

THE ROLE OF NON-FERROUS METALS AND ALLOYS IN
ELECTRICAL ENGINEERING INDUSTRIES IN PARTICULAR
RELATION TO CABLE INDUSTRIES (*)

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Copper, Copper-cadmium and aluminium are available in the form of wire bars and their governing material specifications are IS.191, IS.2665 and IS.2067 respectively.

The cast weight of the normal wire bars is about 120 kg for copper and copper-cadmium and 35 kg for aluminium.

Copper rods are produced by hot rolling where the wire bars are preheated in a push through type furnace at a temperature of 840°C and hot rolled following oval-square oval-square system of pass progression excepting the final pass where it is round and 18 passes are normally given when rolling from 10.16 cm. square to 6.35 mm diameter.

Copper - Cadmium rods are produced in the same way as copper excepting that a break is made in the hot rolling process, allowing the metal to cool sufficiently to acquire some degree of cold work during the process.

Aluminium rods are manufactured by two methods - hot rolling and Properzi. In the hot rolling process, bars are preheated at about 390°C and generally 18 passes are given when rolling from 10.16 cm square to 9.5 mm diameter and oval round-oval round system of pass progression is followed and in the Properzi process molten metal is poured into a rotary casting wheel, which produces solid rod and the rod is immediately led into a train of rolling mills which

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reduces its section. Quality of the rods manufactured from the two methods is equally good for further processing and Properzi rods are normally harder than hot rolled ones.

Prior to wire drawing, copper and copper-cadmium hot rolled rods are pickled in sulphuric acid - followed by washing and a dip in soap water to remove last traces of acid.

For Copper conductors for enamelling, for coaxial cables etc., and for the production of superfine sizes of wire say 0.081 mm diameter and below, shaved rods are helpful because in the shaving operation oxide layer is completely removed and with the removal of top layer say to thickness of .10% mm to 0.15% mm from the rod some ferrous inclusions which are present in rolled rods are also removed. Aluminium rods do not need such pretreatments for drawing down to wires. For breakdown drawing of wire rods both non-slip and slip type machines of different makes are used.

Process for manufacture of rectangular conductor is the same for both copper and aluminium where the rods are drawn through T.C. dies in a single block machine to get the required sizes of inlet rod for the manufacture of the strips.

Following three methods are generally followed to process the drawn rod to get rectangular conductors:

Rod is flattened between two rollers and

(i) Passed through edge forming rolls

or

(ii) Drawn through holes of a steel plate

or

(iii) Drawn through T.C. dies

For correct radius of corner and better surface finish the last method is preferred. Highly viscous petroleum oil is used as a lubricant for drawing the strips.

Profiles of diamond dies followed are as recommended in British Standard Specification B.S.1393.

Copper conductors need be tinned only where insulant is rubber in order to prevent the deterioration of rubber insulation due to the catalytic effect which copper has upon the oxidation of the rubber. Tinned conductors are also required for plastic cables to facilitate soldering operations for terminations.

Paper insulated Power Cables, dry core telephone cables, coaxial telecommunication cables etc. must have metal sheathing, lead and its alloys are still the materials most commonly used for this job.

The selection of an ideal cable sheathing alloy is extremely complex. Briefly the alloys shall have the following properties:

- (i) A good creep resistance which might permit their use, without reinforcement, on cable operating under low internal pressure or for solid cables.
- (ii) A good creep ductility which is maintained at low rates of sheath expansion.
- (iii) An estimated thirty to forty year life when subjected to bending cycles of the order of one cycle per day.
- (iv) Good fatigue resistance.
- (v) No significant change in properties with time after manufacture.

Unalloyed lead is used as a sheathing material in the conditions where a sheath is not expected to stand the above mentioned abuses but is only for a sheath as an impervious layer preventing access of moisture to the cable insulation.

In western countries aluminium has been recognised as a general purpose sheathing material and has proved its superiority over lead in many respects but unfortunately in our country not much progress has been made though occasionally serious consideration has been given for the use of aluminium as a sheathing material replacing lead as far as practicable.

The advantages of aluminium are primarily that it is considerably lighter and stronger than lead, generally no

reinforcement of the sheath is required, aluminium sheathed cables can be installed in positions of severe vibration.

The problems of joining of aluminium to aluminium or to other electrical conductors have been removed as a result of the successful introduction of fluxes and solders, and with the development of some recent techniques e.g. cold welding, mechanical jointing, ultrasonic methods of joining etc.

Tin - Lead - Zinc solders and organic fluxes are preferred for soldering the stranded Al-conductors of electric cables.

The essentials for getting good joints are:

- (1) Proper design of the joints which have long solder interfaces.
- (2) Use of right type of solder and flux.
- (3) Thorough cleanliness of the surfaces to be jointed.
- (4) Complete removal of the oxide film from the surface of the aluminium.

The results from the jointing tests carried out at The Indian Cable Co.'s Works, Jamshedpur using 25 mm.sq. aluminium strand have shown that with the use of right type of solder and flux a high quality joint is always obtained if the jointing techniques are properly applied.

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