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Production And Characterization of Al-Mg-SiC PARTICULATE Composites at Different Furnace Temperature through Liquid Route using Plunger Technique

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ABSTRACT

Least weight and more strength materials are always required for different applications in engineering .Aluminum-Mg-SiC metal matrix composite (AMMC) is the suitable material in this class. Here plunger technique is used to produce Aluminum -Mg-SiC AMMC through liquid route. The different furnace temperatures were maintained such as 700^0C, 800^0C, and 900^0C for production of AMMC and these are characterized for microstructure, density and hardness.

Key Words - *Composites, furnace temperature, microstructure, hardness, density*

I.INTRODUCTION

In the industrial and structural applications particle incorporated Aluminum Matrix Composites are frequently used [1-4]. Here a new method is applied to produce the required particle incorporated Aluminum Composites. The plunger technique is the modified stir casting method which in principle has been adopted earlier in obtaining very high recovery of Mg in making Al-Mg alloys [5-9, 16]. Ceramic particle s such as Silicon Carbide is taken in the plunger rod to feed into Aluminum-Magnesium alloy melt. Due to uniform distribution of Silicon Carbide particles in the matrix, the composite properties such as hardness and physical properties are changed considerably [10-15]. The influence of furnace temperature during the production of AMMC also affects the properties of composites. To achieve the required properties, proper furnace temperature must be maintained.

II.EXPERIMENTAL PROCEDURE

In this section the detailed experimental procedures adopted and materials used in the present investigation have been discussed. The focus of the present investigation was to study the effect of alloy composition in cast Aluminum-Mg alloys and Aluminum-Mg melt matrix particulate composites reinforced with SiC particulates, produced by plunger technique. The effectiveness of the technique was analyzed by

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measuring the physical and mechanical properties. The properties like density, hardness and microstructure of the prepared composites were evaluated and which were also characterized for microstructure. The material selection, the preparation of composites and methods employed for physical, mechanical, and microstructure characterization were discussed in the following sections.

II. a) Apparatus

A new plunger technique apparatus was prepared in laboratory scale to produce the composite with the required composition. Here a hollow stirrer rod is used to feed the Magnesium chips and Silicon Carbide through plunger rod. The apparatus is shown in figure (Figure 1).The plunger technique is the modification of the stir casting method which is low cost and high effectiveness technique for alloys and composite manufacturing. The parts of the apparatus are shown in figure 1.

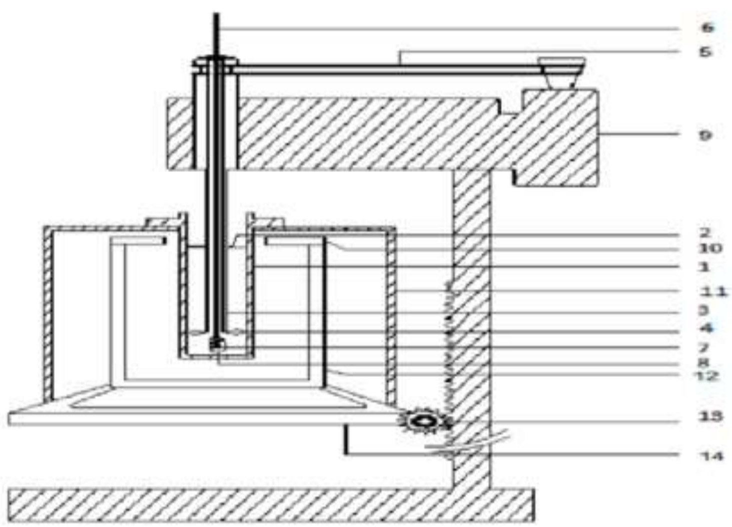

Figure 1: Diagram of Plunger Technique Apparatus for Making Composites (SiC particle incorporated in Aluminium-Mg melt)

1. Crucible
2. Melt Level
3. Hollow Spindle
4. Impeller Blade
5. V-belt Drive
6. Plunger Rod
7. Capsule
8. Particles of Mg turnings and SiC
9. Gear and Motor
10. Split Cover
11. Crucible Holder
12. Electric Furnace
13. Pinion and Rack
14. Lower Plate

Aluminium metal matrix as liquid form was taken in a cast iron crucible .A hollow spindle having three stirred blades fixed at the lower end was used for mixing. A screw feeder assembly was introduced through the hollow spindle for delivering the additions below the agitating blades (Figure-2). SiC particulates were taken into a hopper along the rotating feeder shaft. Particles were transported slowly through the screw mechanism to the discharge end of the screw where they were carried away within the matrix liquid by the stirring effect for homogeneous dispersion in the melt. Continuous feeding was done by rotating feeder shaft handle manually. It was observed that the feeding system gets chocked due to the upward movement of liquid melt and consequent solidification of liquid. Further modification was done in the feeding system for the preparation of composite.

Figure 2: Photograph of perforated mild steel capsule welded to plunger rod (below), Mg or SiC particles inside the capsule shown wrapped with Al foil (top).

II. b) Materials:

The composition of metals to prepare alloys and composites made of (Aluminum-Mg and Aluminum-Mg-Silicon Carbide) are given in the following tables.

TABLE-1 Commercially pure Aluminum Composition ingot used.

Aluminum	Silicon	Iron	Vanadium	Manganese	Copper
99.71	0.11	0.17	0.007	0.002	0.001

Magnesium Composition to prepare the alloys are given in **TABLE-2**

TABLE-2 Magnesium Chemical composition used for alloy preparation.

Zn	Fe	Cu	Al	Pb	Si	Ni	Mn	Mg
0.005	0.05	0.005	0.05	0.005	0.1	0.005	0.1	99.68

620 mesh size Silicon Carbide particles were used for making of AMMC. The chemical analysis of Silicon carbide composition is mentioned in **TABLE-3**

TABLE-3 Silicon Carbide chemical analysis for making of AMMC

Carbon	Si	Silicon Dioxide	Fe	Al	Silicon Carbide
0.3	0.3	0.4	0.1	0.1	98.8

II. c) Production of AMMC

First Al-1 wt %Mg alloy was prepared with same technique. After the addition of required wt% Mg stirring of the alloys are continued for 5-minutes for proper mixing. Then previously prepared Silicon Carbide capsules are introduced into the Aluminum-Mg melt. The particles are dispersed inside the melt to form the particle reinforced AMMC of composition Aluminum-1 % Mg -10% SiC. The said composite was prepared at difference furnace temperature of 700^0C, 800^0C, and 900^0C.

III. RESULTS AND DISCUSSION

III. a) Hardness

To begin with mechanical strength property indicator, hardness parameter determination was made for laboratory scale and tabulated. .First hardness was measured at five positions which were 3 cm apart on the flat casing of the Al-3% Mg alloy and AMMC prepared. The measured hardness (VHN) data were tabulated in TABLE-4.

TABLE-4 Hardness of flat castings

Hardness (VHN)	Temperature	700^0C	800^0C	900^0C
	Al-1 wt%Mg-10wt%SiC AMMC	71.9	72.9	72.1

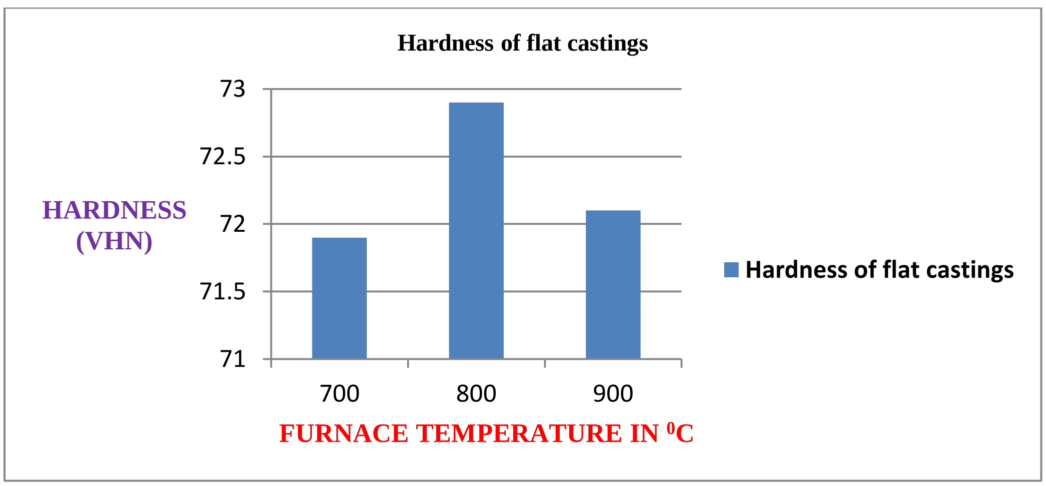

Figure 3: Hardness Vs Temperature of AMMC flat castings

Small samples of (20×10×5) mm size were cut from the three positions of the vertical casting of Aluminum- 1 % Mg -10% SiC. Composite to measure the hardness at the middle of the casting and the data are tabulated in TABLE-5

TABLE-5 Hardness of vertical casting

Hardness (VHN)	Temperature	700^0C	800^0C	900^0C
	Al-1 wt%Mg-10wt%SiC AMMC	72.7	73.1	72.9

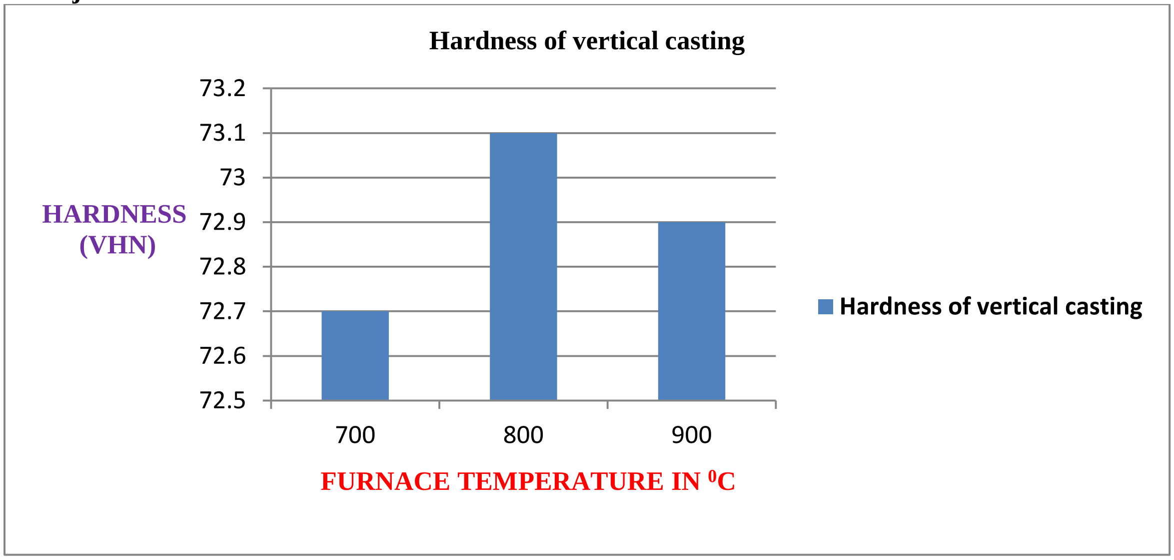

Figure 4: Hardness Vs Temperature of AMMC vertical castings

III. b) Microstructure

The microstructure of the Aluminum- 1 % Mg -10% SiC. Composite shows that the distribution of Silicon Carbide particles is uniform throughout.

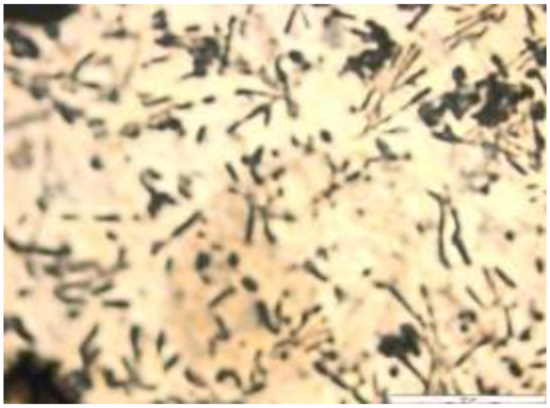

Figure 5: Aluminum- 1 % Mg -10% SiC. Composite

III. c) Density

Density of the cast sample of AMMC was measured as per the procedure discussed. The density was 2.699 gm/cm^3 which is lesser than the rule of mixture, that could be attributed for small porosity in the casting.

IV. CONCLUSIONS

1. The technique used for production of Aluminum Metal Matrix such as Aluminum- 1 % Mg -10% SiC is the effective and low cost method.

2. Silicon Carbide particles are uniformly distributed in the AMMC produced which is clearly visible in the microstructure taken by optical microscope.
3. Accordingly hardness value has increased considerably compare to base metal Aluminum.
4. The figure shows that the hardness is higher at the furnace temperature of 800^0C.
5. The density of AMMC is considerably low, so it can be used in industrial and automobile applications.

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