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Rejection Analysis of High Pressure Die Casting Component By Reverse Engineering

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Abstract: *There are number of manufacturing process, but the one of the best manufacturing process used in the industry is die casting. The die casting also includes various types like hot chamber die casting, cold chamber die casting and gravity die casting. The die casting process is influenced by parameters like product to be manufactured, rate of production, quality of production, etc. Depending on these parameters one of the die casting process is used.An important factor for obtaining defect free pressure diecast parts is good design of the feeding system. Feeding system is a path of flow of molten alloy during filling of casting. In this project a systematic approach has been developed to design feeding system for a high pressure die-casting die.This involved studying current design practices in the industry and translating this into a knowledge base of rules for machine selection, design of gate, gate-runner, runner, overflows and airvents. The designed feeding system is evaluated in terms of criteria such as filling, air entrapment, power utilization, yield, and fettling. A defect of part SCON-200 is analyzed. The main aim of this project is to finding the root cause of the problem and solution to the specific cause. It includes design of the die, analysis of the die parameter, simulation of the product, experimental validation of product. Simulation of the product is done in MAGMA software. After that the trails were conducted on the machine of selected tonnage which gives the accurate result with analytical methodology.*
Keywords: *die casting, MAGMA, SCON-200*

I. Introduction

Rejection of any component occurs due to some defects contained in it which will affect components performance. Due to rejection manufacturing organization has to pay for loss in various areas. Common losses are: loss of material, loss of time, loss of capital which was invested in machine, manpower, etc. Also continuous more rejection will reduce supply rate of good products to customer. Thereby it will reduce productivity. So for avoiding all these losses, there should be production of rejection free components. But any superior machine, method, design, operator manufacturing process cannot manufacture components having zero defects. Hence the organization tries to reduce the percentage of defects to an minimum level in such a way that components functional requirement should not get disturbed. And hence minimizing the defects automatically there is reduction in rejection .The some causes of defects are as follows: due to certain lacunas in design, due to uncontrolled process, due to defect in material used, due to human errors ,etc. For reducing defects one must find the root cause of the defect and then try to find the solution for the same. There are various ways of approaching towards optimum solution such as why-why analysis, brainstorming analysis, etc. In current situation why-why analysis is used to solve the problem. There are many defects in die casted components due to various causes like Porosity, blow holes, low temperature, and high temperature these all problems are of die casting. But the one major problem related to one product called SCON200 was after manufacturing the product when it reached at customer, there was loosing of Screw, failure of screw, bending of screw and missing of the screw. These were the major customer complaints issued to the company 4 to 5 times in month. So the purpose of our project is to find the root cause of the failure and find the solution to the problem and produce the component defect free. Due to this complaint of the customer should be reduced. So the analysis should be done to remove this compliant.

Hot Chamber Machines: Hot chamber machines are used primarily for zinc, and low melting point alloys which, do not readily attack and erode metal pots, cylinders and plungers. Advanced technology and development of new, higher temperature materials has extended the use of this equipment for magnesium alloys. In the hot chamber machine, the injection mechanism is immersed in molten metal in a furnace attached to the machine. As the plunger is raised, a port opens allowing molten metal to fill the cylinder. As the plunger moves downward sealing the port, it forces molten metal through the gooseneck and nozzle into the die.Alter the metal has solidified, the plunger is withdrawn, the die opens, and the resultingcasting is ejected. Hot chamber machines are rapid in operation. Cycle times vary fromless than one second for small components weighing less than one ounce to thirty seconds for a casting of several pounds. Dies are filled quickly (normally between five and forty milliseconds) and metal is injected at high pressures (1,500 to over 4,500 psi).Nevertheless, modern technology gives close control over these values, thus producing castings with line detail, close tolerances and high strength.

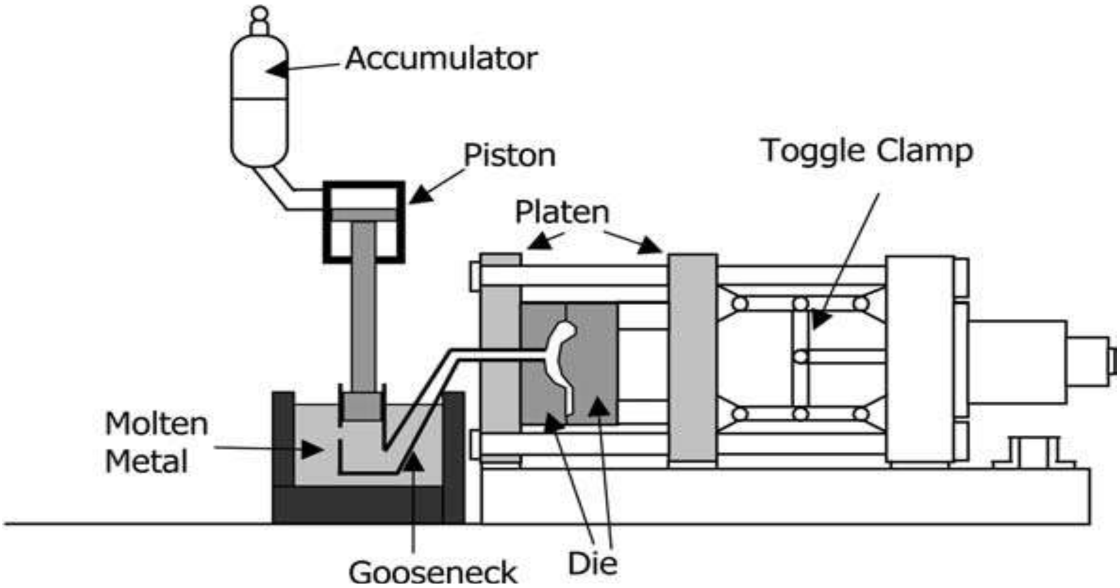

Fig: A Typical High Pressure Die Casting Machine

Cold Chamber Machines: Cold chamber machines differ from hot chamber machines primarily in one respect, the injection plunger and cylinder are not submerged in molten metal. The molten metal is poured into a "cold chamber" through a port or pouring slot by a hand or automatic ladle. A hydraulically operated plunger, advancing forward, seals the port forcing metal into the locked die at high pressures. Injection pressures range from 3,000 to over 10,000 psi for both aluminum and magnesium alloys, and from 6.000 to over 15,000 psi for copper base alloys. In a cold chamber machine, more molten metal is poured into the chamber than is needed to fill the die cavity. This helps sustain sufficient pressure to pack the cavity solidly with casting alloy. Excess metal is ejected along with the casting and is part of the complete shot.The main difference between cold-chamber die casting and hot-chamber die casting manufacture is that in the cold-chamber process the molten metal for the casting is introduced to the shot chamber from an external source, while in the hot chamber process the source of molten material is attached to the machine.

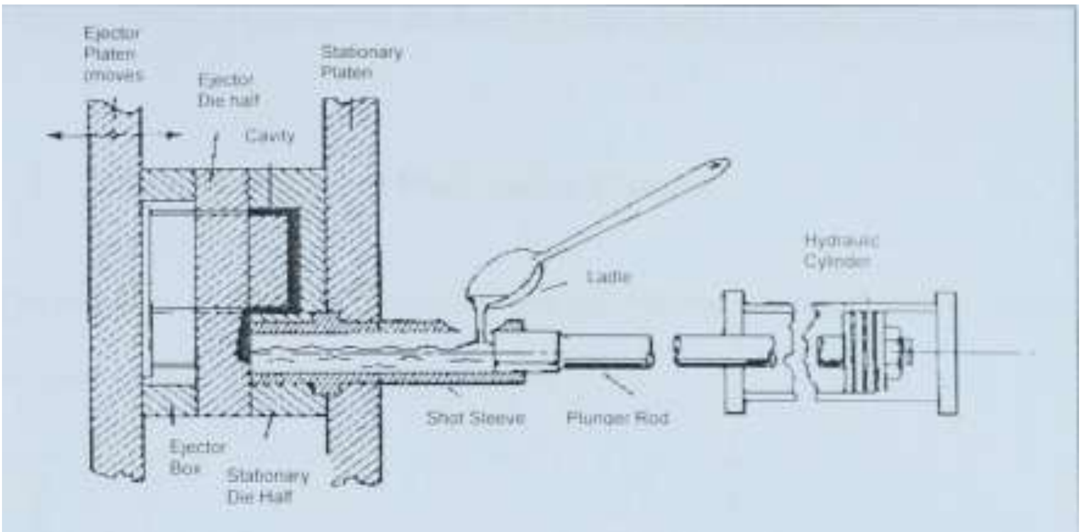

Fig: A Typical Cold Chamber Die Casting Machine

II. Methodology

- Check the 3D Model and 2D Drawing given by the customer
- Ensure that 3D Model matches with the 2D drawing and make model inspection report

- Identify critical and major dimensions
- Check for design feasibility and decide parting line
- Get customer approval for the selected parting line
- Add drafts to the model considering tolerances for MMC
- Add shrinkage to the mode
- Generate surface as per the decided parting line
- Split core and cavity considering the manufacturing aspects
- Check for draft analysis and clearance analysis Optimize feed system as per the filling pattern shown by MAGMA
- Create model base Provide ejector positions in the component and inserts Create cooling holes.
- Conduct concept design review meeting.
- Change the model or layout based on the review output Freeze the layout.
- Prepare detail drawings of inserts and mold base elements
- Checking of the detail drawing
- Release drawings to manufacturing
- Check for any design non-conformity with the assembly division.

Calculations:

Gate and Runner calculations:

PART NAME: SCON-200 PART MATL: ZAMAK-3

1) Component weight= 143 gms

2) No of cavities = 2

3) Component material = ZAMAK-3

4) Over flow weight= 25% of component weight = 35 gms

5)Material through gate = Component weight + O/F. weight =178.75 gms

6) Density of material to cast= 6.7gms/cc

7) Volume of material through gate = material through gate/density of material to cast=26.86cc

8) Minimum wall thickness = 1.1 mm.

9) Velocity of gate = 4300 cm/sec

10)Cavity fill time = 0.007 sec.

11)Gate thickness = 0.5 mm.

12)Fill rate = Volume of material through gate/cavity fill time = 3811.30 cc/sec

13) Area of gate = Fill rate/velocity of gate = 88.63 mm sq.

14)Length of gate = Area of gate/ Thickness of gate = 177.27 mm.

15) Area of runner = 4 X Gate area = 354.54 mm sq.

16) Width of runner = SQRT 2 X Area of runner = 26.63 mm.

17)Depth of runner = Width of runner/2 = 13.31 mm.

Selection of Die Casting Machine:

18) Component projected area = 8700 mm sq.

19) Projected area of runner, O/F and biscuit =50% X component projected area. =4350 mm sq

20) Total projected area = 1.3 X Component Projected area = 26100 mm sq

21) Die opening force = Total projected area X Specific Inj. Pressure = 104.40 ton

22) Die locking force = 1.2 X Die opening force = 125.28 ton

23) Machine to be used = 400 ton

Plunger Size Calculations

24) Shot weight =2 X Component weightX Number of castings = 572 gms

25) Plunger diameter = 60 mm

Scope: Alloy pressure die castings are finding applications in major three types of market viz. Primary market Replacement market and Substitution market. The automobiles component and fittings, telephone industry, electrical appliances, electronic components and builder hardware & fittings etc. are the major market for Al. Pressure Die Castings. The requirement of defense, aeronautic and space is also there, where mechanical properties and durability are of prime importance, therefore it is essential that the best features of design should be employed and optimum casting technique with minimum cost be adopted. The primary market is expected to continue as the leading market, with demand growth in requirement as the field like, builder hardware, automobile components, electrical appliances, electronic components, telephone industry are growing to meet the demand of more and more urbanization and change of life style. The technological developments are opening up the new field of application of the Pressure Die cast components.

III. Conclusion

After calculating all the design parameters like gate velocity, Gate area, metal temperature and cavity fill time .Total number of air vents is decided by back pressure analysis in magma soft. According to the standard if the value of back pressure of entrapped air in casting cavity is more than 2 bar then it will lead to air porosity after machining of casting.After finalizing all the parameters of the die. The casting die has been manufactured. For validating the manual design calculations and analysis with magma soft, test has been performed on the first component manufactured from die. The result of this project work is design the parts of die casting that parts are shown in below

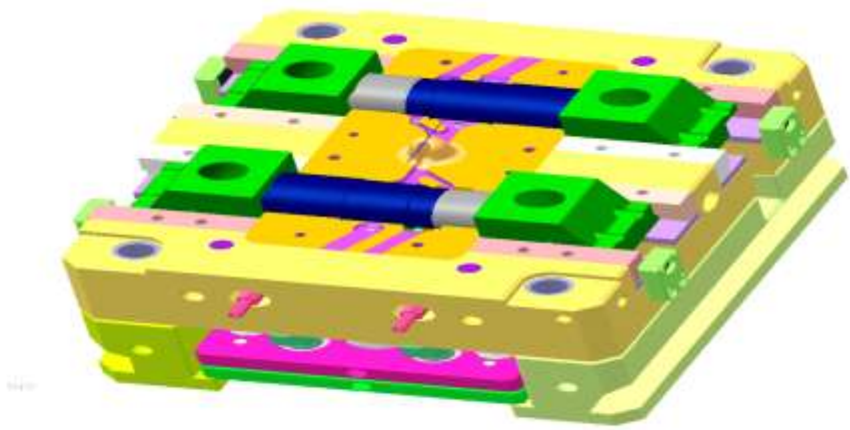

Figure: Moving Side Housing

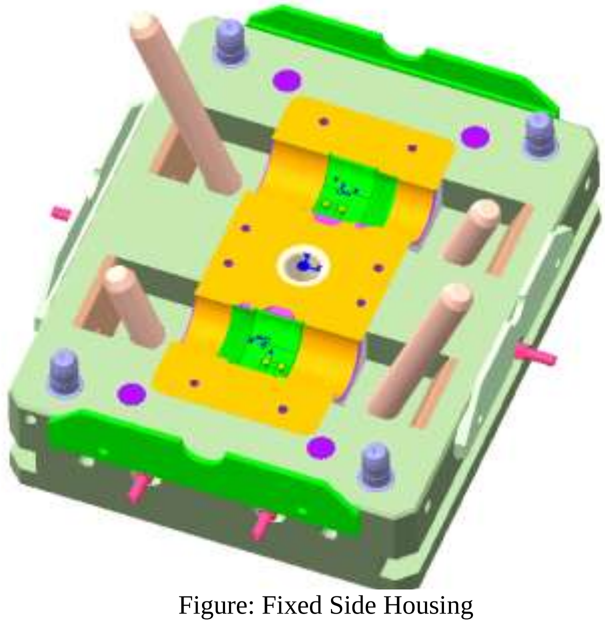

Figure: Fixed Side Housing

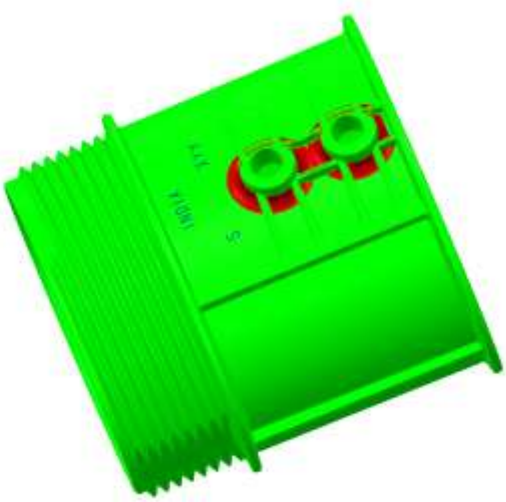

Figure: SCON-200

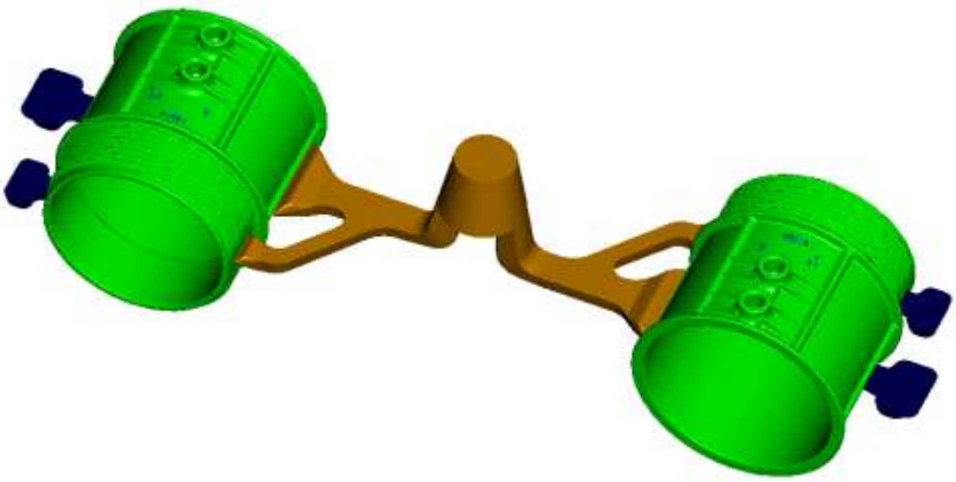

Figure: SCON-200 with runner and gate

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