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Fabrication of Low Cost Stir Casting Setup for Preparing Al Based MMC's

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ABSTRACT

Now-a-days a large variety of heating techniques/furnaces are available. There may be many method for supplying heat to the work but heat is produced either by combustion of fuel or electric resistance heating. Taking into consideration the effect of cost, safety, simplicity and ease of construction we are going for an electrical resistance heating furnace with indirect heating provisions. The stir casting furnace has two main parts that enable to perform all its operations, they are: Furnace Elements and Control Panel. In Metal matrix composites, the Aluminium Matrix Composites are gaining increasing attention for applications in aerospace, defence and automobile industries. This paper shows the design and fabrication of stir-casting furnace and aluminium melted and casted to form.

Keywords— Stir casting furnace, design, fabrication, casting, aluminium

I.INTRODUCTION

This Stir casting of metal matrix composites (MMC) was initiated in 1968, when S. Ray introduced alumina particles into aluminium melt by stirring molten aluminium alloys containing the ceramic powders. In a stir casting process, the reinforcing phases are distributed into molten matrix by mechanical stirrer. Mechanical stirring in the furnace is a key element of this process. The resultant molten alloy, with ceramic particles, can then be used for die casting, permanent mould casting, or sand casting. Stir casting is suitable for manufacturing composites with up to 30% volume fractions of reinforcement. The cast composites are sometimes further extruded to reduce porosity, refine the microstructure, and homogenize the distribution of the reinforcement. A major concern associated with the stir casting process is the segregation of reinforcing particles which is caused by the surfacing or settling of the reinforcement particles during the melting and casting processes [1].

There are different routes by which MMCs may be manufactured, and among all the liquid-state processes, stir casting technology is considered to have the most potential for engineering applications in terms of production capacity and cost efficiency Casting techniques are economical, easier to apply and more convenient for mass

production [2]. Stir casting is currently the most popular commercial method of producing aluminium based composites Stir casting of MMCs was initiated in 1968, when S. Ray introduced alumina particles into aluminium melt by stirring molten aluminum alloys containing the ceramic powders. Stir casting is suitable for manufacturing composites with up to 30% volume fractions of reinforcement ;allows for the use of conventional metal processing methods with the addition of an appropriate stirring system such as mechanical stirring; ultrasonic or electromagnetic stirring; or centrifugal force stirring , to achieve proper mixing of reinforcement into melt. Recently a drastically changes occurred in stir casting process. Researchers are introduced a two-step and electromagnetic assisted stir cast process to achieve better mechanical properties of fabricated composite[3]. In which matrix material is to be heated above its melting point, where it reaches in liquidus form after that molten metal is cooled to the stage where it becomes semi solid. Particles that are preheated added and mixed through stirring mechanism. Slurry formed is heated again till liquid state is being achieved. Many authors fabricated PAMMCs with different reinforcement through stir casting route and tested the mechanical properties.

Electrically Operated Aluminum Stir Casting Furnace fully Automatic Type) With Squeeze Casting & Vacuum Casting Arrangement are available with commercial suppliers in capacity of 10kG and working temperature in the range of 1000ºC.

Stir casting furnace used in R & D section in research institutes have 1 Kg to 3Kg capacity and having price in the range of 30-40 thousands. Aluminum melting furnace bottom type for melting up to 10 kg aluminum in cast iron crucible maximum temperature of furnace 1000 ^{0}C are available for industrial used and having price in the range of 3 to 3.5 lakhs.

Stir casting is one of the most universally used approach to manufacture particle reinforced composites and among all the fabrication techniques considered, stir casting stands out as the most economical method. Majorly of authors fabricated the composite by stir casting process with different reinforcements like SiC, Al2O3, fly ash, ground nut and rice husk ash. Authors also suggested that stir casting process is the simplest and cheapest route to fabricate the particulate type metal matrix composites.

A comparison between stir casting and powder metallurgy has been shown in Fig. 1.

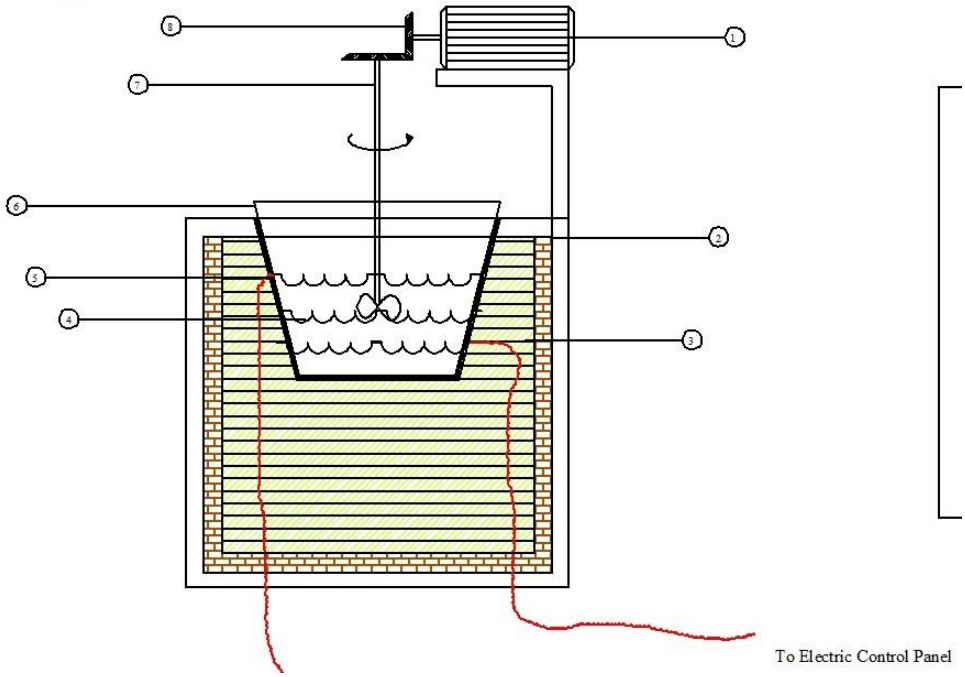
Table 1 Comparison of Composite Preparation Methods

Process → / ↓ **Parameter**	**Stir Casting**	**Powder Metallurgy**
Reinforcement Distribution	Inhomogeneous distribution	Homogeneous distribution

Wettability	Poor, Some reagent required	Better
Mechanical Properties	Good	Best results obtained
Cost	Most cost effective	Expensive
Volume Fraction	Up to 20%,	More than 30% possible
Range of shape and size	Not limited by size	Varity of shapes, size limited

II.CONSTRUCTION OF FURNACE

Fig. 1 schematic set up of stir casting furnace to be fabricated. Control panel for electric supply will be fabricated separately.



1	Electric Motor	5	Ceramic Pot
2	Refractory Bricks	6	Crucible
3	Ceramic Blanket	7	Stirrer

4	Electric Heating Coil	8	Bevel Gear

Fig.1 Schematic Set up of stir casting Furnace

III. FABRICATION OF SET UP

1. Fabrication of stir casting furnace will be completed in following steps

a) Fabrication of frame (rectangular box construction) with mild steel angle plate.

b) Walls will be covered with asbestos sheets for providing insulation.

c) Ceramic fire bricks will be used for constructing walls of furnace.

d) Ceramic pot will be used surrounded by electric heating coil and will be places in prepared frame box and insulation of ceramic blanket will be provided around it.

e) Crucible with capacity of melting 1kG Aluminum will be used and placed inside ceramic pot.

f) The part and instruments will be fixed within the control panel. The power will also be supplied to the furnace through the control panel.

g) For melting Aluminum small pieces of metal will be placed in crucible and preheated reinforcement will be added for preparing composite.

Crucible will be taken out of furnace by taking all the safety measures and molten metal will be poured into mold. Fig. 2 shows actual set up of stir casting furnace fabricated.

Fig.2 Fabricated Set up of Stir Casting Furnace

IV COST ANALYSIS

Following table 2 shows cost analysis of furnace

TABLE 2 COST ANALYSIS

Sr.No.	Name of Component	Cost (Rs)
01	Mild steel Frame	500
02	Plywood	150
03	Ceramic Blanket (1Bundle)	900
04	Crucible (1 kG Capacity)	50
05	Heating coil (2000 W)	40
06	Energy Meter	400
07	Thermocouple (Range 1200ºC)	900
08	Aluminum (1 kG)	250
09	Mold Preparation Material	250
10	Ceramic Fire Bricks (50 Nos)	900
11	Stirrer Motor (0-60rpm)	1200
12	Stirrer (Bevel gears, Bearings etc.)	200
Total		5740

IV.RESULTS

- In the present work furnace has been fabricated for melting Aluminium and preparing Al based MMC's
- The furnace reaches sufficient temperature to melt aluminium and other metals with similar melting points.
- Al starts melting at about 500ºC and it takes 40-50 minutes to reach this temperature in near about 2 unit's electricity consumption for 1 kG Aluminium.

V.CONCLUSIONS

- This stir casting furnace will be useful for preparing Al based MMC's with different reinforcement and finding out their properties.
- Stir casting process is cost effective and conventional route for manufacturing of composite material.

- This research work will help in development of new composite material which can be used in many industrial applications.
- Aluminium scrap has been melted successfully using the furnace and casting of the molten aluminium has been done.

VI.ACKNOWLEDGMENT

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