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Design and Analysis for Automatic Gravity Die Casting Machine

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ABSTRACT:The casting industry is one of the major industries in the world with a great impact in everybody`s life. Die casting is a process where a permanent mould is used, and molten metal is injected by pressure. But in the gravity die casting process the molten metal enters the mould under gravity. The entire method faced many problems like shrinkage porosity, blow holes; turbulence is the main cause of operating gravity die casting by using manual working system. This project aims to reduce rejection in finished product and reduces cycle time/setup time and reduces manual work by increasing precision and accuracy. This can be achieved by changing the Manual System to Automatic Gravity Die Casting Machine. The system not only reduces the time but improve quality due to repeatability in casting process. It also reduces skilled workers. The automation helps in reducing the production cost and the process lead time. This Paper brief on design, analysis and production of automatic gravity die casting machine.

KEYWORDS: Die Casting, Gravity Die Casting, Automatic Gravity Die Casting Machine.

I.INTRODUCTION

In gravity die casting molten aluminium is poured into a metallic tool. The casting temperature is about 750°C. The tolerances and surface finish are good. The use of sand cores in gravity die casting enables casting of very complex components. Gravity die casting method is competitive casting method when production quantity is relatively small or when heat treatment is needed to improve the mechanical properties. This casting method gives better tolerances and surface finish than sand casting. The tooling costs are somewhat higher than by sand casting.Following fig shows gravity die casting process. Sometimes referred to as Permanent Mould, GDC is a repeatable casting process used for non-ferrous alloy parts, typically aluminium, Zinc and Copper Base alloys. The process differs from HPDC in that Gravity- rather than high pressure- is used to fill the mould with the liquid alloy. GDC is suited to medium to high volumes products and typically parts are of a heavier section than HPDC, but thinner sections than sand casting.

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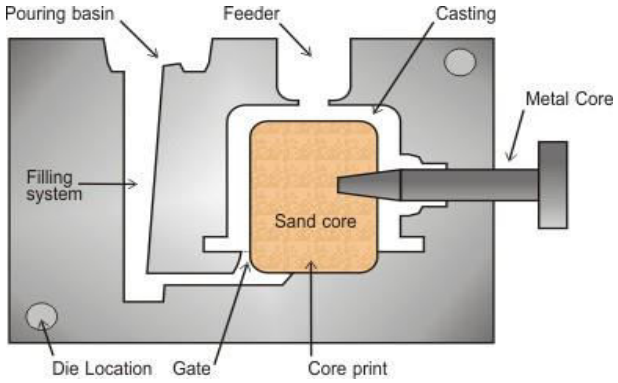

Fig. No 1

II.GRAVITY DIE CASTING

- **Gravity Die Casting Machine**

The operation of Gravity Die Casting machine starts with pouring of molten metal (which is at 1200 C) into the pouring pan which would make the whole process semi-automatic. And thus, the conventional method of manual pouring directly into die ends here. After the pouring of molten metal into the pouring pan which is attached to the die, the metal starts flowing into the die with uniform speed. After 15 seconds, the casting solidifies with reduced losses. Finally, the casting is removed and then the die is cleaned with the pressurized air. Then the machine is brought to original position for further manufacturing of casting products.

- **Manual Process**

The die is heated and then sprayed with a refractory coating, and closed. The coating both helps control the temperature of the die during manufacture and it also assists in the removal of the casting. Molten metal is then manually poured into the die, (although in some cases a machine can be used) and allowed to solidify. The die is then opened and the cast parts either removed by hand or in some cases ejector pins are used.Finally, the scrap, which includes the gate, runners, sprues and flash, is removed from the casting(s). The castings are then processed to remove sharp edges and excess material, then blast cleaned (if required) prior to despatch to the customer.

III. DESIGN OF MACHINE

Gravity die casting was one of the very earliest processes to be invented for metal and light alloy die casting. In this process which can be fully automated, the molten metal is poured directly from a ladle into a semi-permanent or permanent die. The goal is to fill the die with minimum turbulence through one or more channels to reduce oxidation and foaming. Thisminimises porosity and inclusions, giving optimum metal characteristics in the final casting.

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- **We have to design Automatic gravity die casting machine as per requirements**

Table No.1

Sr no	Requirements	Measurements
1	Automation grade	Automatic
2	Power	Hydraulic
3	Cylinder Force N	5000
4	Die Mounting Plates (H x V) mm	1000*360
5	Space between Die plate (H x V) mm	600*100
6	Max. Die Height mm	600
7	Min. Die Height mm	100
8	Die Opening Stroke mm	700
9	Ejection pin mm	150
10	Motor Capacity kw	1.2
11	Working Pressure (bar)	450
12	Maximum Die Weight kg	500
13	Cycle Time Sec	10
14	Oil Tank Capacity Liters.	150

- **Design of Pillar shaft**
  Design of shaft primarily involves in determining stresses at critical point in the shaft that is arising due to aforementioned loading.

- **Design based on Strength**
  In this method, design is carried out so that stress at any location of the shaft should not exceed the material yield stress. However, no consideration for shaft deflection and shaft twist is included.

- **Design based on Stiffness**
  Basic idea of design in such case depends on the allowable deflection and twist of the shaft.

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- **Basic stress equations**

$$\sigma_b = \frac{32M}{\pi d_0^3 (1 - k^4)}$$

Where
M : Bending moment at the point of interest
do : Outer diameter of the shaft
k : Ratio of inner to outer diameters of the shaft (k = 0 for a solid shaft because inner diameter is zero)

- **Layout of Machine**

In today's fast-changing world scenario, the customers want and need are continuously changing and growing. Manufacturing system should rapidly respond to changing customer demand and diminishing product life cycle to be competitive. Now company works in manual process. Manual manufacturing systems are unable to solve these problems. So, we come with an idea of automatic machine. In this process which can be fully automated, the molten metal is poured directly from a ladle into a semi-permanent or permanent die. The goal is to fill the die with minimum turbulence through one or more channels to reduce oxidation and foaming. This minimises porosity and inclusions, giving optimum metal characteristics in the final casting. Gravity die casting equipment can have a horizontal mould opening die-casting, the metal flow at the die inlet is controlled .

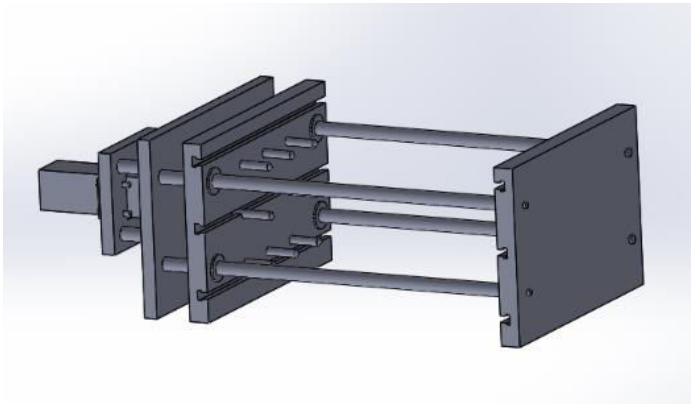

Fig. No. 2 - Isometric Drawing of GDC Machine

- **How automatic GDC works**

It works with aid of hydraulics to minimize human efforts and errors. In automatic process with the control panel and cylinder we can control to and fro of moving dies with buttons. Due to this we can increase productivity.

IV. RESULT AND DISCUSSION

In manual process, the main defects are the parting line which causes due to not closing dies properly and due to that leakage of molten metal can occur. Blowholes are also been seen, these forms of holes may arise from entrapment of more than one sort of gas during the course of mould filling and solidification. So, to remove these defects after moulding, workers used to do the grinding of casting and remove the parting line. To remove blowholes, we have to put nitrogen in the dies before pouring the molten metal. This increases the cycle time of each casting thus reducing the productivity.

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In machine process, due to proper alignment of the dies and the hydraulic cylinder, the dies are been closed firmly which avoids leakage of molten metal & blow holes can be prevented. Due to automation, the accuracy and efficiency of the process increases and human error reduces and also reduces the human effort of ejecting the castings from the die after moulding process.

V. CONCLUSION

After studying process of manual gravity die casting and semi-automated gravity dies casting machine. We get results and selection which one is best. Using of manual operation in gravity die casting gives numbers of defect with lesssafety and more workers required. Time required for Manual gravity die casting process is more. More setup time, more cycle time and waiting time as compared to semi-automatic gravity die casting process. So, we have change manual process to machine operated gravity die casting technology. Following result shown in machine operation gravity die casting processes.After all conclusion we get machine operated gravity die casting machine is best method gravity die casting. Gravity die casting machine is easy to handle and high production with quality. In automatic gravity die casting process time required less to complete job, more worker safety, more production quantity with quality.

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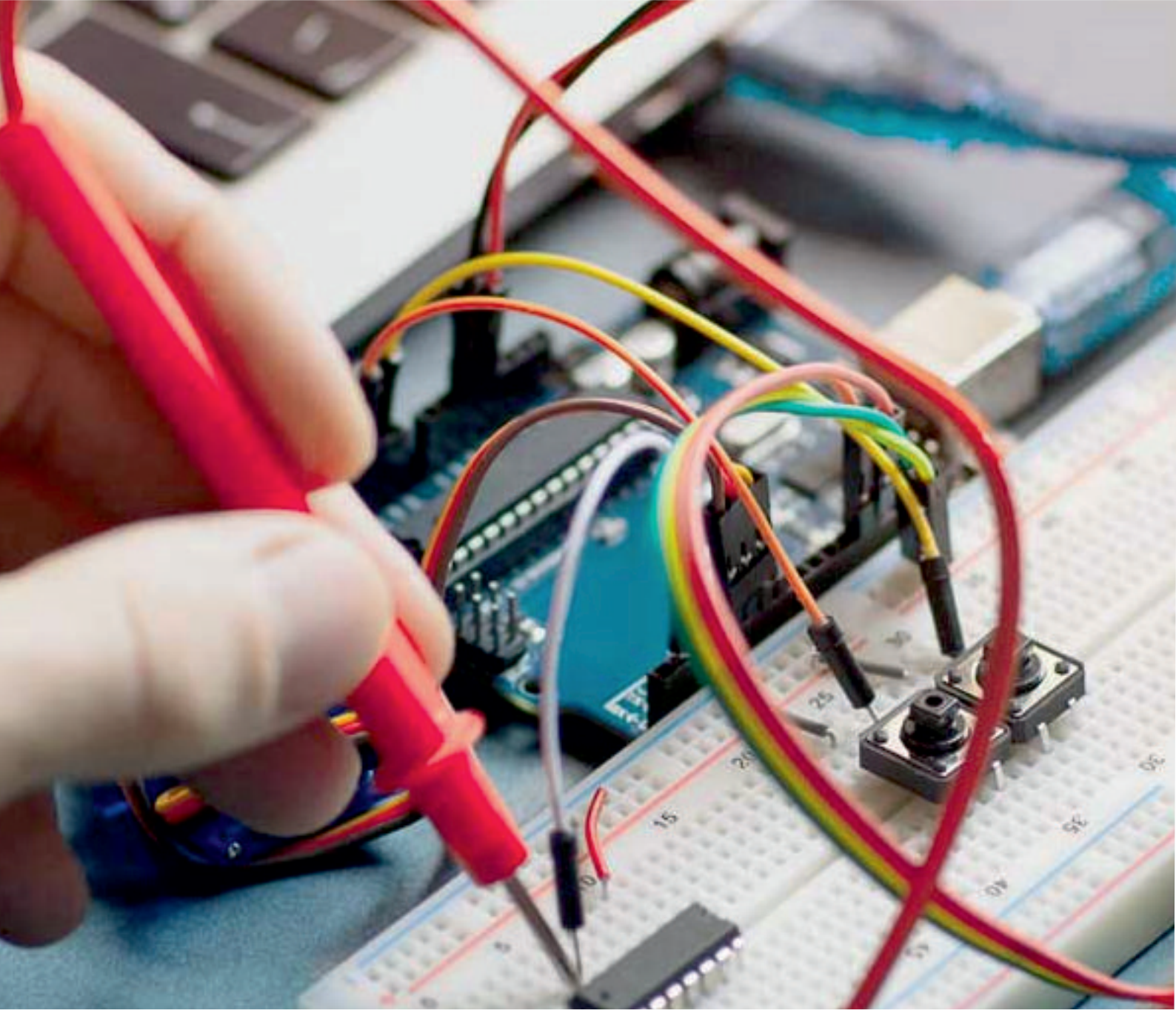

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