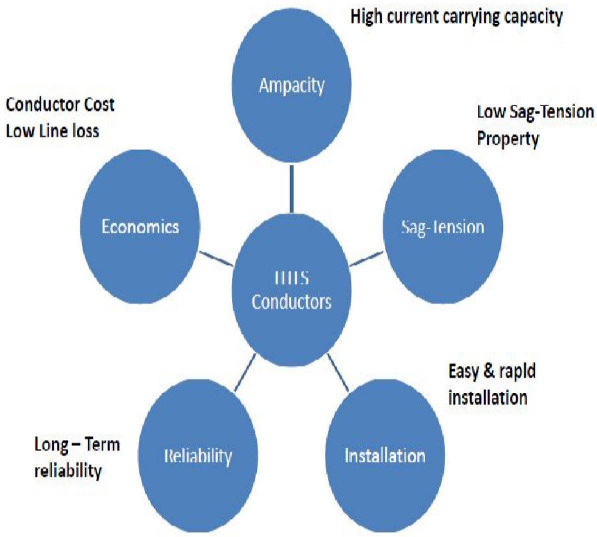
Key Words:-ACSR, Ampacity, Right Of Way, overhead transmission, maximum power.

I. INTRODUCTION

Ampacity is defined as the maximum amount of electrical current a conductor or device can carry before sustaining immediate or progressive deterioration. Also described as current rating or current-carrying capacity, ampacity is the RMS electric current which a device or conductor can continuously carry while remaining within its temperature rating.

Indian power generation is 2,28,721MW and power is transmitted for generating station to distributing area at voltage level of 220KV,400KV,765KV,and also at +500KV HVDC transmission network. To meet the demand of electricity various ultra mega power project at used others generating station are also build up in large capacity. Normally generating station are established near resources like coal, fuel, whereas power need to be transferred othere area over long distance. Although in India there is nearly more than 1 lackh circuit km transmission line network still nearly same capacity need to be built up in next 10years of time to meet rising demand and evaquate power generated by various generating station. To construct transmission line RW(ROW) is getting difficult day by day due to huge rise in land cost hence construction of line is becoming difficult day by day. The same is the difficulty throughout the world for construction of transmission corridor and hence researches are going on for increasing in transmission capacity of existing transmission network. The conductors which carries the current from one place to other place that means the amount of current it can carry is called ampacity of conductors and is related to electrical resistance, lower is resistance of conductors can carry large value of current. If say existing transmission line carrying a say 100MW capacity is upgraded to double capacity by using high ampacity conductors. It can solve problem of transmission of electricity and also save huge cost These are new type of which are made from new aluminum alloy and can transfer more power with lesser sag. Normal conductors can operate up to 85°C where as these special conductors can be operated up to 200°C .Hence they can carry doubled the current of existing capacity

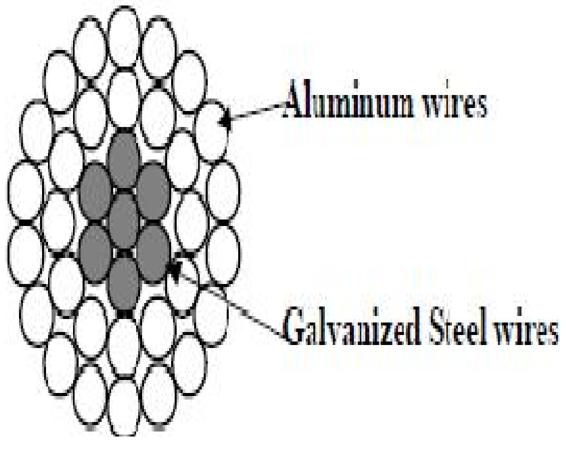
II. WHY TO GO FOR HIGH AMPACITY OR HTLS CONDUCTOR?



(1)

III. CONVENTIONAL ACSR VERSUS HTLS CONDUCTORS

ACSR conductor (see Figure shown below) has a steel core, consisting of one or more steel wires, surrounded by one or more layers of 1350-H19 aluminum wires. 98% to 99% of the electrical current in ACSR flows in the aluminum strands. Depending on the relative size of the steel core and the aluminum wire cross-section, as little as 15% and as much as 65% of the composite ACSR strength is due to the steel core.



IV. CROSS-SECTION OF 30/7 ACSR CONDUCTOR

1350-H19 aluminum wires, which are nearly pure aluminum, begin to anneal slowly at around 93°C. At 100°C, 125°C, and 150°C, these aluminum wires lose 10% of their ultimate tensile strength in a year, two weeks, and 12 hours, respectively. Beyond 150oC, aluminum strands rapidly anneal but the steel core wires are not affected by these temperature levels. With regard to sag at high temperature, the steel core elongates at approximately half the rate of the aluminum layers so that conductor tension is transferred from the aluminum layers to the steel core as the conductor temperature rises. At a sufficiently high temperature, all of the conductor tension is in the steel core and the elongation rate beyond this “kneepoint” temperature is essentially that of steel alone. The proportion of total tension carried by the aluminum layers and the steel core varies with the relative areas of steel and aluminum, the temperature of the conductor and the tension history (creep elongation).(2)

V. HTLS CONDUCTOR MATERIALS

The vast majority (approximately 80%) of bare stranded overhead conductors used in transmission lines consist of a combination of 1350-H19 (nearly pure aluminum – 1350 – drawn to the highest temper possible – H19) wires, stranded in one or more helical layers around a core consisting of one or more galvanized steel strands. By varying the size of the steel core, the composite tensile strength and elastic modulus of an ACSR conductor of given resistance can be varied over a range of 3 to 1.

The mechanical and electrical properties of ACSR (and all aluminum conductors such as AAC, AAAC, and ACAR) are quite stable with time so long as the temperature of the aluminum strands remains less than 100°C. Above 100°C, the work-hardened aluminum strands lose tensile strength at an increasing rate with temperature though the steel core strands are unaffected by operation at temperatures up to at least 300°C (though the galvanizing may be damaged by prolonged exposure to temperatures above 200°C). The sag-temperature behavior of ACSR is also dependent on the size of the steel core. At moderate to low conductor temperatures, the thermal elongation rate of ACSR is between that of steel (11.5 microstrain per °C) and that of aluminum (23 microstrain per °C). For example, with Drake ACSR, the thermal elongation is 18.9 microstrain per °C, at a conductor temperature below the kneepoint temperature (about 70°C under final conditions) Above the kneepoint temperature, the thermal elongation of any ACSR conductor is approximately that of steel alone (11.5 microstrain per °C). HTLS conductors are able to operate continuously at temperatures above 100°C (the HT part) and exhibit thermal elongation rates which are less than ACSR (the LS part). No HTLS conductor can be stranded out of conventional 1350-H19 aluminum wires and ordinary galvanized steel wires. As shown in the following tables, the wire materials used for HTLS conductors are capable of continuous operation at temperatures in excess of 100°C with stable electrical and mechanical properties. For example, annealed aluminum strands can be run continuously at 300°C without any deterioration in conductivity. As will be discussed in later chapter, all of the HTLS conductors considered in this study consist of a high strength core surrounded by one or more layers of aluminum wires which carry most of the electrical current. For those HTLS conductors with annealed aluminum strands, the conductor stiffness and breaking strength is largely determined by the core. For those HTLS conductors with Zirconium aluminum strands, the composite conductor strength and stiffness depends on both the reinforcing core and the aluminum strand layers. With the exception of the CTC carbon fiber composite core, the various aluminum alloys and the reinforcing materials are normally in wire form with a wire diameter of the order of 0.1 to 0.2 inches. In certain designs, the aluminum wires are provided with a trapezoidal cross-section in order to maximize the aluminum area for a given conductor diameter. The reinforcing core wires are typically round. The properties of the wires vary with wire diameter. Generally the smaller the wire, the more work hardening done in drawing it and the higher its tensile strength, though such variations with wire diameter are typically modest. As can be seen in Table 1, the properties of the conducting aluminum wires and the reinforcing core wires are dramatically different. These differences can be used to advantage in various designs.(2)

Table 1
Characteristics of aluminum and aluminum alloy wires

Type of Aluminium		Minimum Conductivity [%IACS]	Typical Tensile Strength [Mpa] [kpsi]	Allowable Operating Temperature(°C)	
				Continuous	Emergency*
Hard Drawn 1350 aluminum	1350-H19 (HAL)	61.2	159 – 200 23 - 29	90*	125*
Thermal Resistant Zirconium aluminum	TAL	60	159 – 176 23 - 26	150	180
Extra Thermal Resistant Zirconium aluminum	ZTAL	60	159 – 176 23 - 26	210	240
Fully Annealed 1350 aluminum	1350-0	61.8**	59 – 97 8.5 – 14	350	350

(2)

* - Manufacturers often suggest performing rating calculations at 75oC/100oC

** - Typical conductivity for annealed aluminum is 63.0%.

VI. TYPES OF HIGH AMPACITY CONDUCTORS

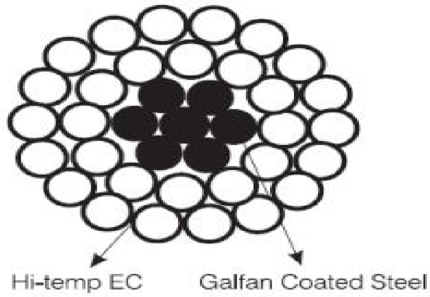
a)Low Resistance Conductors
AL59 Alloy Conductors
1120 Alloy Conductors
EHC Alloy

b) Dull Surface Finish
Dull Conductor
Colored Conductors

c) High Temperature (HTLS) Conductors
ACSS (Aluminium Conductor Steel Supported)
TACSR (Thermal Alloy Conductor Steel Re-inforced)
STACIR (Super thermal Aluminium Conductor Invar Reinforced)
ACCC (Aluminium Conductor Composite Core)
ACCR (Aluminium Conductor Composite Reinforced) (1)

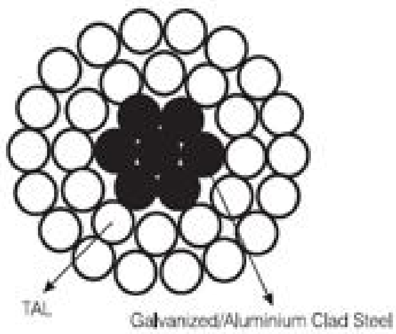
VII. CONSTRUCTION OF CONDUCTORS:

1. ACSS (Aluminium Conductor Steel Supported):-
G Trans Aluminium Conductor Steel Supported (ACSS) has unique capabilities for high operating temperature and Better Aeolian vibration resistance. G Trans ACSS is a composite Aluminium steel conductor that looks just like conventional ACSR conductor. The difference is in the aluminium temper. The aluminium used in G Trans ACSS is fully annealed wire (O) where as the aluminium used in ACSR is fully work hardened (H19).(3)



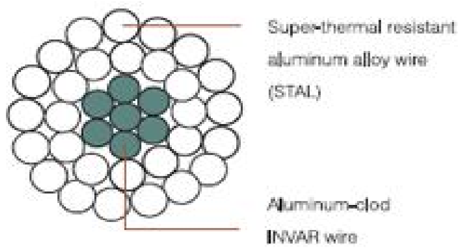
(3)

2. TACSR (Thermal Alloy Conductor Steel Re-inforced)
Outer Conductive wire: Thermal aluminium alloy wire which can continuously operate up to 150°C.
Inner Core wire : Aluminium Clad/Galvanized steel wire.(3)



(3)

3. STACIR (Super thermal Aluminium Conductor Invar Reinforced)
Outer Conductive wire: Super thermal aluminium alloy wire which can continuously operate up to 210°C.
Inner Core wire: Aluminium Clad Invar wire (Invar is a metal which is having 36% Ni in Steel)(3)



(3)

4. ACCC (Aluminium Conductor Composite Core):-
In one embodiment, an ACCC cable comprises a core comprised of composite material surrounded by a protective coating. The composite material is comprised of a plurality of fibers selected from one or more fiber types and embedded in a matrix. The important characteristics of the ACCC cable are a relatively high modulus of elasticity and a relatively

low coefficient of thermal expansion of the structural core.

VIII. ECONOMICS OF HIGH AMPACITY CONDUCTOR

Given below is a comparative case study for building a new line with conventional ACSR with HPC conductor. It can been seen that is for 100kms 400kv D/C Quad.

Items	% of project cost	Cost - New ACSR Line (₹ in Cr.)	Cost - New HPC Line (₹ in Cr.)	Differential (%)
Tower cost	20	44.9	39.48	-12
Conductor cost	38	84.31	247.99	194
Insulator Cost	5	11.41	11.14	-2
Hardware Cost	3	5.59	5.38	-4
Other Supply Cost	3	7.28	6.77	-7
Erection & Foundation	15	33.05	32.18	-3
Row cost	5	10	9	-10
Forest cost (15 KM)	11	23.4	22.77	-3
Total cost (100 KM Line)		**219.94**	**374.71**	
Transfer Capacity		3400 MW	6800 MW	100
Cost in ₹/ MW / KM		6468.82	5510.44	-15

(1)

From above chart it can be seen that through cost of building a line with high ampacity conductor is higher, on a per MW/km basis, the cost is 15% lower. Also, if re-conductoring exercise is undertaken for an existing ACSR line, the cost of project would be equivalent to cost of building a new ACSR line (with a significant time benefits) and lesser wastage of land/ forest resources.(1)

IX. ADVANTAGES AND CHALLENGES

- High temperature withstanding capacity.
- Enhanced current carrying capacity.
- Reduction in overall capital expenditure.
- Availability is not known.
- Reliability is to be proved

X. APPLICATION

- Used for reducing I^2R losses: Under equal load conditions reduces the I^2R losses by 30 to 40%.
- 100% more current carrying capacity, compared with traditional conductors.
- Up gradation of existing line without any modification to existing structure.
- Conductors are used for both up gradation and for new power transmission and distribution lines.(1)

ACKLOWGEMENT

With great delight, we wish to express my deep sence of gratitude towards my guide Prof.Joydeep Sarkar Department of Electrical Engineering for his generous help & constant guidance, he gave me throughout the completion of this seminar. We also wish to thank Prof. D.D.Shinde (Principal,SIEM, Nashik) and Prof. H.R.Kulkarni, Head of Electrical Engineering Department, SIEM, Nashik for making the facilities available in the department for this work.

REFERENCES

[1] Sterlite Technologies Limited.
[2] Demonstration of Advanced Conductors for Overhead Transmission Lines By EPRI (Electric Power Research Institute)
[3] Gupta Power Infrastructure Limited.

***