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Design Improvement of Shell Core Process and Mountings

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Abstract: Foundry industry is one of the largest industry for producing automobile and other industrial components that are not easy to manufacture with other methods and also due to ability for producing components with required properties. Mostly, complex and intricate shape components are possible to produce with help of cores made up of silica sand. These cores can be produced manually or in core shooter machine depending upon economic and quantity. Most widely used method for core producing in industry is using core shooter machine which helps in fast, reliable and economic to cost. Due to increasing competition, it is required to make improvements in the process of producing cores in core shooter machine. In this present work, the whole core making process in core shooter machine is analyse and modifications related to core box and heater plate mounted on core shooter machine, core box design in order to reduce material wastages and power consumption. It will be an advantageous to the core making industries in terms of cost related to minimum material utilization, minimum power consumption and also minimum time taken for setting up machine for production.
Keywords: core making; core shooter machine; design; optimization; improved productivity.

I. INTRODUCTION

Core shooter machines are applied in foundry industry for making cores which are used in casting for making holes, recesses, void space. This core shooter machines utilize resin coated sand as a raw material which flows through the shooting area into the core box where it gets heated up to get solidified and after solidified, core is removed with help of ejection mechanism. Usually, extra sand gets solidified in the way it passes through shooting area called as shooting candles and it's not part of core required.

Therefore, unwanted part is cut or removed and regarded as a wastage of core sand. Also, foundry utilizes a fixed heater plate irrespective of the core box which causes high energy consumption along with high initial heating time for curing purpose.

In this work, new design is developed by integrating heater plates with core box, along with reducing the size of shooting candles. Firstly, 3D design of core shooter machine is prepared based on the existing design along with core box using SOLIDWORKS; secondly, based on the parameters related to core making process design is optimized to reduce number of heaters, shooting candles size, initial heating lead time, wastage of raw material, energy consumption annually.

II. METHODOLOGY

Recent developments are made in the field of foundry industry due to increase in industrial globalization by reducing the cost while maintaining quality, new process development, more efficient machinery with aid of programmable logic controller, simulation software's.

In core making process, many experiments are carried out using vents distribution, shooting area to fill the core box effectively. Design and analysis were also carried out to find heat loss and also making of salt core process is developed.

Based on research survey it is found that there are no efforts made to reduce the initial heating time for heaters, shooting candles length, reducing the number of heaters.

This parameters are core of research where whole design is designed by choosing better, easily available, cost-effective method for manufacturability.

CAD drawings are developed using SOLIDWORKS and then, energy consumptions calculations, raw material calculation, shooting candle length are calculated for comparison of benefits between existing and new design.

Identification of Opportunities and Research Gaps

⇩

Define Problem Related to Core Making

⇩

Identifying and List out Parameters for Optimization

⇩

Brainstorming the Alternative Solutions and Choose Appropriate

⇩

Based on Selected Solution Develop a New Design

⇩

Generate CAD Drawings

⇩

Check for Manufacturability, Feasibility, Cost Reduction

⇩

Final Design

III.EXISTING DESIGN

A 3D model is developed in SOLIDWORKS based on the existing machine through reverse engineering. Design includes main machine structure, guide bars, machine mounting plates and are assembled with core box and heater plates with help of its mounting.

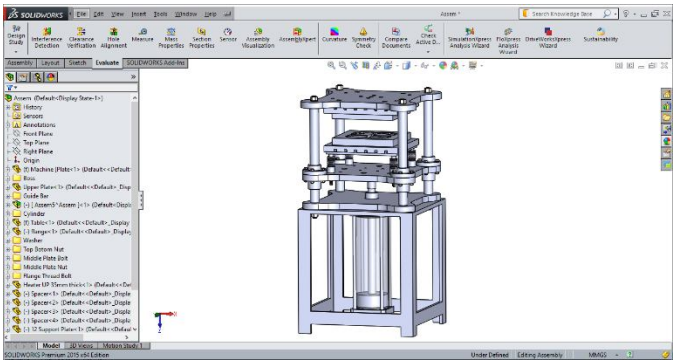

Fig. 1. Existing core shooter machine

Finally based on the number of heaters an energy consumption is calculated for operating in 3 shifts annually. Also, shooting area length is obtained from the design.

A. Energy Consumption

Machine ON Hours: 24 hours
Power cut OFF / day: 6 hours (Approx.)
Avg. Power consume Hours:
= (ON - cut OFF) Hours
= 24- 6
= 18 Hours
Voltage of heater (Watts): 1100 Watt

No of heaters: 12

Total Watts of energy per hour:

= Voltage of heater x No of heaters

= 1100 x 12

= 13200 Watts

Total Watts of energy per day:

= Total Watts / Hour x Avg. Power Consume hours

= 13200 x 18

= 237600 Watts / Day

Total Kilo Watt / Day:

= 237600 / 1000

= 237.6 Kilo Watt / Day

Total Kilo Watt / Year:

= Total Kilo Watt / day x No of Days

= 237.6 x 288

= 68428.8 Kilo Watt

Total Cost of Energy (Excluding Fixed Cost):

= Total Kilo Watt / Year x Cost per KwH

= 68428.8 x 4.25

= 290822.4 Rupees

Through interpreting design, shooting area length is found about 95 mm which cause an extra material wastage in each cycle of core making process.

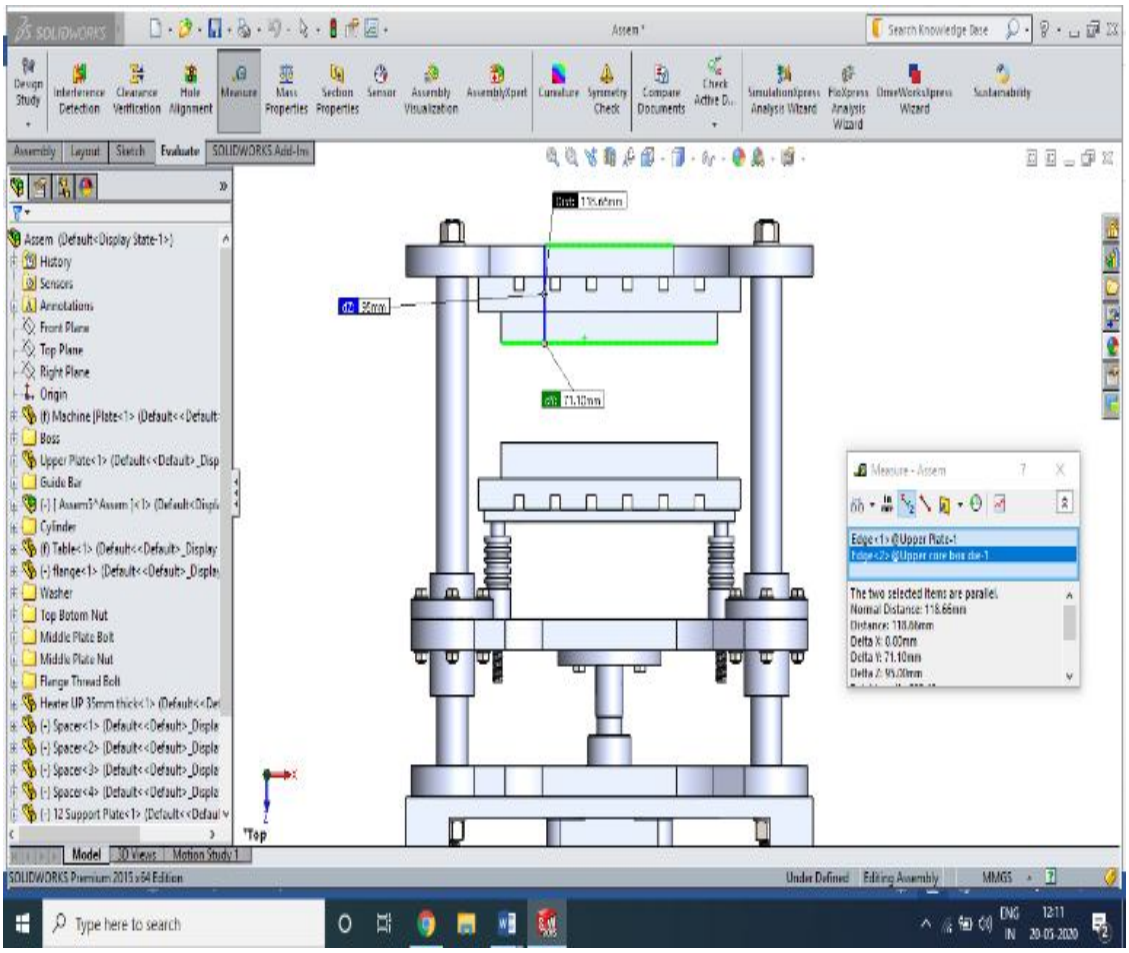

Fig. 2. Shooting area length in existing design

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IV. NEW DESIGN

Based on the existing design interpretation, top machine mounting plate is modified to reduce the shooting area length. Heater plates are integrated with a core box by increasing the thickness of core box which leads to have optimal number of heaters to heat core box. Also, an insulator like asbestos sheet is used to prevent the heat loss taking place at lower core mounted on plate.

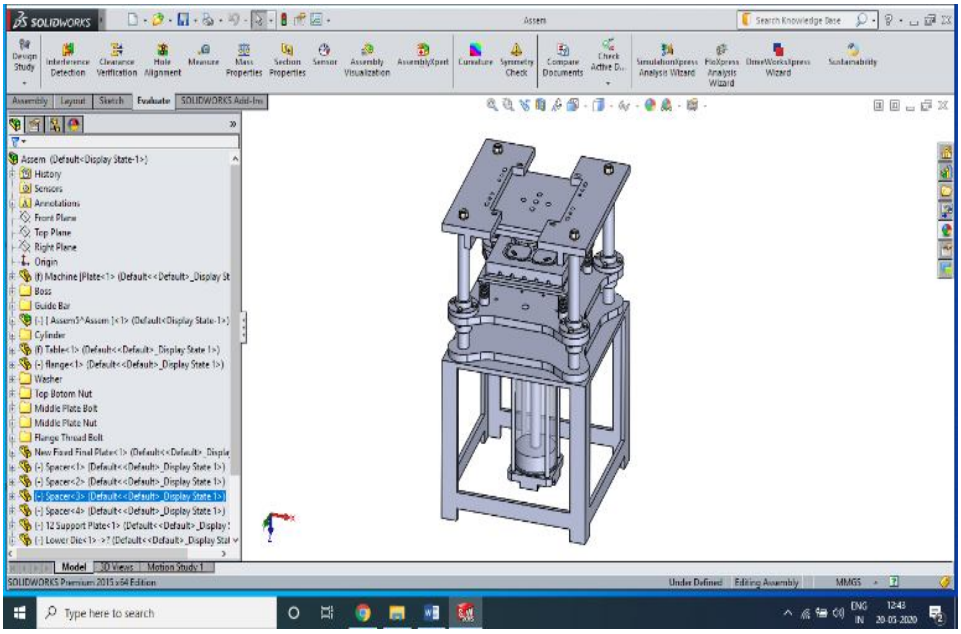

Fig. 3. New core shooter machine design

For the same parameters energy calculation is carried out, a shooting area length is found and also raw material wastage calculation is done.

A. Energy Consumption

Voltage of heater (Watts):
1300 Watt for Upper Heaters and 1100 Watt for Lower Heater
No of heaters: 9
Total Watts of energy per hour:
= 10700 Watts / Hour
Total Watts of energy per day:
= Total Watts / Hour x Avg. Power Consume hours
= 10700 x 18
= 192600 Watts / Day
Total Kilo Watt / Day:
= 192600 / 1000
= 192.6 Kilo Watt / Day
Total Kilo Watt / Year:
= Total Kilo Watt / day x No of Days
= 192.6 x 288
= 55468.8 Kilo Watt
Total Cost of Energy (Excluding Fixed Cost):

= Total Kilo Watt / Year x Cost per KwH
= 55468.8 x 4.25
= 235742.4 Rupees

Shooting area length is found about 59 mm in the design with the help of measure tool in SOLIDWORKS.

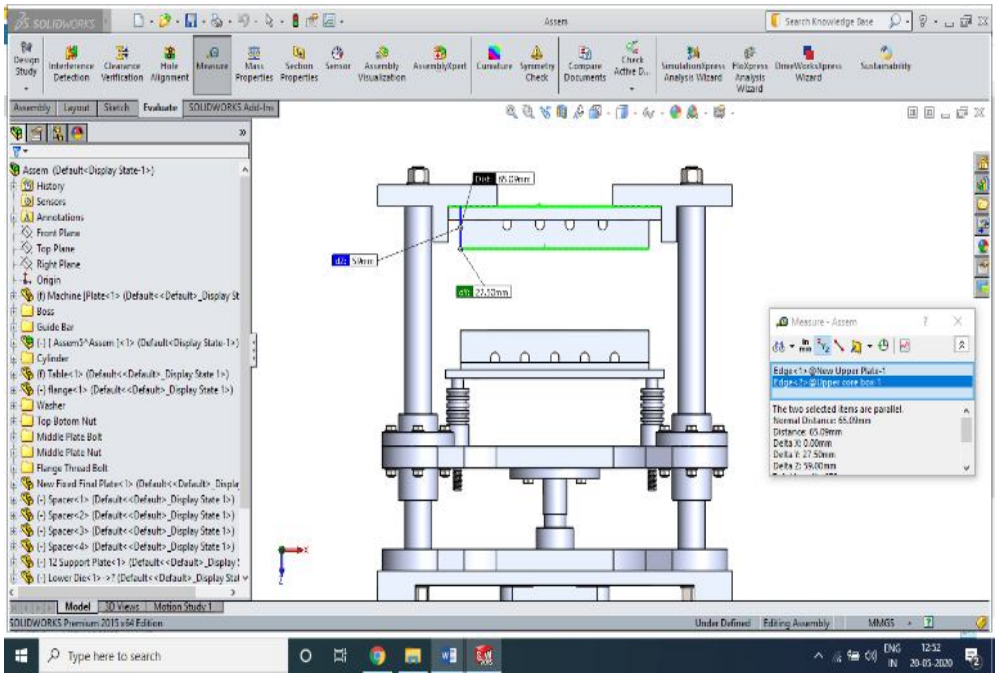

Fig. 4. Shooting area length in new design

B. Raw Material Reduction Calculation

Cycle Time: 1 Minute

No of cores produced per hour: 45 Nos

Total hours of operating cycle: 16 Hours

Weight of reduced shooting candles in new design:

= Volume (mm^3) x Density of sand (g/mm^3)

= $\pi r^2 h$ x 0.001631

= π x 10^2 x 36 x 0.001631

= 18.4536 Grams

= 18 Grams (Approx.)

Total sand saved in single cycle:

= No of shooting holes x Wt. of reduced shooting candle

= 5 x 18

= 90 Grams

Sand saved in one day:

= No of cycles/day x total sand saved in single cycle

= 960 x 90

= 86400 Grams

= 86.4 Kg

Sand saved in a year:

= Sand saved in one day x Days of operating in year

= 86.4 x 288

= 24883.2 Kg

Total Cost reduced in year:

= Sand saved in a year x cost of sand per kg

= 24883.2 x 14

= 348,364.8 Rupees

V. RESULTS AND DISCUSSION

Core shooter machine is being redesign by considering parameter that affects it performance and efficiency. Also, an effort is made to reduce energy consumption, material wastage leading to lean manufacturing. Based on these study following points can be concluded:

A. Shorter length of the shooting candles produce along with cores. There is a 36 mm reduction in length of shooting candles. Hence, less cost will account for reclamation of sand.
B. Sand wastage of 18 grams per shooting hole is reduced.
C. Die size determines the number of heaters required for heating purpose. No external heater plate is required, grooves are made for heaters in die by increasing thickness of die. There is reduction of 3 Nos of heaters in core box.
D. No of heater determines energy consumption which leads to efficient energy consumption. Therefore, it will help in saving energy.
E. Heat loss due to conduction is reduced with aid of insulator i.e. Asbestos. Hence, it lead to improved efficiency.

VI. CONCLUSION

A core shooter machine has been designed for optimization of energy consumption, raw material reduction along with shooting candle length. Thus on comparison of calculations of both design it is found that new design is optimized in terms of cost and wastage related to core making process.

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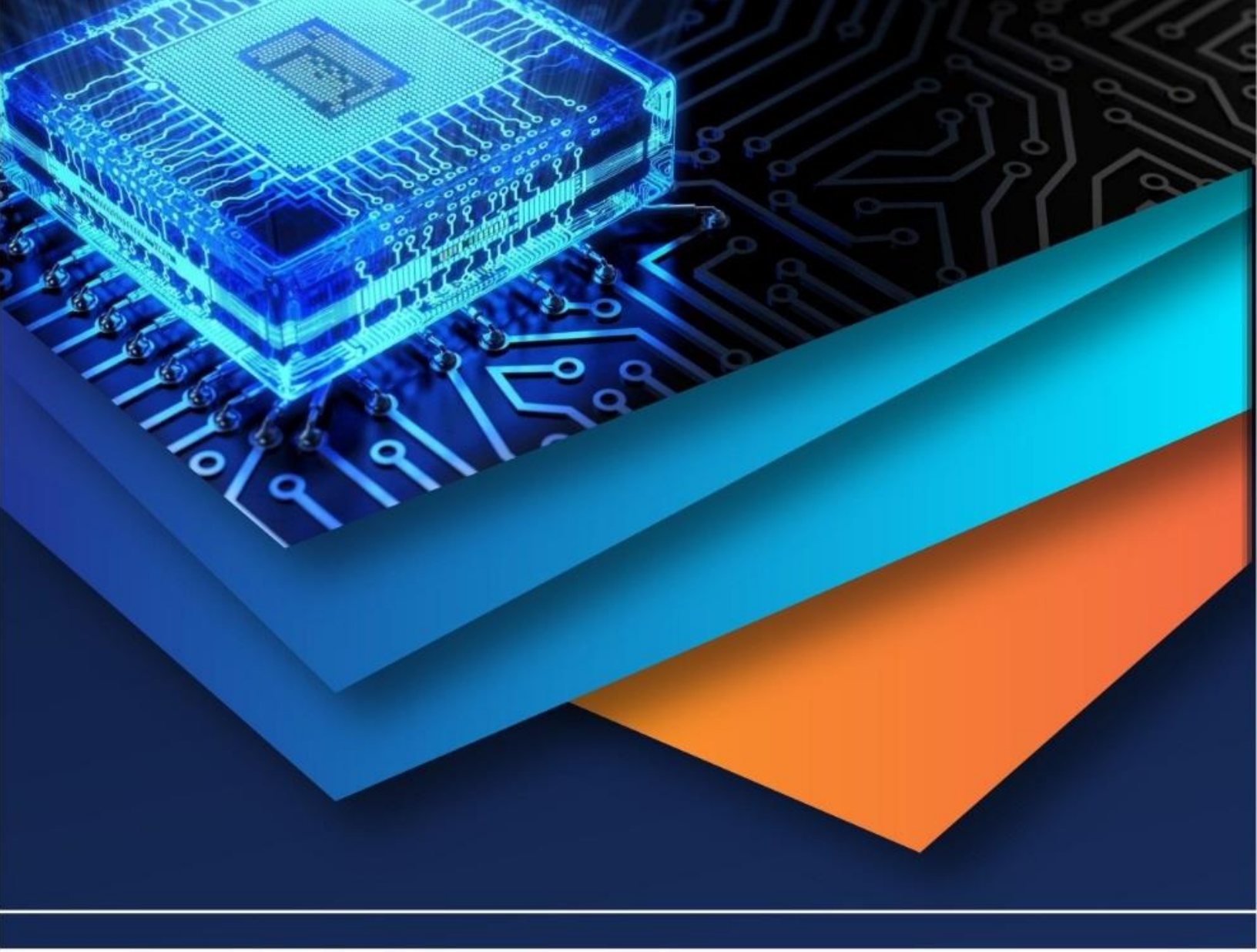

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