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DESIGN & FABRICATION OF PORTABLE SHELL MOULDING MACHINE

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Abstract— According to the current scenario in the industry, there is no portable shell moulding machine with low cost. Current available machines in market which produces both job and batch type products. Also to manufacture the shell core is very expensive by using the existing shell moulding machine which is not affordable by the small scale and start-up companies. This paper overcomes the existing problems associated with manufacturing of shell core. Our project consists of components such as DOME (Hollow Semi-circular Cylinder with ends covered with sheets), Pattern (Mild Steel), Insulating material (Asbestos powder) mixed with thermosetting resin (Epoxy). This paper optimizes the current existing machine in many aspects such as reduction in size of the machine, eliminate the use of bulky components, for example compressor, actuator which handles the scope of the metal pattern, ejector pins & Furnace. The method used for preparing the final shell cores is to pour the mixture of fine silica sand and thermosetting resin in the pattern and heating in dome with the use of heater rods (Clamped inside the dome).

Keywords— Metal Pattern, Dome, Heater Rods, Creo, Fine silica sand, Asbestos powder, Epoxy resin.

I. INTRODUCTION

Shell moulding is a moulding process, which uses a mixture of sand and resin to form a shell cores. The sand resin mixture can be recycled by burning off the resin at high temperature. Shell moulding process produces shell cores of surface finish is in the range of 0.3-4 micrometers. The resin also assists in forming a very smooth surface. Shell moulding process is available in automatic, semi-automatic and manual form. Shell moulding process produces better dimensional accuracy, higher productivity rate & low labour requirement as compared to other casting processes. Shell moulding process is generally preferred in order to achieve high precision rate in shell cores. Shell moulding process allows the user to use both ferrous and non-ferrous metals such as cast iron, carbon steel, stainless steel, etc. Shell moulding process is used to produce hollow components. Shell mould casting allows the manufacturers to produce parts of complex shapes. This shell moulding machine allows the manufactures to produce the shell"core in both job type & Batch type form.

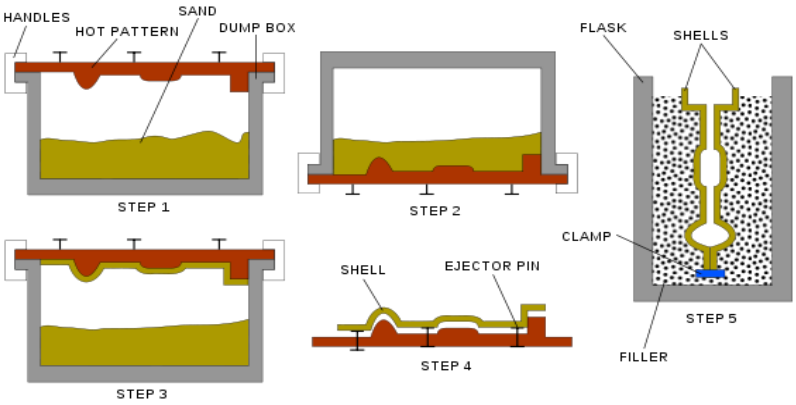

Image.01.Shell Core Process

II. PROBLEM DEFINATION

In discussion with Current Industries, manufacturing of shell cores is expensive with machines which are available in the current Market.
By discussing with the industry Managing Director With above problem and researching the current problems faced by the industry regarding the manufacturing of the shell core with low quantity, we came to know the exact reasons of the problem and the following points are observed.

1. Here is no portable shell moulding machine available in the market with low cost. Machine cost start from minimum one lac & above.
2. Due to the cost problem Small scale/ Start-up companies cannot afford shell moulding.
3. For current exiting machine Skilled operator is required.

3. According to the current existing machines maximum batch type production is affordable by the manufacturer.
4. Because of this existing scenario for the manufacturing of shell core in less quantity it is becoming very difficult for start-up companies and also established company to survive in the market.
5. Hence, we came on the conclusion to fabricate the portable shell moulding machine which eliminates the current existing problems faced while manufacturing i.e. machine cost is less than 25000 thousand rupees.

III.OBJECTIVES, METHODOLOGY, SCOPE OF WORK

A) OBJECTIVES

1. To reduce the Total time for the manufacturing of shell core.
2. Optimization of the Shell core machine.
3. Increase the Productivity by taking multiple cores at a time.
4. Reduce the Manufacturing cost of shell core manufacturing.

B) METHODOLOGY

1. Problem Identification of the current industry.
2. Study the different shell molding machines available in market with manufacturing processes of shell core on the same machines.
2. Study of processes used in the shell molding by taking practical input from industries.
3. Study of Research papers and other material available in our college library.
5. Design and calculations for machine and its components for proposed machines.
6. Surveying the market for the prices of the components from which the proposed machine is designed and will be manufactured.
7. Purchasing materials from the market and will be manufactured core shell machine.

C) SCOPE OF WORK

As discussed with current Industry is having a problem in manufacturing the shell cores with the existing machine and after study of existing machine system, the present analysis focuses on the below mentioned points.

1) Study of different shell moulding machines and their manufacturing processes.
2) Study of processes using shell moulding by taking practical input from industry.
3) Study the Design and calculations and its component as in industry.
4) Study the 'Surveying the market for the prices of the components from which the existing machine is designed and manufactured.

IV.SPECIFICATION OF THE MACHINE

1. Dimension of the hollow rectangular rods:-
A) Length - 1400 mm - 2 Nos B) Length- 900 mm – 2 Nos c) Length - 850 mm.
D) Cross sectional area - 1.25 x 1.25 inch. E) Thickness – 1 mm.
2 Dimension of the sheet:-
A) Lengh-1400 mm B) Width- 900 mm.
3. Dimension of the hollow cylindrical shaft:-
A) Length of the shaft – 980 mm
B) Outer Diameter of the rod - 30 mm.
C) Inner Diameter of the rod - 26 mm.
4. Heater Rod:-
A) Power capacity: - 750 W.
B) Type: - U-Type
C) Quantity: -3 Nos
5. DOME:-
A) Shape: - Hollow Semi-circular Cylinder
B) Radius: - 180 mm.
C) Length of the DOME is 480 mm.
6. Cuboidal Metal Pattern:
A) L x B x H:- (210 mm x 50 mm x 75 mm).

V. STEPS OF OPERATING THE MACHINE

1) Power ON the U-TYPE Heater Rod which is clamped inside the DOME and retain its temperature in the range of 1750° C to 3500° C by using the temperature controller and to indicate the temperature, the temperature indicator is used.
2) After reaching 2800C inside the DOME, pour the mixture of sand and resin (Epoxy) in the metal pattern and transfer the mixture containing metal pattern inside the DOME to bake them.
3) After two minutes the metal pattern is taken out from the DOME and removes the final shell core product from the metal pattern.

VI. ANALYTICAL DESIGN CALCULATION OF HOLLOW SHAFT

(Material of the Hollow Shaft – MILD STEEL)
E= 2.1×10^5 MPa, ρ= 7900 Kg/m3
Considering point load is applied at the centre of the hollow shaft.

A) Assuming hollow shaft of thickness 2 mm.

D_1= Inner diameter of the hollow shaft = 2.6cm
D_2 = Outer diameter of the hollow shaft = 3cm
L_1= length of the hollow shaft = 98cm
V_1 = Volume of the hollow shaft = $(\pi/4)*(D_2^2 - D_1^{2)}*L_1$
= 172.41 cm^3
ρ= Density of the hollow shaft material = 7.9 gm/cm^3
m= Mass of the hollow shaft = (ρ*V) = 1.362kg
W_1= Weight of the hollow shaft = m*98.1 = 133.61 N
I= Inertia of hollow shaft = $(\pi/64)*(D_2^4-D_1^4)$ = 1.73 cm^4
Y_{max} = $D_2/2$ = 1.5 cm
Z= Section Modulus = I/Y_{max} = 1.153 cm^3
D_3= Inner diameter of DOME = 37.76cm
D_4 = Outer diameter of DOME = 38cm
L_2= length of DOME = 48cm
V_2= Volume of the DOME = $(\pi/16)*(D_4^2-D_3^2)*L_2$
= 171.36 cm^3
$W_{2=}$ Weight of the DOME = (ρ*V*98.1) = 132.802N
M= Moment of hollow shaft at point of weight applied
= $(W_1+W_2)*(L_1/2)$= 13054.188 N-cm
F=Maximum stress acting on load point
= M/Z=11321.932 N/cm^2
Delta = Deflection at load point = $(((W_1+W_2)*L_1)/48EI)$
=$1.521997*10^{-7}$ cm

B) Assuming hollow shaft of thickness 1 mm.

D_1= Inner diameter of the hollow shaft = 2.8cm
D_2 = Outer diameter of the hollow shaft = 3cm
L_1= length of the hollow shaft = 98cm
V_1 = Volume of the hollow shaft = $(\pi/4)*(D_2^2 - D_1^{2)}*L_1$
= 89.2840 cm^3
ρ= Density of the hollow shaft material = 7.9 gm/cm^3
m= Mass of the hollow shaft = (ρ*V) = 0.705kg
W_1= Weight of the hollow shaft = m*98.1 = 69.1605 N
I= Inertia of hollow shaft = $(\pi/64)*(D_2^4-D_1^4)$=0.958 cm^4
Y_{max} = $D_2/2$ = 1.5 cm
Z= Section Modulus = I/Y_{max} = 0.6392 cm^3
D_3= Inner diameter of DOME = 37.76cm
D_4 = Outer diameter of DOME = 38cm
L_2= length of DOME = 48cm
V_2= Volume of the DOME = $(\pi/16)*(D_4^2-D_3^2)*L_2$
= 171.36 cm^3
$W_{2=}$ Weight of the DOME = (ρ*V*98.1) = 132.802N
M= Moment of hollow shaft at point of weight applied
= $(W_1+W_2)*(L_1/2)$ = 9896.16 N-cm
F=Maximum stress acting on load point
= M/Z=15482.1065 N/cm^2
Delta = Deflection at load point = $(((W_1+W_2)*L_1)/48EI)$
=$2.04789*10^{-5}$ cm.

By comparing both the above values for the deflection of the hollow shaft, we came on the conclusion that the first shaft is optimum for the design.

VII. MATERIALS USED FOR THE MACHINE.

We have studied the different properties of the materials for the shell moulding machine and accordingly we have selected the following materials: -

1) Mild Steel – Contains less than 0.3 % carbon. Most suitable for DOME (Canopy), Pattern, Base plate and the body of the table and it is most economical.

2) Stainless Steel – Contains high percentage of iron, chromium and nickel with a minimum of 10.5% chromium content by mass and a maximum of 1.2% carbon by mass. Stainless steels are rolled into sheets, plates, bars, wires. It is most suitable for hollow shaft

3) Silica Sand (Green Sand) – Silica Sand is the most commonly used sand because of its great abundance, and thus low cost and hence we have selected this for one of the important ingredient for the shell core. And hence it is the primary ingredient in the shell core.

4) Epoxy Resin – Epoxy Resins are low molecular weight pre-polymer or higher molecular weight polymers which normally contains at least two ep-oxides groups and it is most widely used as adhesives in the industries. And hence we have selected epoxy resin as the secondary ingredient for the shell core formation which bonds with the sand and provides the strength for the formation of the final shell cores.

5) Asbestos –Asbestos has average tensile strength, resistance to fire, heat and electricity. It is used widely in applications where electrical insulation is required. And hence we have selected asbestos material for the insulation inside the DOME material for the protection from overheating by the heater rod.

Image:-Proposed Shell Moulding Machine

VIII. CONCLUSIONS

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 for its production. This paper 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.

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