JOINING OF ALUMINIUM (*)

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Joining of Aluminium to itself or to its alloys can be performed by a number of methods. All conventional joining processes such as arc, resistance and pressure welding, brazing, hard and soft soldering have been successfully used for aluminium and its alloys. Very recently ultrasonic welding, explosive welding and certain other specialised techniques have also been employed.

However, joining of aluminium has its special problem as aluminium has a tenacious oxide skin which forms very quickly on the surfaces of the materials to be joined and increases with temperature. This mut be removed before any joining can be effected.

In order to obtain sound and dense weld by arc welding process Tungsten Inert Gas method is widely used for thin sheets. In this process, a non-consumable tungsten electrode produce the welding arc between the electrode and the base metal. Generally, the weld joint results from fusion of the base metal. Filler metal can be added when thick sheets are welded by feeding a separate rod into the arc (MIG Process), Thoriated tungsten is also used for electrodes; they are mo e expensive than ordinary tungsten electrodes, but have several advantages. For example they have better emissivity and operate at much lower temperatures than standard tungsten, and do not become molten. The electrode tip remains square and consumption is negligible. In addition, they are not easily contaminated by the weld metal when they contact the work piece. However, these processes are now widely used and detailed information can be obtained from technical literature without much effort and hence just briefly mentioned here.

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Owing to a number of disadvantages associated with fusion welding, brazing of aluminium and aluminium alloy is used, particularly when joining light gauge sheets. Pure aluminium is easily joined by brazing and therefore widely used for small jobs and repair works. Standard brazing processes such as torch, twin-carbon arc, furnace, induction and dip brazing are employed. Adequate temperature control is essential. A brazing flux is also indispensable for aluminium brazing operations. Fluxes are made in the form of powder. Lap joints are generally used for brazing aluminium and its alloys. Proper assembling with optimum pressure between the sheets is very important, since improper assembling will cause flux entrapment and binds flowing of the filler metal.

Soldering of aluminium has been discussed in some details in this paper as this is not yet a widely used technique in India due, possibly, to non availability of detailed information of technique. Soldering of aluminium causes difficulties due to the formation of tenacious oxide layer which is extremely difficult to remove.

The problem of soldering of aluminium is therefore, basically the problem of removing the oxide skin of aluminium at the soldering temperature. This can be done in two ways:-

(a) Mechanical removal of the oxide scale simultaneously with application of the molten solder and

(b) Removal of the skin by means of suitable flux

Of the two processes the first is achieved in two ways again which are:

(i) Mechanical scale removal by means of quartz brush or wire brushing with the application of solder

(ii) Using a soldering metal having a wide crystallization range so that the first frozen solid crystals of excess phase act as abrasive bodies which remove the oxide film or using a rod sintered from a mixture of soldering powder and a refractory material like asbestos powder.

Suitable fluxes are basically mixtures of the alkali metal chlorides and fluorides with special additions for different conditions.

Besides inorganic fluxes for soldering aluminium with low melting solders organic fluxes containing trimethanolamine, ammonium-fluoborate and cadmium fluoborate have been used. Residues from these are reported to cause less corrosion.

Choice of solder material has to be considered from the point of view of two consideration, (a) galvanic potential of the solder material with respect to aluminium. Choice of zinc-magnesium-aluminium alloy is preferred to tin-lead solder as in the latter case, there would be high galvanic potential causing deterioration of the joint in the high humidity condition; (b) the strength requirement: if high strength is required a high melting point solder is likely to give better strength. In such cases, Al-Si, Al-Cu-Si, Al-Zn and Al-Zn-Cu alloys will be preferable. Where strength is not of primary consideration a low melting point solder has got its advantage from application point of view. Such solders are Zn-Sn, Zn-Cd-Cu-Al and Zn-Sn-Ag-Al ones. The fluxes are to be chosen so that their melting points are slightly lower than the solder to be used. However soldering is not a suitable method for heat-treated aluminium alloys.

Since pressure welding is now widely used in joining of aluminium conductors this has been discussed in some detail with reference to the types of tools used, nature of joint preparation and amount of deformation to effect good joining.

For aluminium, welding at room temperature requires about 60% deformation. An advantage of the process is that, the joint possess none of the weakness inherent in the cast structure associated with fusion technique.

Ultrasonic soldering, is also another method of fluxless soldering for aluminium. The term ultrasonic does not refer to a mode of heating for soldering. Rather it refers to an additional device used to facilitate soldering without any significant changes in temperature of the assembly. This is done mainly

by forming a pool of molten metal on top of the oxidised aluminium and then breaking through the layer or oxides with ultrasonic cavitation. T-he solder alloy is then in a position to wet the clean aluminium underneath and the tarnishes float to the surface of the solder. This is especially true for the high-zinc alloys.

Explosive welding is a solid state bonding in which the weld is produced by plastic flow of the metal as in cold pressure welding. A combination of metallurgical and mechanical bond is characteristic of explosive welds in aluminium. Though a new process it is at present finding fairly wide use in connecting high voltage standard aluminium conductors to a collar, joining the butted ends of two aluminium pipes by welding them to an external sleeve, and a few more specialized use. This is however, a comparatively new process whose fields of application is being further widened. It is felt it will take still some time to find its wide application in industry, especially in India.

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