Design and Fabrication of Stirrer Motor Speed Controller for better process

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ABSTRACT

The aim of this research is to optimize of stir casting process parameters by speed controlling. There are wide variety of methods are used. In this context only speed control is considered for better process. Taking into consideration the effect of cost, safety, simplicity and ease of construction we are going for an speed controlling by rheostat. It consist of two main parts that enable to perform all its operations , they are: Motor and Rheostat This paper shows the design and fabrication of Stirrer Motor Speed Controller for better process

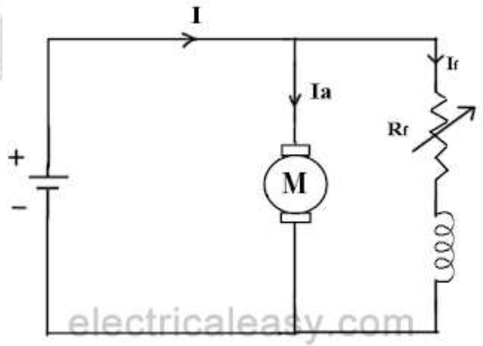
1.INTRODUCTION

. Stir-casting is also otherwise known as "Semi-Solid Metal Casting" or "Rheocasting" or "Compocasting" and is mainly use with the non-ferrous metals. The process combines the advantages of casting and forging. The **stir casting** method generally involves the heating of the matrix material to a melting temperature in a crucible which is chemically inert to the materials that are going to be charged into it. The crucible can be of various types and the most basic type being the coke fired.

DC motors find extensive applications in industries where precise speed control over a wider range of speed both above and below the rated speed Usually speed control of DC motor is achieved with rheostat

1.1.Principle

Flux control method. It is already explained above that the speed of a dc motor is inversely proportional to the flux per pole. Thus by decreasing the flux, speed can be increased and vice versa. To control the flux, a rheostatis added in series with the field winding, as shown in the circuit diagram.



The magnitude of E_b can be given by EMF equation of a DC generator.

$$E_b = {}^{P\emptyset NZ}/_{60A}$$

(where, P = no. of poles, Ø = flux/pole, N = speed in rpm, Z = no. of armature conductors, A = parallel paths) E_b can also be given as,

$$E_b = V - I_a R_a$$

Thus, from the above equations

$$N = {E_b\,60A}/{P\text{Ø}Z}$$

but, for a DC motor A, P and Z are constants

Therefore,

$$N \propto K\, {E_b}/{\text{Ø}}$$

(where, K=constant)

2.DESIGN

2.1. DC motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills.

2.2.Rheostat

A rheostat is a variable resistor which is used to control current. They are able to vary the resistance in a circuit without interruption. The construction is very similar to the construction of a potentiometers. It uses only two connections, even when 3 terminals (as in a potentiometer) are present.

Rheostat, adjustable resistor used in applications that require the adjustment of current or the varying of resistance in an electric circuit. The rheostat can adjust generator characteristics, dim lights, and start or control the speed of motors.

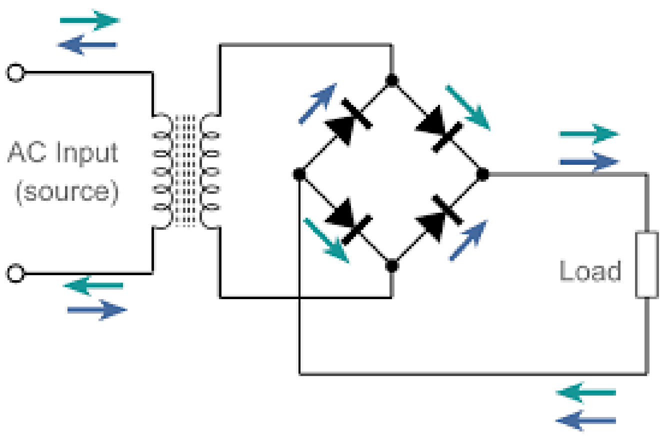
2.3. Power conversion

Powerconversion is converting electric energy from one form to another such as converting between AC and DC or changing The voltage or frequency; or some combination of these. Apower converter is an electrical or electro-mechanical device for converting electrical energy. This could be as simple as atransformer to change the voltage of AC power, but also includes far more complex systems. The term can also refer to a class of electrical machinery that is used to convert one frequency of alternating current into another frequency.

2.4. Rectifier

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction.

The process is known as rectification, since it "straightens" the direction of current. Physically, rectifiers take a number of forms, including vacuum tube diodes, mercury-arc valves, stacks of copper and selenium oxide plates, semiconductor diodes, silicon-controlled rectifiers and other silicon-based semiconductor switches. Historically, even synchronous electromechanical switches and motors have been used. Early radio receivers, called crystal radios, used a "cat's whisker" of fine wire pressing on a crystal of galena(lead sulfide) to serve as a point-contact rectifier or "crystal detector".



2.5. Ammeter

Ammeter (Fig 4) indicates the current flowing through the circuit at a particular instant of time through the circuit. The ammeter used here is a moving iron (MI type) Ammeter having dial area 72mm^2 and has a range of 10A. The manufacturer of this ammeter is M –Tech industries.

Fig 4 Ammeter

2.6. Voltmeter

The voltmeter (Fig 5) is connected in the circuit to measure the voltage across the coil. This one is also moving iron (MI) type voltmeter with dial area of 72mm2. The range of the voltmeter is of 300V. This is also manufactured by M-Tech Industries.

2.7. Transformer

The transformer is used to convert the 220V AC supply into 12V AC supply because 12V is the operating range of the relay.

2.8. AC to DC converter

This is a rectifier which converts the 12V AC output from the transformer in to 12V DC supply which is fed to the relay. It uses a Guerter circuit (Fig 9) to perform this.

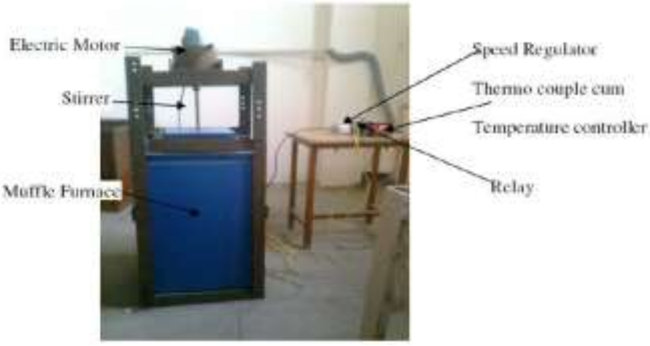
2.9. Selector Switch

A 15Amps 250V rotary selector switch is used to on or off the power supply

3.FABRICATION OF SPEED CONTROLLER FOR STIR CASTING

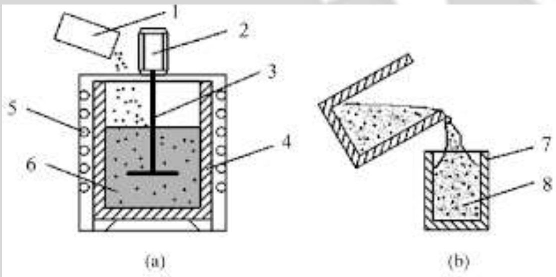
3.1 Step 1

The first part in the construction of the speed controller in stir casting. To work with highest efficiency the speed control has to variable range and withstand heat resistant. To achieve this, the furnace needs to be as insulated as possible while being able to withstand the thermal stresses developing within the furnace. The construction of the body starts with building the furnace frame. The furnace frame is made of mild steel angle sections weld joined, upon which galvanized steel plates are also welded to form the body. Galvanization of the steel sheets adds to the insulating property of the furnace wall which is much needed, as a result we are able to keep the temperature of the walls at near about atmospheric temperature and avoid over-heating.



3.2.Step 2

The next part in the building is the pot and coil set-up. The pot is made up of ceramic particles and is heated up to a temperature of 2100^0C in phases. It is done so that it can get heated up to 2100^0C and still remains intact. The pot is an important part of the furnace as the coil is wrapped around it as well as the crucible is placed inside it. The pot can be made in various shapes and sizes and generally is made with square cross section, but here the furnace is subjected to top loading so we have taken a pot of circular cross section.



3.3 Step 3

Now the second order of construction is making the control panel to regulate end control the temperature and heating inside the furnace. The control panel is made out of Bakelite boards and joined through aluminium angles and channel sections with screws and rivets . The part and instruments are fixed within the control panel. The power is also supplied to the furnace through the control panel. The heating coil is joined to the control panel with glass wires. These have high temperature sustainability.

3.4 Step 4

The main supply is controlled by a selector switch. The supply is given directly through the selector switch to the Ammeter (which gives the net amount of current flowing through the coil at a particular instant), then the supply is provided through the energy meter which calculates the net energy consumed in the whole circuit. The voltmeter is connected in parallel across the heating coil (which denotes the net voltage across the coil). The supply from the Ammeter goes to the porcelain connector at the bottom of the furnace.

The bimetallic thermocouple is connected to the PID temperature controller through a wire from a similar porcelain connector below the furnace and joined across the NC circuit of the controller. The temperature controller analyses the emf generated in the thermocouple to indicate the temperature inside the furnace. A supply of 220V is also supplied to the controller. The output of the controller goes to a miniature transformer which converts the 220V AC supply into a 12V AC output. This output is then connected to a "GUERTER CIRCUIT" which converts this 12V AC supply into a 12V DC output. This 12V DC supply is given to a contactor consisting of a latch and a coil acting as an electromagnet. The supply that is given from the Ammeter to the furnace is passed through this connector. When the temperature of the furnace goes above the set temperature the controller gives a 220V AC output which gets converted into 12V DC through the transformer and the Guerter circuit. When the contactor receives this 12V DC supply the electromagnet gets magnetized and pulled the latch there by breaking the circuit, hence avoiding overheating of the furnace.

4.MELTING AND CASTING OF ALUMINIUM

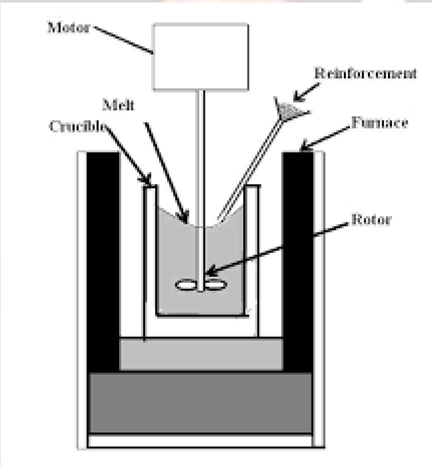
4.1 Melting of Aluminium

4.1.1 Step 1

The furnace is heated upto a temperature of 950^{o}C, in 3 phases in 3 days, so as to remove any moisture present inside the furnace or on the heating wire. Even a single drop of moisture can damage the heating coil permanently. So, it is necessary to remove any moisture present inside the furnace. In the 1st phase (i.e., on the 1st day), the furnace was heated up to a temperature of 500^{o}C. The top cover is kept open until a temperature of 300^{o}C is reached, so that the moisture can escape when heated. After attaining 300^{o}C, the cover is closed. In the 2nd phase (i.e., on the 2nd day), the furnace was heated up to a temperature of 750^{o}C and the rest of the procedures were followed. In the 3rd phase (i.e., on the 3rd day), the furnace was heated up to a set temperature of 950^{o}C. After reaching this temperature the heater automatically shut down.

4.1.2 Step 2

The aluminium scraps were cut into small pieces and hammered to get small tablets of aluminium scrap. About 100 gm of aluminium scrap was taken in the graphite crucible. The graphite crucible was placed inside the container of the furnace. The furnace along with the crucible containing the aluminium scraps was heated up to a temperature of about 800^{o}C to melt the aluminium completely. The crucible was taken out of the furnace with the help of tongs and by taking other safety measures like wearing insulating hand gloves. The energy meter reading was noted to find out the efficiency of the furnace.



5.CONCLUSION

Hence, we successfully fabricated a Stir-Casting Furnace set-up. Aluminium scrap was melted successfully using the furnace and casting of the molten aluminium was done. The energy meter reading was noted. Hence, the furnace is efficient

REFERENCES

[1] Vikram Singh and R.C. Prasad; Tensile and Fracture Behaviour of 6061 Al-SiCp metal matrix composites; *International Symposium of Research Students on Materials Science and Engineering*, Chennai, India, Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Madras, December 20-22, 2004.

[2] S.Sarkar, Nigamananda Ray, Dilip Kumar Kerketta; Some studies on Aluminium Matrix In-Situ composites produced by Stir Casting Method 2010.

[3] Sourav Kayal, Ravindra Behera, G. Sutradhar; Castability of Al-SiCp metal matrix composites in thin walled castings; *International Journal of Engineering Science and Technology (IJEST)*.

[4] S. Naher, D. Brabazon, L. Looney; Computational and experimental analysis of particulate distribution during Al–SiC MMC fabrication; *Composites: Part A, 38*,2007, 719–729.

[5] D.J. Lahaie, J.D. Embury, F.W. Zok; Damage accumulation and mechanical properties of particle-reinforced metal– matrix composites during hydrostatic extrusion; *Composites Science and Technology, 64*,2004,1539–1549.

[6] T.V. Christy, N. Murugan and S. Kumar; A Comparative Study on the Microstructures and Mechanical Properties of Al 6061 Alloy and the MMC Al 6061/TiB2/12P; *Journal of Minerals & Materials Characterization & Engineering, 9(1)*, 2010, pp.57-65.

[7] I.S.Rout, D.R.Patra, S.S.Padhi, J.N.Biswal and T.K.Panda, Design and Fabrication of motorized automated Object lifting jack, *IOSR Journal of Engineering, 4(5)*, May 2014, pp 6-12

[8] A. R. K. Swamy, A. Ramesha, G.B. Veeresh Kumar, J. N. Prakash; Effect of Particulate Reinforcements on the Mechanical Properties of Al6061-WC and Al6061-Gr MMCs; *Journal of Minerals & Materials Characterization & Engineering,10(12)*, 2011, pp.1141-1152.

[9] M.Sahoo, D.R.Patra and I.S.Rout, Fabrication and Study of Titanium diboride powder and aluminium titanium alloy composite, *International Journal of Advanced Research Trends in Engineering and Technology,1(4)*, December 2014,pp 57-65.

[10] Manoj Singla, D. Deepak Dwivedi, Lakhvir Singh, Vikas Chawla; Development of Aluminium Based Silicon Carbide Particulate Metal Matrix Composite; *Journal of Minerals & Materials Characterization & Engineering, 8(6)*,2009, pp 455-467