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AN IMPROVED ALUMINIUM CONDUCTOR (*)

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The engineering requirements of a conductor material are that it should be (i) plentiful and not too expensive, (ii) an adequate conductor of electricity(iii) mechanically strong to withstand stresses and strains, (iv) ductile and strong enough to be rolled and drawn into wires and (v) compare satisfactorily with a copper conductor cable in performance, reliability, durability and cost. Aluminium meets most of these requirements and is extensively available in India.

Electrical Properties of Aluminium

The electrical conductivity of aluminium is second only to that of copper amongst engineering conductor materials. For equal electrical resistance an aluminium conductor has one and a half times the cross sectional area of copper but weighs only half as much. It can normally transmit 78% of the load that can be carried by copper conductor of equal cross sectional area for the same rise of temperature. It is also noted for its non-toxicity, non-magnetic and non-sparking property.

The widespread use of aluminium in electrical transmission calls for the development of an aluminium conductor with high conductivity and adequate strength. These are diverse metallurgical objectives since the conductivity decreases as alloying elements are added to the lattice of aluminium to raise its strength. Upgrading of Indian electric grade aluminium is, therefore, important if the process improves the strength and conductivity simultaneously and imparts better corrosion resistance. The problem of conductivity of Indian aluminium is important as it seems to have forced

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the Indian Standard Institution to relax in a subtle manner the minimum requirements of conductivity.

Experimental Work

In order to impart the Indian electric grade aluminium competitive and exclusive properties, a programme of basic research was undertaken at the National Metallurgical Laboratory to determine the effect of binary solute additions of silicon, iron, manganese and magnesium, each upto 1%, on its electrical conductivity and strength. It was shown that the conductivity can be improved if the soluble impurities are removed by (i) heat treatment (ii) suitable alloy additions and (iii) by both, through precipitation of intermetallic compounds. Whilst substantial improvement in its conductivity was obtained on prolonged ageing between 350-400°C, the tensile strength fell considerably.

Development of PM-2 Conductor

An upgraded electric grade aluminium designated PM-2 was developed and semicommercial size wire-bars were cast and subsequently rolled and drawn into wires corresponding to the specification of the ACSR conductor at the Jamshedpur works of M/s. Indian Cable Company Pvt. Ltd., Table 1 summarises the electrical and mechanical properties of PM-2 and shows its superiority over a hard drawn conductor as specified by Indian, British and ASTM standards.

Attention was, therefore, concentrated on the satisfactory development of the PM-2 conductor. Four wire bars (30 Kg each) PM-17 to PM-20, were cast in order to study the effect of variation of the nominal PM-2 composition on strength and electrical properties. The wire-bars were also rolled and drawn into ACSR conductors (2.5 mm. dia) successfully at the Indian Cable Co. Ltd., Jamshedpur and satisfied the Indian standards.

Corrosion Tests

A number of samples of conductor wires made from PM-2, indigenous and imported aluminium were exposed to wet chlorine atmosphere for periods up to 48 hours. It was seen that the surfaces of the indigeneous and imported E.C. grade aluminium conductor

were heavily corroded in comparison with that of PM-2. When exposed to sodium hydroxide atmosphere, PM-2 conductor suffered less corrosion than either of the other two.

Earthing Test

The suitability of PM-2 as earthing material was tested by keeping it in a mixture simulating the earthing conditions i.e. alternate layers of charcoal and common salt along-with indigeneous and imported aluminium conductors. It was seen that pitting had started in indigeneous and imported grades of conductor but was substantially less in PM-2.

Conclusions

The upgraded PM-2 conductor claims the following:

i. Practically no additional cost

ii. Mechanically strong and capable of being rolled and drawn into wires without change in existing machinery.

iii. Superior electrical properties, 15% higher strength and improved ductility than specified in the Indian, British and ASTM standards.

iv. Better corrosion resistance.

/Ahmed:

TABLE I - ELECTRICAL AND MECHANICAL PROPERTIES OF PM-2 CONDUCTOR* AS COMPARED WITH DIFFERENT STANDARDS FOR EC GRADE ALUMINIUM

	PM-2	Indian 398-1953/1961	British/ ASTM 215-1956 / B 230-1960
1. Resistance, ohms/km at 20 °C	4.585	4.654	-
2. Resistivity at 20°C microhm - cm	2.810	2.873	2.8264/2.8264
3. Conductivity at 20°C % IACS	61.4	60.0	61.0/61.0
4. Tensile strength - Psi	28,400	24,200	24,200/24,500
5. Improvement in T.S.	15%	-	-
6. Elongation on 10" gaage length	3.5%	1.9%	-/1.5
7. Wrapping test	passes	6 wrapp round on its own dia.	6 wrappround on its own dia.

* Test carried out by the Indian Cable Company Ltd., Jamshedpur.