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Characterrization Al-4.5cu Alloy and Study of Wear Resistance

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ABSTRACT: The growth in consumption of aluminium during the last thirty years has been more than that of many other metals including iron and copper. The electrolytic reduction of alumina (Al_2O_3) dissolved in molten cryolite was independently developed by Charles Hall in Ohio and Paul Heroult in France in 1886, the first internal-combustion-engine-powered vehicles were appearing, and aluminium would play a role as an automotive material of increasing engineering value because of its excellent properties. Aluminium has a density of only 2.7 g/cm3, about one-third as much as steel (7.83 g/cm3), copper (8.93 g/cm3), or brass (8.53 g/cm3). The most commonly used designation system is that of the Aluminium Association of America. According to this system wrought aluminium alloys are designated by the four digit number system.

Keywords: Cold rolling, Tinius oslen tensometer, uUTM

I. INTRODUCTION

The aluminium industry's growth was not limited to these developments as the first commercial applications of aluminium were novelty items such as house numbers, mirror frames, cooking utensils and serving trays, were also a major early market. In time, aluminium grew in diversity of applications to the extent that every aspect of modern life would be directly or indirectly affected by its use. Aluminium is a lightweight, soft metal with normally a dull silvery appearance caused by a thin layer of oxidation that forms quickly when the metal is exposed to air. Pure aluminium has a lesser melting point than Aluminium oxide. It is nontoxic (as the metal), nonmagnetic, and non sparking. It has excellent corrosion resistance and durability because of the protective oxide layer. The aluminium base alloys may in general be characterized as eutectic systems which contains inter metallic compounds or elements as the excess phases. Because of the relatively low solubilities of most of the alloying elements in aluminium and the complexity of the alloys are produced in any aluminium base alloy may contain many metallic phases, which are complex in composition. These phases usually are appreciably more soluble near the eutectic temperatures making it possible to heat-treat some of the alloys by solution and aging heat treatments.

II. MATERIAL AND METHODS

AL-4.5wt% Cu Alloy

The binary aluminums-copper alloys are one of the oldest casting alloys. Al-4.5wt%Cu alloy belongs to the family of 2xx.x series of aluminium alloys. Copper is the principal alloying element in this group. The phase diagram for aluminium-copper alloys is shown in figure. With respect to the Al-4.5 wt.% Cu alloy, the structure in the as-cast state consists of α-aluminium, with a very heterogeneous distribution of copper in solution, with dendritic morphology and eutectic (lamellar mixture of phase a and micro constituent $CuAl_2$) located between dendrite arms and grain boundaries [11].

III. WEAR MECHANISMS

In which a solid moving relative to a sliding surface causes material to be removed from the surface. The relative motion for wear to occur may be sliding or rolling. Abrasive wear occurs when a hard rough surface slides across a softer surface. American Society for Testing and Materials defines it as the loss of material due to hard particles or hard protuberances that are forced against and move along a solid surface. Wear, in turn, is defined as damage to a solid surface that generally involves progressive loss of material and is due to relative motion between that surface and a contacting substance or substances.

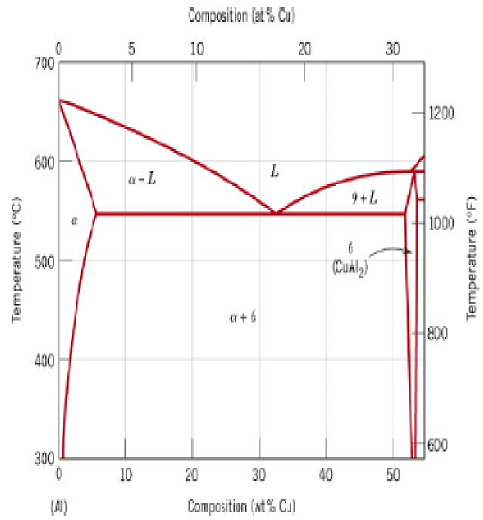

Fig. 1. AL-Cu Phase Diagram.

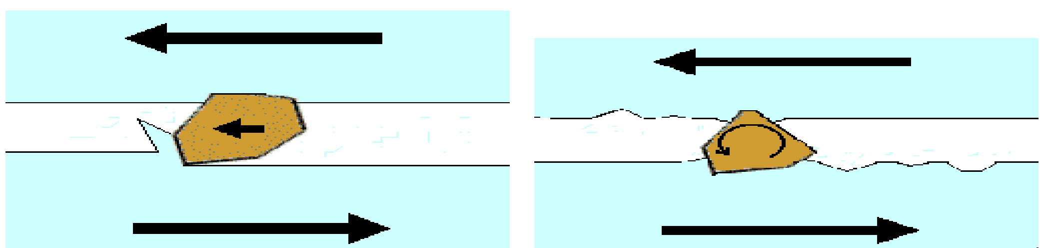

Fig. 2. Mechanism of material removal in abrasive wear.

The rate at which the surfaces abrade depends on the characteristics of each surface, the presence of abrasives between the first and second surfaces, the speed of contact, and other environmental conditions. In short, loss rates are not inherent to a material.

IV. EXPERIMENTAL PROCEDURE

The material for investigation was in the pure form of aluminium and copper. Aluminium was in the form of slab so cutting was required using bend saw. Copper was in the form of strip, so first the copper strips were rolled to very low thickness and then cut it in the form of chips using cutter so that the melting becomes easy.

Al-4.5wt%Cu Alloy Making:

This alloy made by addition of pure alluminium in master alloy Al-33wt%Cu.

Calculation for Al-4.5wt%Cu Alloy

Al-4.5wt%Cu alloy was made 7.5 Kg.

Since size of was limited, So Al-4.5wt%Cu alloy was made in three lots of 2.5 Kg.

Since the composition of master alloy was Al-33wt%Cu, and composition of alloy was Al-4.5wt%Cu.

Therefore amount of Master alloy (x) = (2500×4.5)/33 = 340gm.

Therefore amount of Aluminium = 2500 - 340 = 2160gm.

Since there are some Aluminium losses, so amount of Aluminium was taken 5% extra,

Therefore total amount of Aluminium = (2160 + 108) = 2268gm.

Casting of Al-4.5wt% Cu Alloy

After weighing, pieces of aluminium and Master Alloy were kept in a crucible with dross cleaning flux added to it and then kept in Silicon Carbide furnace at temperature $750^{\circ}C$. In Silicon Carbide furnace, Silicon Carbide rods work as heating elements. After complete homogenization, the crucible was taken out and degasser, kept in aluminium foil was added in the melt. Then the melt was casted in cylindrical form.

Fig. 3. Cast Iron mould used for casting Al-4.5wt% Cu alloy.

V. RESULTS

Effect of grain refinement on microstructure of Al-4.5wt%Cu alloy

The microstructures of as cast Al-4.5wt%Cu alloy and grain refined Al-4.5wt%Cu alloy are shown in figure . The microstructure of as-cast Al-4.5wt%Cu alloy consists of α-aluminium with a very heterogeneous distribution of copper in solution, with dendritic morphology and eutectic (lamellar mixture of phase α and micro constituent $CuAl_2$) located between dendrite arms and grain boundaries (Figure)

Grain refinement of Al-4.5wt%Cu alloy was done by the addition of 0.2%, 0.4%, 0.6% and 0.8% Al-3Ti-0.15C master alloy respectively. As grain refiner is added to the melt, $TiAl_3$ and TiC particles are formed as a result of chemical reaction of aluminium with titanium and carbon with titanium. These particles nucleate α-Al by heterogeneous nucleation and reduce the time required to solidify the melt. According to peritectic theory proposed by Crossley and Mondolfo (1951), $TiAl_3$ particles in the master alloy nucleate solid aluminium by peritectic reaction.

VI. CONCLUSION

Grain refinement is a common industrial practice to obtain higher mechanical properties of aluminium alloy. It is achieved in aluminium alloys by addition of specific amount of selected grain-refiner in the melt. Effect of grain refinement on the microstructure and mechanical properties of Al-4.5wt%Cu alloy grain refined with Al-3Ti-0.15C, was investigated and the following main conclusions are drawn from the work done. Grain refinement changes the dendritic microstructure of Al-4.5wt%Cu alloy in fine equiaxed grain structure. Grain size of Al-4.5wt%Cu alloy can be optimally reduced by addition of 0.6% Al-3Ti-0.15C grain refiner. Further increase of grain-refiner quantity does not provide any more significant change.

Fig. 4. Microstructure of as cast Al-4.5wt% Cu alloy.

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