Innovative Design on Fabrication of Energy Conservation in Non-Ferrous Casting Manufacturing Process

P. Gnanavel

Department of Manufacturing Engineering, Reda Production System, Singapore

E-mail : pgnanavelin@gmail.com

ABSTRACT

To solve the power crisis, we are having two options. Either we can increase the production or reduce the wastage. Instead of increasing the power production, it is better to reduce unnecessary consumption. Augmentation of production capabilities is a costlier option. But reducing wastage is wiser, more viable, and practical and zero investment way to achieve energy security. This reduction in consumption is achieved by minimising the wastages and through proper usage. The above-said problem was solved by this project with a low cost.

The development of unbounded casting process improves flexibility and enhances mould ability. The concept of unbounded casting is to change the kind of binder or to avoid substantial binder. Magnetic moulding is a type of unbounded moulding process in which a dry and free flowing magnetic steel shots or granules are used as mould materials. The pattern for the required job is made of using expendable polystyrene materials. An electromagnetic field is created using electromagnets and this magnetic field is used as the binding force.

In this paper, the design and fabrication issues of Magnetic Moulds are explained.

Keywords: Magnetic mould, Horseshoe magnetic, Mechanical properties, Cost analysis, Energy conservation.

INTRODUCTION

Organisations in today's competitive environment face dynamic and unpredictable demand from customers. The need to manufacture small quantities of highly customised products with perfect quality and 100% on time delivery at low cost is forcing companies to abandon the old ideas and to develop new manufacturing techniques. A number of manufacturing techniques are evolved during the last few years and Magnetic molding is one among such techniques. Magnetic moulding is a type of unbounded moulding process in which a dry and free flowing magnetic steel shots or granules are used as mould materials. The pattern for the required job is made of using expendable polystyrene materials. An electromagnetic field is created using electromagnets and this magnetic field is used as the binding force. After pouring and solidification is over, the magnetic field is cutoff and the casting can be easily taken out from the mould box without doing the knocking out operation, which is normally done, in conventional sand castings. Magnetic moulding requires only less floor space and it is easy to prepare the mould, as it just requires setting the magnetic field using electromagnets. In Magnetic moulding, sound castings can be produced, as heat transfer rate is high because of metallic conduction.

PROCEDURE OF MAGNETIC MOULDING

In magnetic moulding, steel shots or steel granules are used as the moulding material, the binding force used in magnetic moulding process is magnetic force.

Step 1: Construction of Horseshoe Magnet

Horseshoe magnet is made of steel sheets cut and laminated to form core of U shape. It is wound with copper wire on the base. The winding consists of two parallel stretch of windings each of 300 turns in a horseshoe magnet with a mould box inserted between the

square poles in a magnetic path, so that the flux lines pass through the magnetic media. Hence, complete magnetic coupling is achieved.

Step 2: Pattern Material Making and Assembly

In magnetic moulding process, foamed polystyrene is used as pattern material. Fabricated patterns are made from sheets of foamed polystyrene, which is available in various thicknesses. The pattern is assembled with special glues, which grip quickly and leave a minimum residue on vaporisation. The surfaces are smoothened by emery paper of fine grade to prepare pattern. Sprue, gates and the feeder are glued together and assembly is given a fine coating to avoid sintering of the moulding material.

Step3: Preparation of the Mould

Iron shots or iron granules and magnetic oxides are used as moulding material in the magnetic moulding process. Usually the size of iron granules is used from 0.3 mm to 1.2 mm in diameter. The pattern assembly is positioned in the flask and dry, free flowing magnetically moulding material is filled around the pattern. If necessary packing can be improved by applying vibration, when the current is passed through the coil, magnetic field is produced which holds the material together.

Step4: Pouring

After the application of magnetic field, molten metal is poured through the space of pattern. The metal replaces the polystyrene, which vaporises leaving a casting of same shape as the pattern. The evolved gases and vapour passes away through the moulding material. The magnetic field should be applied until the metal solidifies.

Step 5: Removal of Casting

After the casting solidifies, the power is switched off. The material is now in free condition, so that the casting can be easily withdrawn from the flask. The gates and risers are removed from the castings. The magnetically mould material is then cooled and screened for further use.

DESIGN OF MOULD BOX

(A) Length and Width of the Mould Box

The dimensions of the mould box are decided from the size of the casting and the gating system.

L= l + (2*25)

Where L= the length and width of mould box.

l = the cross-sectional size of casting. 25 mm is the minimum clearance given on both side of the casting. In this report, the maximum size of the casting is limited to 100 mm so, the length of the mould box used is calculated as 150 mm.

(B) Height of the Mould Box

L=Lc + Lb+ Lt.

Where L= Maximum height of the casting

Lc=Clearance between bottom surface of mould box and the bottom surface of casting.

Lb= Clearance between top surface of mould box and the top surface of casting.

Lt is decided by considering the height of the gating system above the casting. While Fig. 1 shows Fig. 2 depicts the design of the mould box.

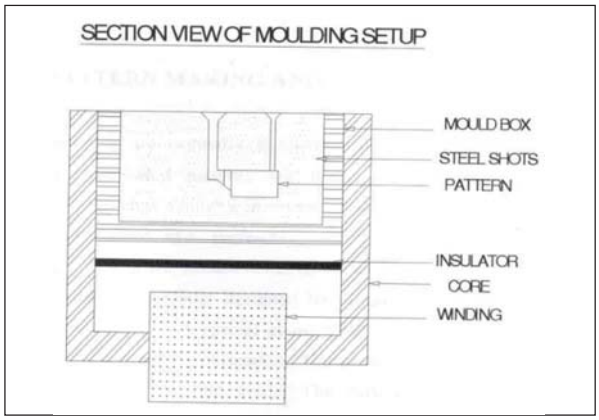

Fig. 1: Section view of moulding setup.

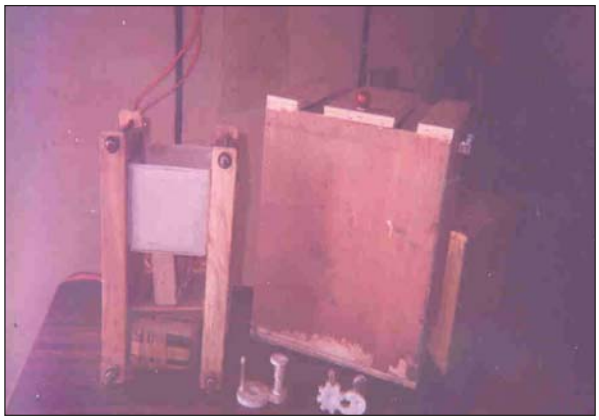

Fig. 2: New design of Magnetic mould box.

COST ANALYSIS

A. Cost Involved in Fabricating Magnet

(a) Cost of Steel Sheet

Cost of 1 kg of steel sheet = Rs.60.

Total cost of steel sheet =Rs.3600.

Cost of cutting a lamination of steel sheet = Rs.500.

Cost of winding coil=Rs.600.

Total cost of core =Rs.4700.

(b) Cost of Copper Wire

Cost of 1 kg of copper wire =Rs.240.

Total cost of copper wire =Rs.2400

(c) Cost of Enamel Coating

Total Cost =Rs.280.

Total Cost of Horseshoe Magnet = Rs.4700+2400+280 = Rs.7380.

B. Cost Involved in Fabricating Accessories

Cost of Steel Shots	=	Rs.1000.
Cost of Pattern	=	Rs.25.
Labour share for making MouldBbox	=	Rs.57
Cost of Moulding Setup	=	Rs.7380+1000
	=	Rs.8040
Total Cost of Moulding Setup	=	7380+1000 + 25+62 = Rs.8467.

FACTORS INFLUENCING MOULDING ACCURACY

- Effect of shot size in strength of mould compact due to magnetic field.
- Variation of strength of mould due to variation in ampere turns supplied.
- Theoretical aspects in design of mould box.

SAMPLE CASTINGS MADE ON MAGNETIC MOULDS

- Square block - Dimension of the block is 5*5*5cm
- Bush -Cylindrical bush
- Gear wheel
- Pattern with varying thickness fins.
- Shaper table bracket.

Samples made by magnetic moulding are shown in Fig. 3.

Fig. 3 : Samples made by magnetic moulding.

COST ANALYSIS

Table-1 : Green Sand Mould-Casting Process

Process	Cost (Rs.)
Sand + Core preparation	626.45
Mould process	0.50
Machining process	0.15
TOTAL	627.10

Table 2. Magnetic mould casting process

Process	Cost (Rs.)
Core+Magnetic mould Preparation	152.30
Mixing process	0.25
Machining process	0.15
TOTAL	**152.70**

While Tables-1 and 2 compares the costing of sand and magnetic moulding processes, Table-3 compares the mechanical properties of the cast materials.

SUMMARIES

1. The electrical energy cost is reduced for around Rs.371.25 (US$ 8.07).

Table-3 : Mechanical Properties

Process	Rockwell Hardness Test(HRC)	Double Shear Comp Stress (Tonnes)	Tensile Test UltimateLoad(kg)	Impact Load(kg)
Magnetic M.C	57.8	3	400	52
Green Sand	54	2.5	320	45

2. Also man material cost reduced for around Rs.103.25 (US$ 2.24).
3. Sound castings were made with magnetic moulding process.
4. The major problem was that the steel shots moved from one pole to other pole of magnet due to magnetic field intensity. If the magnetic force is reduced to avoid this problem, due to low strength, mould dilation would take place.
5. Even-though aluminium has low melting point, it burns out the entire pattern and a good sound casting was obtained.

REFERENCES

1. Khanna, O.P, B.Sc., Engg., M.E. (Hons.), Ph.D., 2001.A Text Book of Foundry Technology, Faridadad, Haryana.
2. Kenneth G. Budinski and Michael K. Budinski, 2002, Engineering Materials, Eighth Edition.
3. Khanna, O.P, B.Sc., Engg., M.E. (Hons.), Ph.D., 2001, Material Science and Metallurgy, Faridadad, Haryana.
4. Kothari, D.P., and Nagrath, I.J., 2004, Electric Machines, Third Edition, Tata McGraw-Hill, New Delhi. ■