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Research Paper

DIE DESIGNING AND MOLTEN METAL FLOW ANALYSIS FOR INTERMEDIATE FLANGE

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The die casting process is an effective near net shape manufacturing process for producing geometrically complex components which require a high production rate and an excellent surface finish. However, one problem area has been indicated that die castings are often rejected by die casters as a result of being machined, and the defects for causing the rejections are frequently not clearly defined. And also the common defects found in these defective castings were categorized as follows: porosity, cold laps, flow lines, aluminum oxide inclusions, lubricant or mold coating inclusions, and mechanical cracks. To develop 3-D of intermediate flange as per the customer requirement using 2-D drawing in Pro/E. To Develop Die for intermediate flange {core, cavity, runner and gate, etc.}, using Pro/E software. Make molten metal flow analysis for this Die using Magma software.

Keywords: Die design, Metal flow analysis, Hot chamber die pressure casting

INTRODUCTION

Casting is a manufacturing process by which a liquid material is usually poured into a mold which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods. Casting is a 6000 year old process. The oldest surviving casting is a copper frog from 3200 BC.

Die Pressure Casting

Die casting is a manufacturing process that can produce geometrically complex metal parts through the use of reusable molds, called dies. The die casting process involves the use of a furnace, metal, die casting machine, and die. The metal, typically a non-ferrous alloy such as aluminum or zinc, is melted in the furnace and then injected into the dies in the die casting Machine. There are two main types of die casting machines-hot chamber machines (used for alloys with low melting temperatures, such as zinc) and cold chamber

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machines (used for alloys with high melting temperatures, such as aluminum).Pressure die casting offers an economical way of producing large quantities of complex, high-tolerance parts in aluminum, zinc and copper alloys. The continued growth of the die casting process depends, to a large extent, on the greater use of die castings in the automotive industry.

Casting Defects

Any unwanted deviation from the desired requirements in a cast product results in a defect (Allsop and Kennedy, 1983). Some defects in the cast products are tolerable while others can be rectified by additional processes like welding, etc. The following are the major defects which are likely to occur:

1. Hot tearing
2. Blow holes
3. Porosity
4. Pouring metal defects
5. Pin holes

DESIGNING

Modeling of Intermediate Flange in PRO/E:

Figure 1: Intermediate Flange

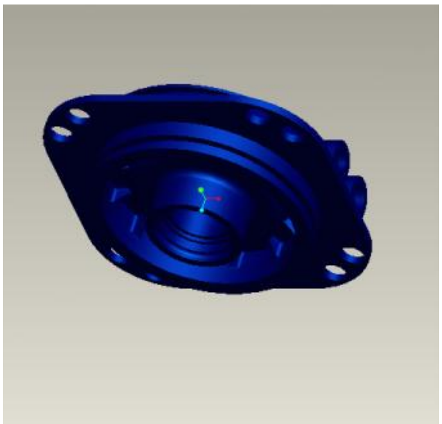
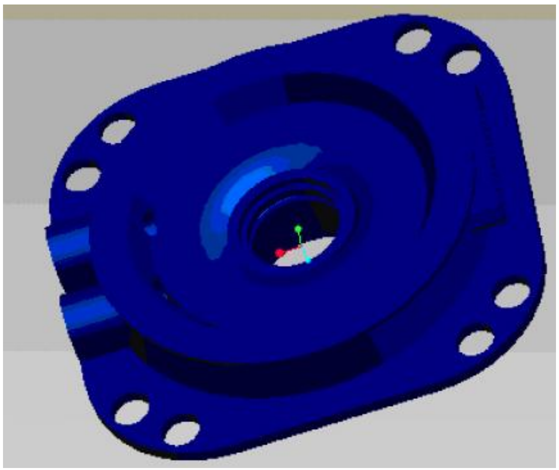


Figure 2: Extrude Feature

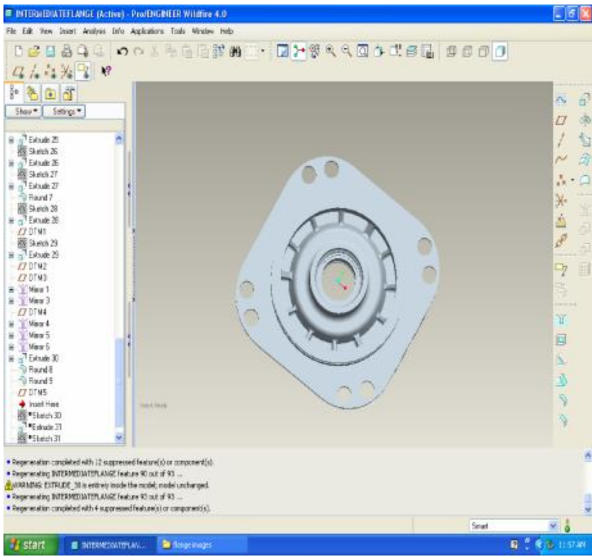


It is used to any commercial vehicles. It is used to mount the piston in breaking systems.

Rib Feature

Ribs are used to strengthen the part. For this part there are 12 ribs. First create rib using rib tool as per the dimensions and create a datum axis as shown in Figure 3. Increase the stiffness of a component. Add strength to a component

Figure 3: Rib Feature

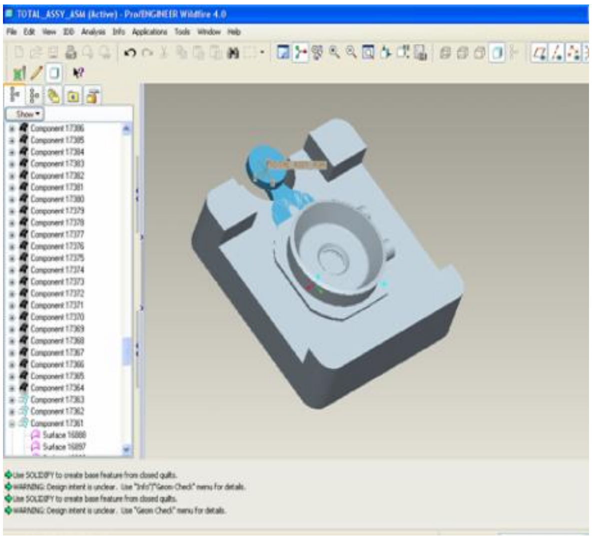


Die Designing of Intermediate Flange

Die casting is a metal casting process that is characterized by forcing molten metal under high pressure in to a mould cavity. Most die castings are made from non ferrous metals- zinc, copper, aluminum and based alloys. Depending on the type of metal being cast, a hot-or cold machine is used. The casting equipment and the metal dies represent large capital costs and this tends to limit the process to high volume production. Manufacture of parts using die casting is relatively simple, which keeps the incremental cost per item low. It is especially suited for a large quantity of small to medium sized castings, which is why die casting produces more castings than any other casting process. Die castings are characterized by a very good surface finish (by casting standards) and dimensional consistency. The design of defect less die is very important. It mainly consists of the following components:

- Cavity holder
- Core holder
- Intermediate cavity
- Ejector front plate
- Ejector back plate
- Ejector pins
- Ejector guide pillers
- Guide piller bush
- Parallel blocks
- Spreader
- Sprue bush

Figure 4: Cavity Holder



Flange Cavity

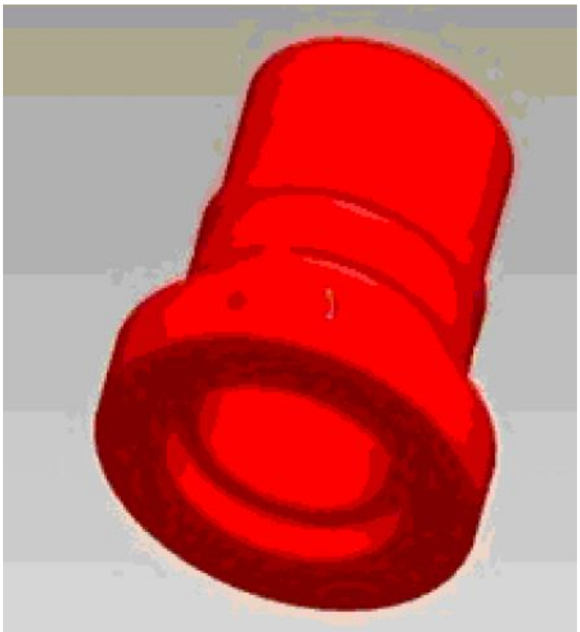
It consists of intermedite flange with runner and gate system. The molten metal is going to be fill into this cavity through runner and gate system shown in Figure 5.

Figure 5: Flange Cavity

Spure Bush

A sprue is the passage through which liquid material is introduced into a mold. During casting or molding. The material in the sprue will solidify and need to be removed from the finished part Figure 6.

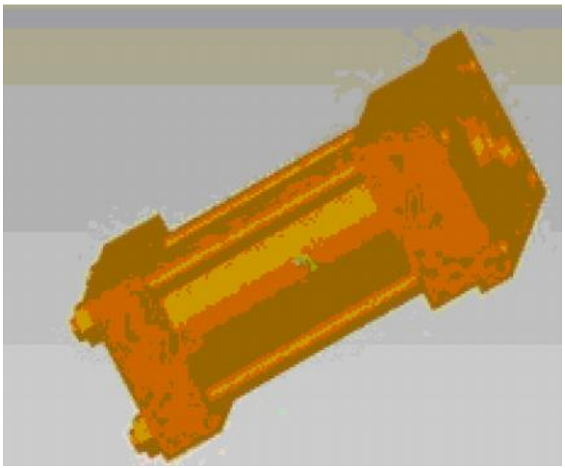
Figure 6: Sprue Bush



Side Cores

Side cores are used to gripping purpose or these are used to, to divide the parting line as shown in Figure 7.

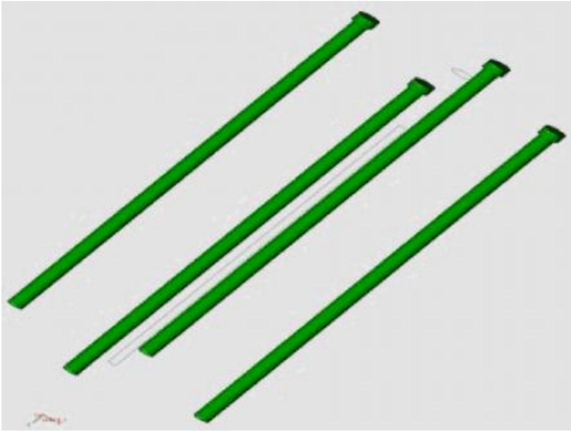
Figure 7: Side Core



Ejector Pins

These ejector pins are used to eject the component shown in Figure 8.

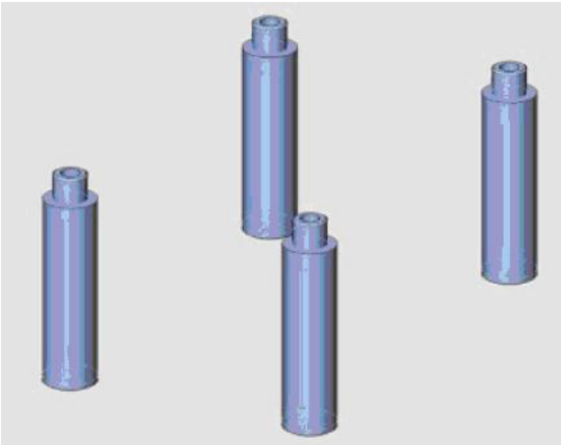
Figure 8: Ejector Pins



Ejector Guide Pillers

The guide pillar is used for die and a mould component which is used to make sure that combination has accurate locating and guiding activity as shown in Figure 9.

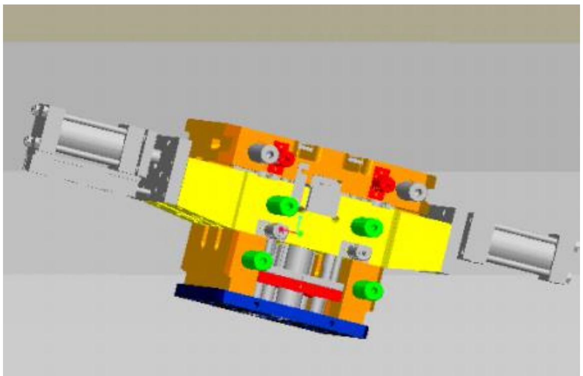
Figure 9: Guide Pillers



Molten Metal Flow Analysis Magma

The Application of MAGMASOFT as a world wide proven tool for improving the quality and productivity in the casting process. In first iteration MAGMA SOFT shows the capability of the tool to analysis and solve Casting problems.

Figure 10: Assembly of Flange Die



EXPERIMENTAL PROCEDURE / DETAILS

Input Data to Machine

Type of die cast	:	Hot chamber pressure die casting
Nitrogen pressure	:	80 bar
Cooling time	:	9 sec
Ejection forward delay	:	3 sec
Material	:	$AlSi_9Cu_3$
Die material	:	H13

Table 1: Input Parameters 1

Plunger diameter	80 mm
Plunger length	230 mm
Area of plunger	5026.548 mm^2
Volume of shot sleeve	1156.106 cm^3
Shot sleeve filling	34.697%
Slow shot velocity	0.526 m/s
Theoritically cavity filling time	65 ms
Fast shot velocity	1.25 m/s
Velocity at ingate	86.17 m/s

Metal Temparature

Minimum metal temperature noticed at end of the mould filling is 644 °C.

Fgure 11: Varying Metal Temparatures

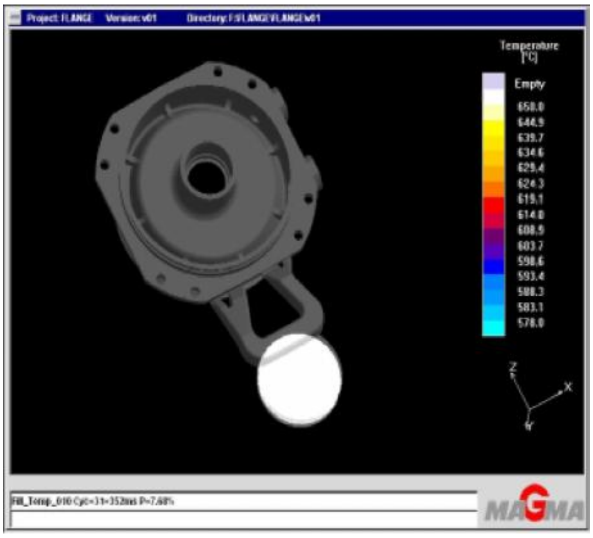


Figure 12: Pouring Rate

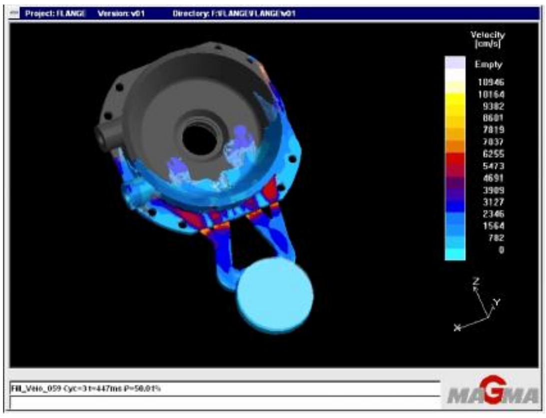
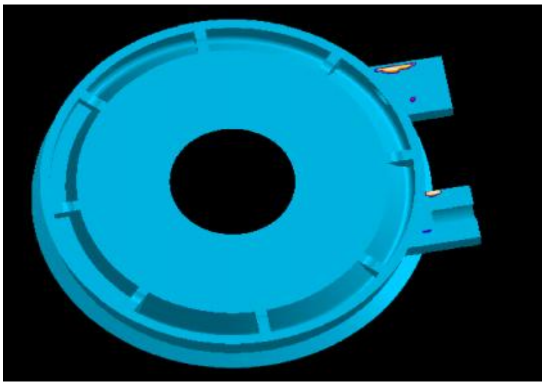


Figure 13: Porosity Defect



Liquid Molten Velocity

At velocity range 700 to 10000 cm/s the molten metal did not filling correctly. So the following porosity defect occurs during solidification as shown in Figure 13.

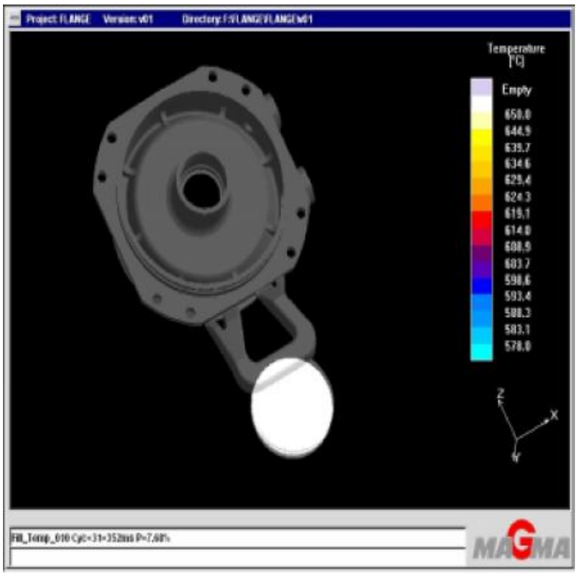
Table 2: Input Parameters 2

Plunger diameter	70 mm
Plunger length	230 mm
Area of plunger	3848.5 mm^2
Volume of shot sleeve	1156.106 cm^3
Shot sleeve filling	45.38%
Slow shot velocity	0.250 m/s
Theoritically cavity filling time	65 ms
Fast shot velocity	2.8 m/s
Velocity at ingate	34.40 m/s

Metal Temperature

The initial temparature is (650 °C) to Liquidus temperature (578 °C) in deg.C.

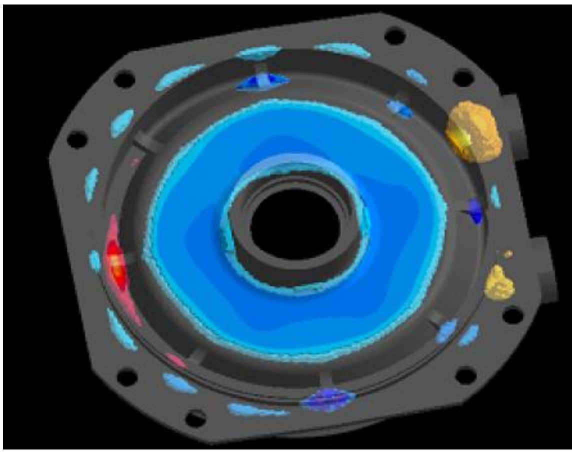
Figure 14: Poring Rate



Hot Spot

The hot spot found in solidificatio as shown Figure 15.

Figure 15: Hot Spot Defect



Liquid Molten Velocity

At velocity range >8000 and <= 11000 cm/s the die is defect less. Since runner and gate

Figure 16: Pouring Rate

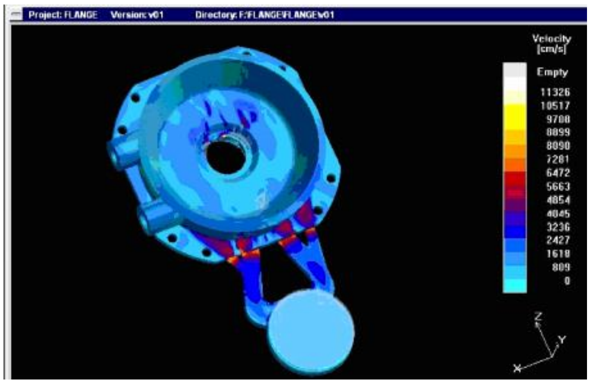
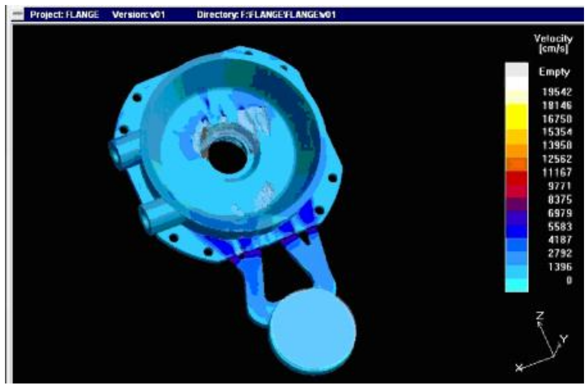


Figure 17: Defectless Die



is going to be break after solidification so there is no effect on die at velocity 11000 cm/s.

The above figure tells that there is no porosity defect and hot spot in die at velocity range >11000 and <=19000 cm/s, liquid molten metal temperature at 680 °C.

CONCLUSION

The maximum molten metal temperature at end of the mould filling is 680 °C. In the die casting process the die will maintain at 150 °C. The porosity defect occurs at a velocity range between 700 cm/s to 10000 cm/s. The die is defectless when the velocity ranges between >11000 cm/s and < 19000 cm/s.

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