



Design of a stir casting machine

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ABSTRACT: Non-homogeneous particle distribution is one of the greatest problems in casting of metal matrix composites (MMC's), because of ceramic materials have different density, melting point and boiling point. But other light materials like Aluminium, copper and magnesium etc, have less density of melting point and boiling point, so ceramic particle mixing is very difficult to light materials. This paper deals with design the solid model components of stirrer assembly stand, screw rod, stirrer rod, nano/micro particle preheater, base stand, furnace stand, electronic assembly stand, electric furnace, heating vessel, path way pipe with heater and also, cooling die and die stand are made by solid model with require dimensions to design and fabricate of stir casting machine. In this machine the nano particle preheater attached in the top of the furnace, because of red hot condition with constant temperature of nano particle injected by push rod into the molten metal. The stirrer rod designed by variation of speed (0-2000rpm) for mixing purpose. We can set any constant rpm or any variation rpm at any time. Here avoid the non wettability of particles or floating or settling of particles. After mixed molten metal transfer into the mould with constant temperature through taper pathway heater pipe into the die. From this cast part improve all the mechanical properties without casting defects

Key words: nano particle preheater, stirrer rod, electric furnace, pathway pipe heater, die stand, die.

I. Introduction

Metal matrix composites (MMC) are a range of advanced materials providing properties have not achieved by conventional materials. This stir casting material properties increased strength, high elastic models, higher service temperature, improve wear resistance, decreased part weight, low thermal shocks, high electrical and thermal conductivity, and low coefficient of thermal expansion compound compared to conventional metal and alloys, [1] the excellent mechanical properties of these materials and the relatively low producing cost make them very attractive for a variety of application in automotive and aerospace industries. Technology for electromagnetic stirring of aluminium Reverberatory Furnaces[2] the simplicity of design the capital costs for installation of the equipment can be lower than a water-cooled stirring technology, with the solid design of the stirrer and specially designed control and drive system, low operating costs through low energy consumption can be achieved

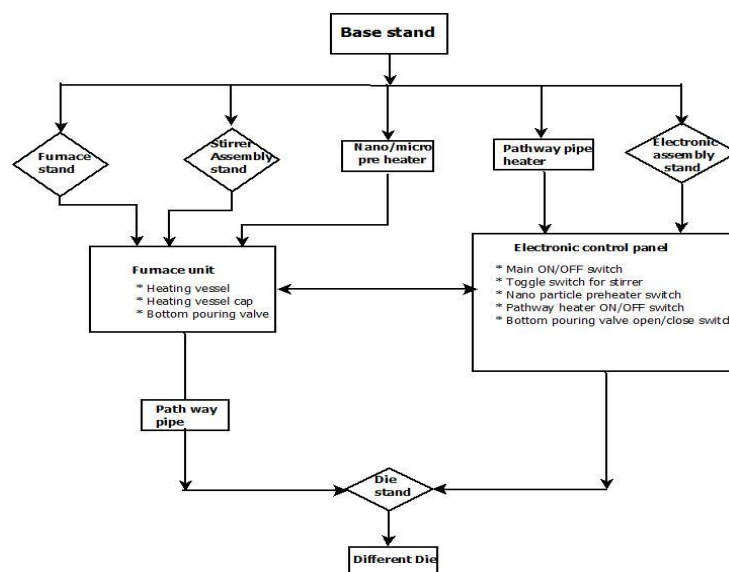


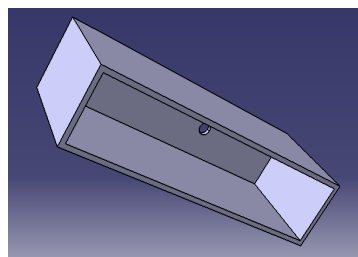
Figure 1. Block diagram of stir casting machine.

A study of published works showed that design of newly fabricated tribological machine for wear and frictional experiments under dry/wet condition [3], the operating parameters had a significant effect on wear, frictional and interface temperature behaviour of the composite the increase in applied load and or sliding distance increased the weight loss and frictional coefficient

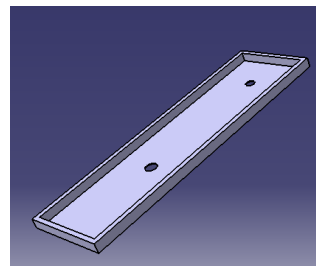
Report on design analysis of an electrical induction furnace for melting aluminium scrap [4], the induction furnace design and subsequently its fabrication should be promoted considering the abundant power sources, less maintenance cost and labour requirements. A study of published works showed that design and simulation of component-based manufacturing machine systems [5], the design and building component-based manufacturing systems can dramatically reduce machine/system development lead-times and provide proof-of-concepts. Results on design and construction of an electrical furnace to fire ceramic product [6], the furnace has automation facility with efficiency of 77%. From the published works, Stir casting methods when used to make the A356/Al₂O₃ micro and nano composites [7] revealed that the nano composites exhibited better properties in terms of compressive strength, hardness with reduced porosity.

Influence of stirring speed and stirring time on distribution of particles in cast metal matrix composite was demonstrated by S. Balasivanandha prabu et.al [8]. From the results, higher the stirring speed and time better the distribution of particles and increase in hardness. From the literature [9], stir cast components are showed with superior mechanical properties, fine microstructure and minimal porosity. The important challenges for design of stir casting machine is analysed in this study. In this machine, all the casted parts show even particle distribution and also increase all the mechanical properties. However the present work elaborates the mechanical property changes in the casting part.

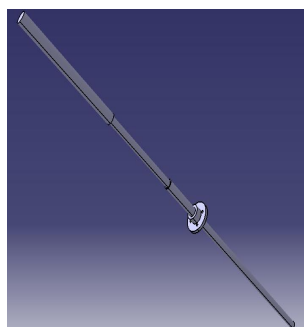
II. Design of stir casting machine components



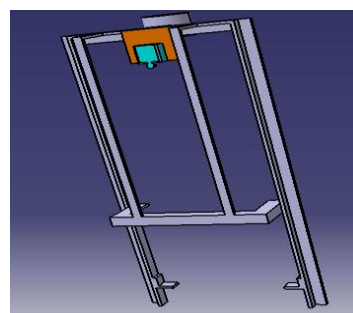
(a) Stir assembly cover



(b) Stir assembly bottom cover



(c) Screw rod



(d) Stirrer assembly stand

Figure 2:

The solid model of stirrer assembly with cover length of 605 mm, width 150 mm, thickness 10 mm, height 230 mm and stirrer rod hole diameter 28 mm are shown in Figure 2a. The stirrer assembly bottom cover length is 625 mm, width 170 mm, thickness 22 mm. Stirrer rod hole diameter is 25 mm is shown in Figure 2b. Screw rod height 1660 mm, diameter vary from 25 mm to 30 mm are shown in Figure 2c. Figure 2d shows stirrer assembly stand with height 1190 mm, width 490 mm, thickness 40 mm. These four components are made of mild steel. This stirrer assembly cover for the purpose of keeping the stirrer motor and stirrer rod. Screw rod for up and down movement of stirrer rod into molten metal for mixing purpose and also stirrer assembly stand for supporting the stirrer assembly cover.

The solid model of stirrer rod with total length of 835 mm, diameter 15 mm and bottom of stirrer blade thickness 10 mm and blade height 32 mm are shown in Figure 3a. The nano particle pre heater length 230 mm, diameter 440 mm, top cover diameter 100 mm, and centre push rod holes diameter 17 mm, bottom pipe channel

diameter 17.5 mm and length 125 mm are shown in Figure 3b. The nano particle push rod wood handle length 110 mm and length of the rod 335 mm at the bottom of sharp angle at 60° are shown in Figure 3c.

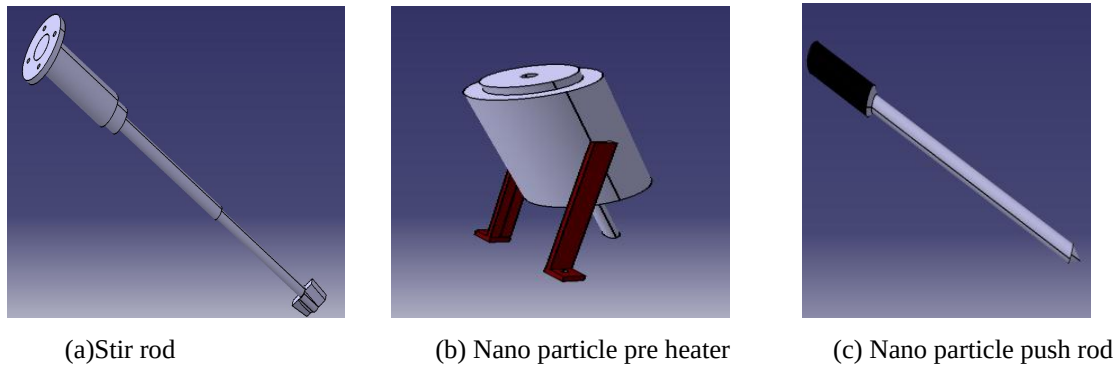


Figure 3:

These three components are made of AISI 310 grade heat resistant and corrosion resistant steel material. This stirrer rod is used for mixing purpose of liquid metal with solid nano particles. Nano particle pre heater is used for heating the nano particle at different temperature and nano particle push rod is used to push the heated nano particle into liquid metal with uniform flow of nano solid particles are shown in Figures 3b and 3c.



Figure 4:

The 3D solid model of the base stand component having length 710 mm, height 220 mm, and with 500 mm is shown in figure 4a. Similarly, the solid model of furnace stand length 1000 mm and width 410 mm and thickness 75 mm is shown in figure 4b. These two stands were made in mild steel. This base stand used for supporting the furnace.

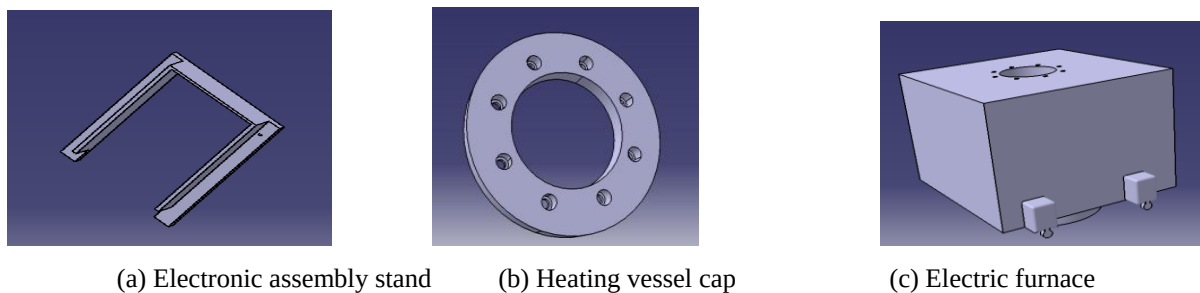
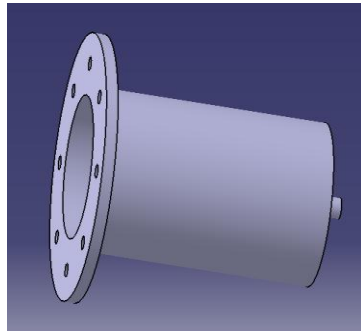


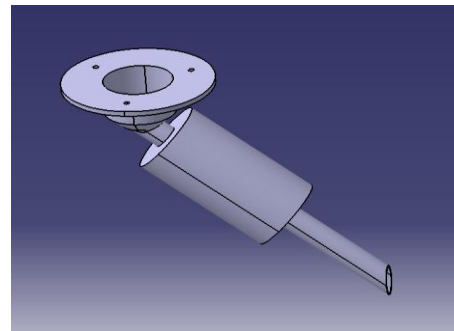
Figure 5:

The solid model of electronic assembly stand length 610 mm, width 310 mm and thickness 10 mm is shown in figure 5a. Heating vessel cap outer diameter 220 mm, inner diameter 115 mm, thickness 20 mm and 10 mm diameter holes in 8 numbers on the top of the vessel cap are shown in figure 5b. The electric furnace with length 406 mm, height 330 mm, and inner vessel diameter 115 mm is shown in figure 5c. These three components have

made in mild steel. This electric assembly stand used for supporting the electronic control panel, heating vessel cap for grip the heating vessel in centre axis of the furnace.



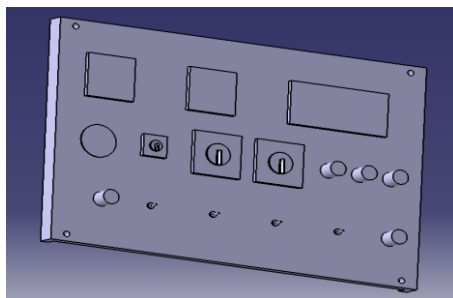
(a) Heating vessel



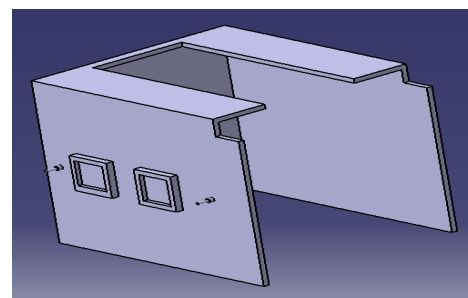
(b) pathway channel with heater

Figure 6:

The solid model of heating vessel having length 206 mm, outer diameter 116 mm and bottom pouring valve diameter 20 mm are shown in Figure 6a. The pathway channel pipe with length of 330 mm and diameter of pipe is 35 mm, with a heater length of 250 mm and diameter 150 mm in the heater. Pathway channel top cover of outer diameter 250 mm, inner diameter 116 mm and 10 mm diameter with three holes are shown in Figure 6b. These two components are made with AISI 310 grade heat resistant and corrosion resistant steel material. The vessel has been heated for producing the molten metal and pathway channel pipe with heater is used for transferring the molten metal into the die with constant temperature of liquid metal.



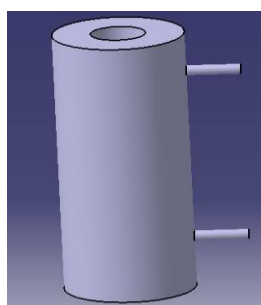
(a) Electronic assembly cover



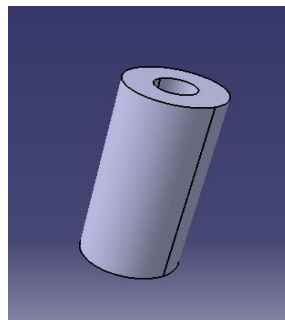
(b) Heater assembly cover

Figure 7:

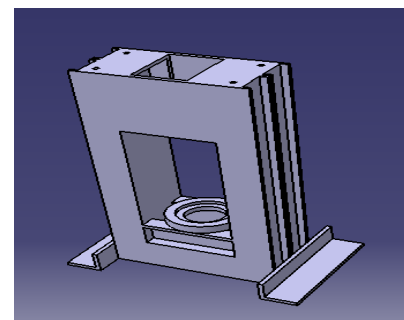
The solid model of electronic assembly cover with length 470 mm, width 310 mm, and thickness 10 mm is shown in Figure 7a. Numbers of control switches are connected in the electronic assembly cover are also shown in this figure. The heater assembly cover length 445 mm and length 370 mm, width 370 mm and centre hollow cap width 170 mm are shown in Figure 7b. These two components have made in mild steel. This electronic assembly cover to keep all the electronic control switches inside the cover. And also, the heater assembly cover to keep the nano/micro particle preheating control switch and pathway channel pipe heater control switch.



(a) Cooling die



(b) without cooling die



(c) die stand

Figure 8

The solid model components of cooling die length 260 mm, outer diameter 110 mm, inner diameter 46 mm, water inlet valve diameter 10 mm are shown in Figure 8a. Without cooling die length 260 mm, outer diameter 110 mm, and inner diameter 46 mm are shown in Figure 8b. Die stand length 300 mm, height 690 mm, thickness 130 mm, centre hollow slot length 130 mm, width 105 mm are shown in Figure 8c. Cooling die is made in mild steel material. The die stand is made up of mild steel. This stand is to keep and grip the die for different casting technique.

III. Parts list of complete stir casting machine

The following table (Table 1) lists the complete components involved for design of the stir casting machine

Table 1:

Serial NO:	Name of the component	Material	Quantity
1	Stir assembly cover	Mild steel	1
2	Stir assembly bottom cover	Mild steel	1
3	Screw rod	Mild steel	1
4	Stirrer assembly stand	Mild steel	1
5	Stir rod	310 steel	1
6	Nano particle pre heater & injector	310 steel	1
7	Nano particle push rod	310 steel	1
8	Base stand	Mild steel	1
9	Furnace stand	Mild steel	1
10	Electronic assembly stand	Mild steel	1
11	Electric furnace cover	Mild steel	1
12	Heating vessel	310 steel	1
13	Pathway channel with heater	310 steel	1
14	Electronic assembly cover	Mild steel	1
15	Heater assembly stand	Mild steel	1
16	Split die	Die steel	1
17	Die and squeeze cylinder stand	Mild steel	1

IV. Assembly of stir casting machine

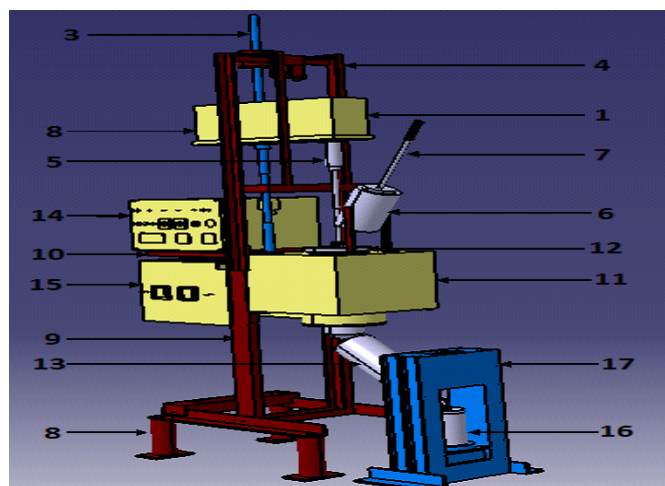


Figure 7: Assembled view of the stir casting machine.

The figure 7 shows the assembled view of the stir casting technique machine and the corresponding parts numbers with its materials used for design the machine are listed in the table 1.

V. Design analysis and calculations

1. Stirrer speed

Rotation is sensed by micro controller through proximity switch mounted near the stirrer shaft. Rotation every second is multiplied for minute and indicated in digital display. Its speed varies from 0 -2000 rpm

2. Die design

Material of the die = Mild steel/ Die steel/ Stainless steel
 Die height and diameter = 260 mm and 46 mm
 A356 Al Alloy density = 2.67 g/cc
 Volume of die (v) = $\pi/4 \times D^2 \times h \times \rho$
 = $\pi/4 \times (4.6)^2 \times 26 \times 2.67$
 = 1154 gram

3. Nano particle pre heater design

Material = AISI 310 grade heat and corrosion resistant steel
 Preheater length and diameter = 170 mm and 46 mm
 Al₂O₃ nano particle density = 3.9 g/cc
 Volume of pre heater (V) = $\pi/4 \times D^2 \times h \times \rho$
 = $\pi/4 \times (4.6)^2 \times 17 \times 3.9$
 = 1102 gram

4. Heating vessel design

Material of the vessel = AISI 310 grade heat and corrosion resistant steel
 Length of the vessel = 160 mm
 Diameter of the vessel = 105 mm
 A356 Al Alloy density = 2.67 g/cc
 Volume of vessel (V) = $\pi/4 \times D^2 \times h \times \rho$
 = $\pi/4 \times (10.5)^2 \times 16 \times 2.67$
 = 3699 gram

VI. Conclusions

1. In this study, the design of stir casting machine was successfully designed for the light materials like aluminium, magnesium and copper to melt and for getting cast part with higher mechanical properties.
2. In this machine the nano particle pre heater attached in the top of the furnace, because of red hot condition with constant temperature of nano particle injected by push rod into the molten metal. The stirrer rod designed by variation of speed (0-2000rpm) for mixing purpose.
3. Here avoid the non wettability of particles or floating or settling of particles. After mixed molten metal transfer into the mould with constant temp through taper pathway heater pipe into the die .From this cast part improve all the mechanical properties without casting defects
4. In this design, pour the molten metal into the die with constant temperature before start the crystal growth. Because the furnace and the die connected through the pathway taper pipe channel with heater. The molten metal transfers into the die with constant temperature before start the crystal growth. The stir casting machine has been used for trial product of A356/Al₂O₃ nano particle composite materials.

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