ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering(ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

Magnetic Mould Casting: Methodology and Comparison with Traditional Sand Casting Process

Vishal Sadade[1], AmitDhake[2], Nishad Dixit[3], Prof. S. P. Deshpande[4]

Under graduate students, Department of Mechanical Engineering, Gokhale Education Society's, R. H. Sapat College of Engineering, Management Studies and Research, Nashik, Maharashtra, India[1,2,3]

Assistant Professor, Department of Mechanical Engineering, Gokhale Education Society's, R. H. Sapat College of Engineering, Management Studies and Research, Nashik, Maharashtra, India[4]

Abstract: Casting is a manufacturing process, which is used directly or indirectly in almost every industry. It is a primary manufacturing process and has its effect on the properties of the resultant product. In this era there is a demand to innovate processes, which can reduce lead-time, reduce cost of production without compromising with the quality of the products and reduce ill effects on environment. Magnetic mould for casting (MMC) is an innovative process having a great potential to replace conventional casting methods due to various advantages associated with it. The setup of magnetic mould casting includes winding of copper wire such that it behaves like a solenoid with hollow cavity in which actual casting process is to be carried out. For making mould two cylinders are used, copper winding is done to outer cylinder and current is allowed to pass through the wire, this results in generation of magnetic field inside the cylinder. Ferrous powder is used as moulding material and thermocol as pattern material. The molten metal when poured, it replaces the pattern and takes its shape and once solidified it can be easily taken out of the mould. Magnetic mould casting reduces the time consumed for sand preparation, mould making and knocking required for casting removal by completely replacing sand with ferrous powder and use of magnetism. The process is eco-friendly as it eliminates the use of sand, successfully reduces the overall process time for casting and results in better properties too.

Keywords: Magnetic Mould, Sand casting, ferrous powder, Time study, Properties.

I. INTRODUCTION

Casting is a manufacturing process that can be performed in a number of ways. The type of process employed for casting has an effect over properties like surface finish, microstructure, hardness, toughness, etc. of the resultant product. In modern days industries there are many factors, which affects the decision of selecting the type of casting process to be used. This includes properties of cast product, time required for manufacturing and environmental effects of the process. Magnetic mould casting (MMC) is an application of electromagnetism to the process of casting. Ferrous Powderconstitutes the mould that is formed by application of magnetic field on it.

The application of magnetic field that induces magnetic bonds between Ferrous particles which gives strength to mould, this reduces the time elapsed in ramming process. Also, breaking of mould becomes easier by using magnetic field, as it is required to switch off the supply to turn down the magnetic field and mould breaks. MMC process employs a one-piece mould and a thermocol pattern, which gives an advantage of cast products being free of defects associated with joint line (Geffroyet. Al.). Also the products have better dimensional tolerances than the products obtained from conventional methods. The amount of machining required is less thus reducing the time and cost involved in finishing a product for use.

The mechanical properties like tensile strength, impact strength and hardness of the products cast from MMC have higher values as compared to sand casting products (P. Gnanvel). The reason behind this improved might be the higher solidification rate of Ferrous mould as its thermal conductivity is more than the sand mould (Geffroy et. Al.). A major concern related to casting is environmental pollution. In casting, foundry waste is releasedand sand once used gets burnt and is of no use, thus adding up to foundry waste whereas in MMC Ferrous powder can be reused and magnetic field had not any effect on the worker's health.

Therefore MMC is an eco-friendly process as waste generation is minimum and due to reusability of mould material. This process is still in its research phase. There is no evidence of its use in any industry till now but it can be used as a replacement of conventional methods of casting as this process has certain advantages over them.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering(ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

II. EXPERTIMENTAL SETUP

Dimensions of Mould Box:
Outer Cylinder (Al) - Diameter and thickness are 200mm and 1mm respectively.
Inner Cylinder (MS) - Diameter and thickness are 180mm and 2mm respectively.
Height of both cylinders is 125mm.

The inner cylinder is closed at one end and filled with ferrous powder of 10 microns. Copper wire of 18 gauges is used to sustain the current for required time period of experiment without damage due to heating. The metal used for this process is nonferrous (here lead, as melting point is less [327˚C] and ease of melting).

Power Supply:Constant DC power supply is provided with the help of single phase 0-270V autotransformer and a bridge rectifier of 230V and 10A rating is used.

Copper wire is wound around the outer cylinder and the numbers of turns were decided once the required magnetic effect was achieved using trial and error method.

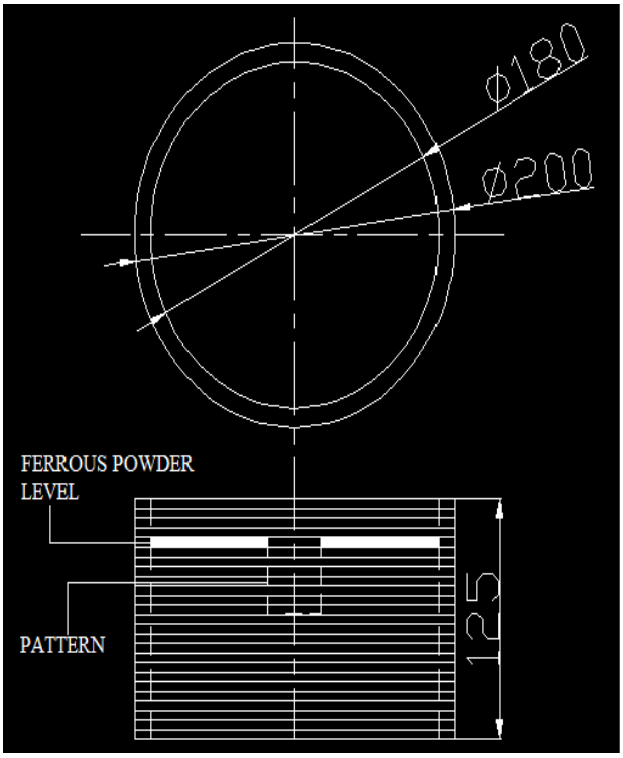

Fig.1. 2D Model

III. EXPERIMENTAL PROCEDURE.

Initially parameters for MMC are decided. The parameters like gauge of copper wire, intensity of voltage required, size of ferrous powder particles and size of thermocol pattern are to be defined first. Following are the steps to be followed to carry out Magnetic Mould Casting.

Preparation of mould and electric connections – As mentioned before copper windings are on outer aluminium cylinder. The mild steel cylinder is inserted inside the outer cylinder which forms the core for magnetic field. There is air gap between both cylinders. Single phase AC supply is given to autotransformer (0-270V) through which voltage is varied accordingly. The output supply of transformer is taken through rectifier which converts AC supply into DC which is further given to copper coils. With the help of ammeter required current can be measured.

Pattern Making –To carry out MMC high density thermocol pattern is used. As the pattern is the replica of the casting, pattern is to be cut into required shape into required quantity before carrying out actual process.

Forming the mould and pouring - This step involves providing the supply to core, filling the inner cylinder with sufficient amount of ferrous powder, inserting the pattern and pouring of molten metal. It starts with filling the powder and inserting the pattern, once the pattern is settled the current is allowed to pass through coil and magnetic field is

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
2nd International Conference on Advances in Mechanical Engineering(ICAME-2016)
Amrutvahini College of Engineering, Sangamner
Vol. 3, Special Issue 1, March 2016

created. This field allows the powder to attract towards the wall of inner cylinder. All this process works on Fleming's left hand rule. Once the attraction is achieved the pouring of molten metal can be started, it is directed on pattern. Due to higher temperature molten metal the pattern vaporizes as soon as it comes in contact and due to its vaporization the cavity created is filled with the metal and takes its shape (shape of the cavity made by pattern by reserving the space in the powder). During all this process the supply is on and once the pattern is completely replaced the metal is allowed to solidify at room temperature.

Casting removal – As soon as we see that the casting is ready (i.e. metal is solidified) supply is turned off. A tool is used to separate the powder and casting, and the solidified casting can be easily taken out without breaking the mould. Once the casting is taken out of the mould it is ready to serve another casting.

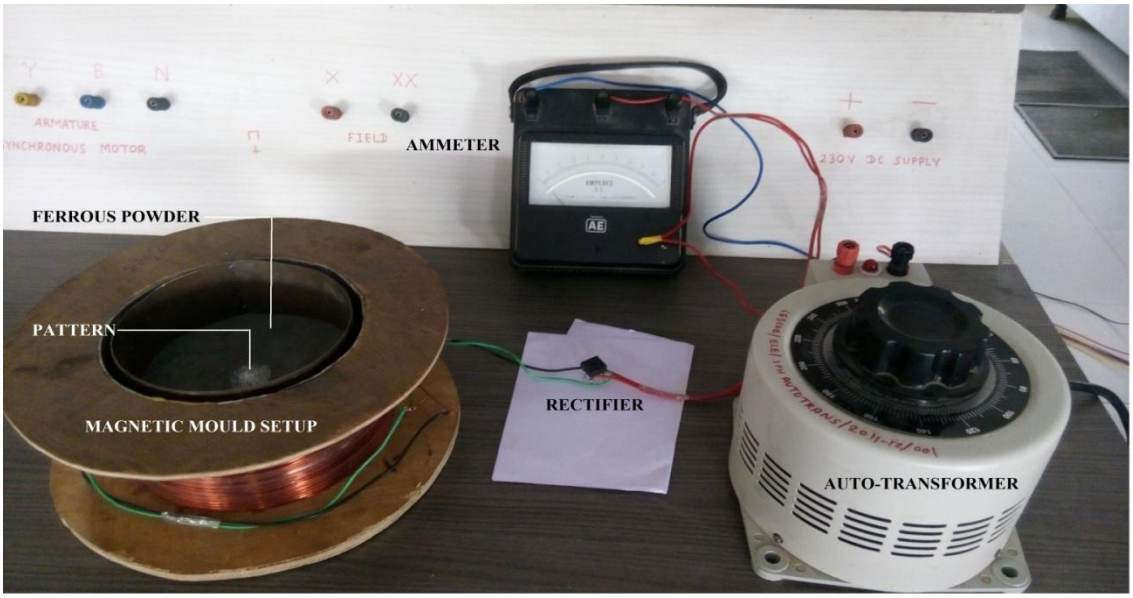

Fig.2.Fabricated Setup

IV. TIME STUDY

Following is the time study carried out for comparison between sand and magnetic casting to compare the time required for manufacturing a single block having same geometry and same material (Here Lead).

PARAMETERS	TIME REQUIRED IN SAND CASTING (MINUTES)	TIME REQUIRED IN MAGNETIC CASTING (MINUTES)
Pattern cutting	10	8
Pattern finishing	3	0
Metal melting	3	3
Mould making	8	5
Pouring	1	1
Solidification And cooling time	12	12
Casting removal	2	1
Rework, Finishing	5	3
Total time	44	33

Table1. Time study

From the above table it can be seen that magnetic casting is time saving manufacturing process as compared to traditional sand casting. The results give the difference of 11 minutes which sand casting takes more than MMC. In addition to this sand casting requires the time for sand preparation i.e. the time for mixing the additives, water and making it usable for casting which is completely eliminated in MMC. For every 250 Kgs of sand the time for its preparation is 20 minutes.

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

IARJSET

International Advanced Research Journal in Science, Engineering and Technology

2nd International Conference on Advances in Mechanical Engineering(ICAME-2016)

Amrutvahini College of Engineering, Sangamner

Vol. 3, Special Issue 1, March 2016

V. PROPERTY COMPARISON

Following is the table showing the comparison between the products manufactured by both the castings on the basis of ultimate tensile strength. For this comparison a rectangular block was selected having area around 78 mm^2.

Table 2.Property Comparison

PARAMETERS	SAND CASTING	MMC
Ultimate load (KN)	1.38	2.24
Ultimate tensile strength (MPa)	17.88	28

Results from this study show clearly that the product manufactured with MMC was produced with greater ultimate tensile strength as compared to sand casting.

VI. CONCLUSION

The mould for magnetic casting was successfully prepared along with its comparison with sand casting on the basis of time study and properties and the results were clearly showing that MMC is advantageous over sand casting. Intricate and complex geometry shapes were easily manufactured with better surface finish. Wastage of sand is completely eliminated making MMC ecofriendly. MMC is quicker, cheaper and is providing better quality product.

ACKNOWLEDGEMENT

Authors would like to thank Prof. K. V. Chandratre , Prof. D. S. Chaudhari (Department of Mechanical Engineering), Prof. M. K. Chaudhari and Prof. A. M. Lulle (Department of Electrical Engineering) for their consistent and valuable guidance throughout the project.

REFERENCES

[1]. Gnanavel, P. (2013) Innovative Design on Fabrication of energy conservation in non-ferrous casting manufacturing process, Indian foundry journal, 59(12), 32-35.
[2]. K.J.suganth Kumar, S.Senthil kumaran, S.Rajendra Boopathy, "Theoretical & experimental investigation of mould strength in magnetic moulding compacts", Journal of materials processing technology 205(2008)235-242.
[3]. Pierre-Marie Geffory, Meroune Lakeghal "Thermal and mechanical behaviour of grey cast iron and ductile iron casting using magnetic moulding & lost foam processes",2009.

BIOGRAPHIES

Vishal Sadade is currently a student of GESRHSCOE, Nashik from the University of Savitribai Phule Pune. His main interest in research includes in Design of mould.

Amit Dhake is currently a student of GESRHSCOE, Nashik from the University of Savitribai Phule Pune. His main interest in research includes in Time study between MMC and Sand Casting.

Nishad Dixit is currently a student of GESRHSCOE, Nashik from the University of Savitribai Phule Pune. His main interest in research includes in study of Properties between MMC and Sand Casting.

Prof. S. P. Deshpande is currently a assistant professor at GESRHSCOE, Nashik from the University of Savitribai Phule Pune. Her main interest in manufacturing and optimization