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Design & Analysis of Portable Shell Moulding Machine

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Abstract: *Shot Blasting machine use a various hanger during machining of various process, in this work its essential to increase production rate in RVM industry. For this its required to increase hanger capacity for the various castings used in the industry. To increase hanger capacity for number of casting its required to re-designed the hanger such a way that its capacity is maximum up to 300Kg of short blasting machine. With the study of shot blasting machine and its hanger we should have to design hanger as requirement*

Keywords: *Shot Blasting Machine, Shot Blasting Hanger Cost Reduction, Productivity Improvement,*

I. Introduction

Shell moulding is a mould casting process, which uses a mixture of sand and resin to form a shell mould. Shell moulding process produces better dimensional accuracy, higher productivity rate & low labour requirement as compared to sand casting. In shell mould casting process, the mould is a thin walled shell created from applying a sand-resin mixture around a pattern and baked at a temperature range of 170-350 o C (338-662 o F). After the formation of expendable shell mould, molten metal is poured into it. This process allows the use of both ferrous and non-ferrous metals such as cast iron, carbon steel, alloy steel, stainless steel, aluminium alloys & copper alloys.

The sand resin mixture can be recycled by burning off the resin at high temperature. The resin also assists in forming a very smooth surface. The process, in general, produces very consistent castings from one casting to the next. The pattern, a metal piece in the shape of the design part, is reused to form multiple shell cores. A reusable pattern allows for higher production rates, while the disposable cores enable complex geometries to be cast. The process, in general, produces very consistent castings from one casting to the next. This shell moulding machine allows the manufactures to produce the shell core in both job and batch type production.

The process of creating a shell mold consists of six steps:

1. Fine silica sand that is covered in a thin (3–6%) thermosetting phenolic resin and liquid catalyst is dumped, blown, or shot onto a hot pattern. The pattern is usually made from cast iron and is heated to 230 to 315 °C (450 to 600 °F). The sand is allowed to sit on the pattern for a few minutes to allow the sand to partially cure.
2. The pattern and sand are then inverted so the excess sand drops free of the pattern, leaving just the "shell". Depending on the time and temperature of the pattern the thickness of the shell is 10 to 20 mm (0.4 to 0.8 in).
3. The pattern and shell together are placed in an oven to finish curing the sand. The shell now has a tensile strength of 350 to 450 psi (2.4 to 3.1 MPa).
4. The hardened shell is then stripped from the pattern.
5. Two or more shells are then combined, via clamping or gluing using a thermoset adhesive, to form a mold. This finished mold can then be used immediately or stored almost indefinitely.
6. For casting the shell mold is placed inside a flask and surrounded with shot, sand, or gravel to reinforce the shell.

II. Problem Statement

In discussion with current industries, manufacturing of shell cores is expensive with machines which are available in the current market.

1. By discussing with the industry employees and researching the current problems faced by the industry regarding the manufacturing of the parts we came to know the exact reasons of the problem and the following points are observed.
2. There is no portable shell moulding machine available in the market for low production.
3. Small scale/ Start-up companies cannot afford production of shell moulding because of high cost of shell molding machines.
4. Current existing machines are useful for batch type productions.

5. Because of this existing scenario for the manufacturing of the parts it is becoming very difficult for start-up companies to survive in the market. So, we have taken this project for study.

III. Aim & Objective

Design &Fabricate the portable shell moulding machine which eliminates the current existing problem of the current industry.

3.1. Objectives -

6. To reduce the time for the manufacturing of shell core.
7. Optimization of the machine.
8. Multiple cores may be produced at a time.
9. Reduce the cost of shell core manufacturing.
10. Increased in profits of industry.

3.2. METHODOLOGY

1. Problem Identification of the existing industry.
2. Study of different shell molding machines available in the market and their processes.
3. Study of processes used in the shell molding by taking practical input from industry.
4. Study of Research papers& Journals.
5. Design and calculations for machine and its components.
6. Surveying the market for the prices of the machine components.
7. Purchasing materials.
8. Fabricate the machine.

4. IMPORTNT PARAMETERS WHILE FABRICATION OF PORTABLE SHELL MOULDING MACHINE

A) Dependent Parameters-

1. Temperature.
2. Thickness of shell.
3. Resin percentage in sand.
4. Grain size of sand.
5. Material of Metal Pattern.

B) Independent Parameters-

1. Operator.

IV. Function Of The Parts Of Machine

i) Hollow cylindrical shaft- It is a hollow cylindrical shaft of mild steel which is used for the lifting/movement of the hollow semi-circular cylinder with ends covered with sheets (DOME) in upward/downward direction and also in left/right direction. The horizontal hollow shaft which is used for lifting the DOME is connected to the vertical element (i.e. a pipe) by I-section mechanism which is welded on the one side of the table.

Fig no3.1 Hollow cylindrical shaft connected with hollow rectangular pipe using Hooke's joint

ii) Hollow Semi-circular Cylinder with ends covered with sheets (DOME)- It is a thin sheet of mild steel having thickness of 2 mm containing layers of asbestos and epoxy resin in the inner surface for the insulation of the heat produced from the heater rod which is clamped inside the DOME so that no heat will expel out of the DOME.

Fig no3.2 Hollow Semi-circular cylinder with ends covered with sheets (DOME)

Iii Cuboidal Metal Pattern- It is a Cuboidal metal of mild steel having the replica of the final shell core product in which fine silica sand and the resin is embedded to obtain the final product (shell cores).

Fig no.3.3 Top View of the metal pattern

iv) Heater rod- It is a U-Shaped Heater rod with a heating temperature range in between 1500C to 4500C and having heating capacity of 750 Watt.

Fig no3.4 U-Shaped Heater Rod

2. **v)Table-** It is the main part of the machine on which all the components of machine are mounted & supported to the whole structure & it is formed by the connection of the 8 rectangular hollow rods (2 rods of length 1400mm, 2 rods of length 900mm & 4 rods of length 850mm) with connecting member as shown in the fig

Fig no3.5 Three legs rectangular pipe

Fig no 3.6 Table

V. Conclusion

1 DIFFERENCE BETWEEN EXISTING MACHINE AND PORTABLE SHELL MOULDING MACHINE (FABRICATED MACHINE)

Table no .1. Difference between existing and fabricated machine

S No.	Parameters	Current	Fabricated
1	Size of cores	Large	Large & Small
2	User	Medium & Large organizations	Small scale/startups organizations
3	Type of Production	Batch type	Job & Batch type
4	Structure	Fixed	Movable
5	Space required	More	Less
6	Handling of the machine	Difficult to move	Easy to move due to portable
7	Operator	Skilled or Semi-skilled	Unskilled
8	Cost of Machine	Expensive	Economical

Observation table for the production of the shell core from the machine is as: -

Table no .2. Observation table of fabricated machine

Time (in minutes)	Temperature (in ^{0}C)
0	33
2	41
4	47

6	55
8	75
10	92
12	105
14	125
15	160
17.5	180

Comparison of the readings for the production of the shell core from the existing machine and the fabricated machine is as: -

EXISTING MACHINE	Temperature reading	175^0C to 370^0C
	Total time required for single shell product	19 minutes
FABRICATED MACHINE	Temperature reading	175^0C to 370^0C
	Total time required for the single shell product	14 minutes 30 seconds

Table no.3. Comparison of the readings

In this study, optimization of existing machine is performed by eliminating the bulky components from the machine and enhancing the manufacturing of the shell cores by reducing the time 4.30 minutes per cycle of production. This project work focuses on the start-ups whose initial investment is low & face crisis in the manufacturing sector because of the high cost of equipment because of high capital, maintenance & production cost. And it also focuses about how to manufacture the multiple cores. Total cost benefited by our fabricated machine is Rs.8, 19,480/- comparing to existing machine without investing higher cost.

VI. Future Scope

From this project, we are now able to produce shell cores using a machine which eliminates bulky components & some of the accessories such as ejector pins & PLC controller. This project will be a good start for startups searching for low initial investments & expecting a better profit margin from the machine. This project produces multiple cores at a time & is suitable for batch type & job type production. This is a manually operated machine. Following, automation can be implemented.

1. Core lifting mechanism can be automated.
2. Sand pouring process can be automated.
3. DOME lifting process can be automated.

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