MECHANICAL PROPERTIES ENHANCEMENT OF AL-SI (ADC12) ALLOY BY HEAT TREATMENT

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Abstract— The present work deals with the effect of heat treatment on the mechanical properties Al-Si (ADC12) alloy. The mechanical properties such as tensile strength, compressive strength, hardness and impact strength of the composites in as cast and heat treated condition were studied in order to achieve the maximum properties. Microstructural examination of the alloy in as cast and heat treated condition was carried out to observe the effect of aging. X-ray diffraction of the alloy in as cast and heat treated condition was done to know the phases present in the material. The fracture surface study was done to ascertain the type of fracture taking place in the alloy. It is observed that there is a substantial improvement in the mechanical properties of the alloy due to heat treatment as compared to the as cast alloy. The microstructural study of the cast alloy shows aluminum dendrites with dendritic arm spacing in the range of 25 microns. The eutectic silicon solidifies in the inter-dendritic region and around the dendrites. On heat treatment the plate shaped eutectic silicon is fragmentated into spherical shape. X-ray diffraction analysis shows major peaks of aluminium and minor peaks of intermetallic phases such as $CuAl_2$, Al_5CuMg and Mg_2Si in as cast as well as in heat treated condition. Tensile fracture surface study shows the fracture is taking place by inter- granular manner (crack propagation along the grain boundary) and morphology of dendrites in the fracture surface.

Keywords— Al-Si alloy; heat treatment; tensile strength; compressive strength; hardness; impact strength; tensile fracture.

I. INTRODUCTION

Considerable efforts are being made to explore the possibilities of improving the mechanical strength of Al so as to meet the requirements for various applications. In order to improve the mechanical strength and modulus of aluminium, it is alloyed with various alloying elements such as Cu, Fe, Zn, Mg, Si, Mn etc [4]. Amongst the various aluminium alloys, Al-Si alloys are used extensively because of their properties like low coefficient of thermal expansion, good bearing properties, good corrosion resistance and adequate strength and are therefore used frequently in aerospace and automobile structural components. It is convenient to divide aluminium alloys into two major categories: cast and wrought alloys. These categories are based on the primary mechanism of property development as heat-treatable and non-heat treatable alloys. Many alloys respond to thermal treatment based on phase solubility. These treatments include solution heat treatment, quenching and precipitation or age hardening. Other materials can be work hardened through mechanical reduction, usually in combination with various annealing procedures for property development. These alloys are referred to as non-heat treatable or work hardening alloys.

II. EXPERIMENTAL WORK

2.1 Material

Al-Si (ADC12) alloy is selected for study in this work. The chemical compositions of aluminium alloy were analyzed using glow discharge spectrometer.

Table 1 Chemical Composition of ADC 12 alloy

Si	Mn	Zn	Mg	Cu	Fe	Ni	Al
10.93	0.18	0.95	0.32	2.17	0.79	0.18	Rest

Table 2 Properties of ADC 12 alloy

Property	ADC12 alloy
Density, g/cm^3	2.76
Thermal Conductivity, W/mK	10-40 at 1100°C
Specific Heat, J/gK	96.2
Elastic Modulus, GPa	68.90
Coefficient of Thermal Expansion, K^{-1}	21.1×10^{-6}
Poisson Ratio	0.33

2.2 Specimen Preparation

The specimens for various mechanical tests were prepared in accordance with the BIS codes mentioned in the table 3.

Table 3

Test	Code	Dimension	No. of specimens
Tensile	IS 1608	10mmφ	3
Compressive	IS 1757	L/D 1.5 - 2.0	3
Impact	IS 1501	55x10x10 V Notch 2mm depth	3
Hardness	IS 1586	15mmφ, L=15mm	3