International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Design & Analysis of Heat Sink High-Pressure Die Casting Component

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Accepted 01 Sept 2016, Available online 02 Sept 2016, **Vol.6, No.5 (Oct 2016)**

Abstract

Die casting is one of the manufacturing process developed in early 1900's. In die casting molten metal is injected into the mold with high pressure. Die casting can be distinguished by two types they are 1) Hot Chamber Die Casting 2) Cold Chamber Die Casting. In hot chamber die casting the molten metal is poured into the mold with the help of ladle wherein cold chamber die casting ladle is not used. With high pressure, the metal is injected into the mold this leads to some defects like dimensional inaccuracies, porosity, warpage, etc., and this paper states the design of hpdc die, gating & runner design, modification of runner and studying of hpdc defects by using Castle Run software.

Keywords: *High Pressure Die Casting, Mold Flow analysis, Gate & Runner design, overflows (O/F)*

1. Introduction

High-Pressure Die Casting is one of the manufacturing processes widely used for mass production. In High pressure die casting die consists of core, cavity and mold bases are made up of steel, and the metal is injected into the cavity at high speed so that is why due to the high temperature and the fast cooling process stresses will be developed and thermal stresses were formed, and there is a possibility of air get entrapped while both fixed & moving housing get closed with a particular force. Due to this, many defects will arise like air porosity, cold shut, shrinkage, warpage apart from these there are many flaws. Thus these castings defects will occur due to an improper gate, runner design. Improper locating of overflows. While manufacturing the casting defects occurs due to wrong machine parameters also in this project we discuss the errors that arises due to improper design

2. Design of gate & runner system for heat sink

2.1. Modelling of Heat Sink

Heat Sink is a component used in cars an electronic circuit will be mounted on a heat sink component. Heat sink model has developed with the Creo 2 Software, and the parting line is made to make core and cavity Inserts

2.2. Design & runner Calculations

1. Casting Weight = 177 Gms
2. Number of cavities = 2
3. Component material= AL_EN46000_AlSi9Cu3Fe
4. Over Flow Weight(O/F)=20% of Component Weight = 70.80 Gms
5. Material through Gate = (Component Weight + O/F Weight) X Number of Cavity = 495.60 Gms
6. Density of material to cast= 2.73 Gms/cc
7. Volume of the material Through gate = Material through Gate/density of material to cast = 181.54 cc
8. Average Wall Thickness= 3 mm
9. Velocity of gate =3500 cm/sec
10. Cavity Fill Time =0.045 sec
11. Gate Thickness=1.6mm
12. Fill Rate =Volume of material through gate/ Cavity fill time = 4034.19 cc/sec
13. Area of Gate per cavity ={(Fill rate/Velocity of Gate)/ Number of Cavity}/ Velocity of the Gate =57.63 mm^2
14. Length of Gate=Area of the gate.Thickness of the gate = 36.02 mm
15. Area of Runner= 2.1 X Gate area X Number of cavity = 242.05 mm^2
16. Plunger Diameter= 50 mm
17. Plunger Velocity= {(Gate Area X Gate velocity x No.of cavity)} / Plunger Area = 205.56 cm/sec
18. Width of runner= √ (2 X Area of runner = 22.00 mm
19. Depth of Runner= Area of Runner/Width of runner = 11 mm

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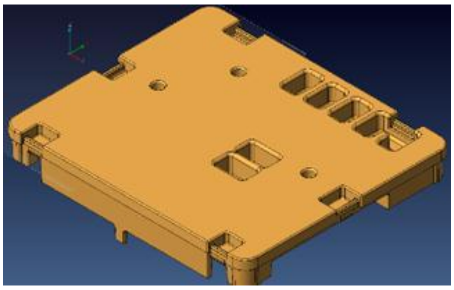

Fig.1 Heat Sink Part Model

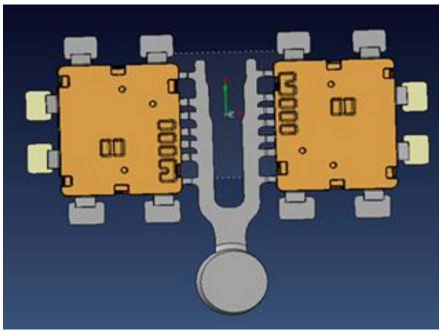

Fig.2 Heat Sink full shot

3. Mold flow analysis

3.1 Introduction

Mold flow analysis is done to know the errors in the die before manufacturing. If the errors are spotted, then it will be very useful to the manufacturer as he can save money & time. Mold flow analysis is a tool is widely used in many of the manufacturing industries to eradicate the defects before starting the production. In this project for performing mold flow analysis, we used Castall Run software for performing mold flow analysis.

3.2 Simulation Setup (1st Iteration)

Metal Alloys : AL_EN46000_AlSi9Cu3Fe
Alloy Temperature [°C] : 670
Die Temperature [°C] : 180
Second phase static pressure [bar]: 600
Third phase pressure [bar]: 1000
Air Vents : False
Fast Shot Volume [cm^3] : 165.3
Total Volume [cm^3] : 263.73
Slow Shot velocity [m/s] : 0.2
Fast Shot velocity [m/s] : 4
Fast Shot time [s] : 0.0140

3.3 1st Iteration Analysis Discussion

We can see in a figures 3 the violet colors refers to the unfilled area, and the dark gray color relates to the area filled in the mold. As the analysis was done for knowing the porosity in the die as from the analysis, we can come to know that the porosity is high.

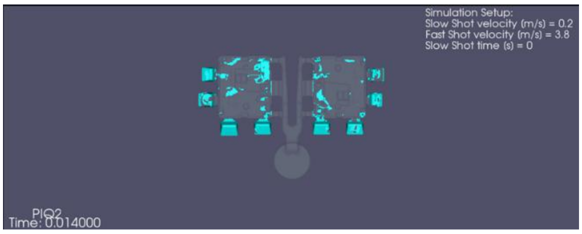

Fig.3 Heat Sink Mold Flow Analysis (1st Iteration)

Air Porosity: It is a casting defect occurs due to trapped air causes it in casting. It is resulting from many reasons like poor gate & runner design, less overflow area.

Most Likely Causes

- First stage velocity is too low.
- First stage velocity is too high.
- Change over point is too early.

Possible Causes

- Change over point is too late
- Wrong shot weight setting on ladle.
- Blocked Pour hole
- Blocked launder on dose furnace
- Tube constricted on dose furnace
- Changing volume effects wave acceleration and change over point
- Irregular operating cycle.
- Die is too cold
- If the die is too cold then air may be trapped during cavity fill as two metal fonts meet.
- Leaking Vacuum.
- Vacuum On too soon/late.
- Ineffective venting or over flows
- Air trapped in cavity.

Least Likely Causes

- Second stage velocity is too low.
- Percentage of solid is too high at cavity fill.
- Intensification is too late.
- Intensification is too low.
- Not enough plunger lube/sticking plunger.
- Poor runner & gating design.
- A lip on the shot sleeve & low ejector pins can cause air to be entrapped in the metal.
- Difficult casting geometry
- Metal is too hot/cold.

3.4 Simulation Setup (2nd Iteration)

Metal Alloys : AL_EN46000_AlSi9Cu3Fe
Alloy Temperature [°C] : 670
Die Temperature [°C] : 180
Second phase static pressure [bar] : 500
Third phase pressure [bar] : 1000

Air Vents	: False
Fast Shot Volume [cm^3]	: 156
Total Volume [cm^3]	: 248.14
Slow Shot velocity [m/s]	: 0.2
Fast Shot velocity [m/s]	: 3.8
Slow Shot time [s]	: 0
Fast Shot time [s]	: 0.017424

3.5 2nd Iteration Results

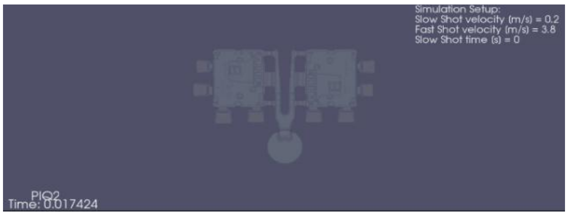

Fig.4 Heat Sink Mold Flow Analysis (2nd Iteration)

As seen in the above figures 4 there is no porosity this is because we had changed the design of runner, gate we decreased the runner & gate area, and we had increased over flows area thus the porosity is reduced.

3.6 Analysis to nnow Filling Time

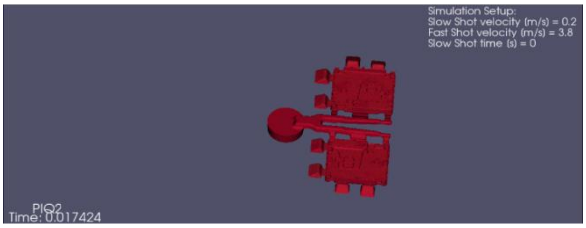

Fig.5 Heat Sink Mold Flow Analysis (Filling Time=0.017424 sec)

3.7 Analysis to know Solidifying Time

Fig.6 Heat Sink Mold Flow Analysis (Solidifying Time=6.8 sec)

3.8 Analysis to know temperature at solidifying time

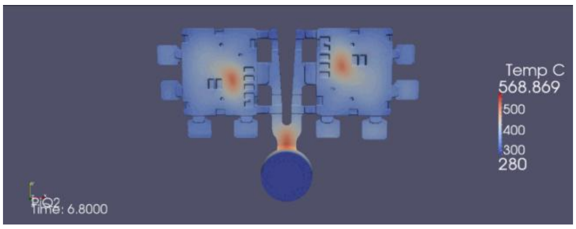

Fig.7 Heat Sink Mold Flow Analysis (Temperature Analysis in casting)

3.9 Analysis to know velocity in the cavity

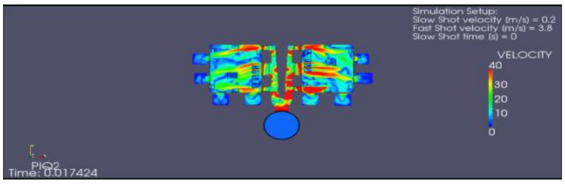

Fig.7 Heat Sink Mold Flow Analysis (Velocity flow Analysis in casting)

4. Results & Discussion

Porosity is a major problem in die casting. As we seen in figure 4, there is 0% porosity hence the design change, i.e., change of gate, runner & increasing over flow area helps in achieving 0% porosity, this is a small die so we cannot be able to provide chill vents. We can do much analysis in this project like temperature analysis by considering the cooling channels. Thus by changing the gate, runner & over flows area we had achieved 0% porosity.

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