DESIGN OF CASTING MOULD FOR BATTERY TERMINAL

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ABSTRACT

The paper is based on mold design of battery terminal by using gravity die casting process. Now a days many companies manufacture lead acid batteries. for these batteries they manufacture battery terminal using gravity die casting process. The material for battery terminal is mostly lead antimony alloy. For this battery terminal they are facing some problems in casting like blow holes. For manufacturing of this component, many companies uses single cavity die for positive(round) and negative(square) battery terminal. By taking into consideration all these points we are going to design and manufacture multi mold casting die.

keywords: *gravity die casting, lead antimony alloy.*

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1. INTRODUCTION

Casting is manufacturing process in 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 materials are usually metals or various cold setting materials that cure after mixing two or more components together. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods.

Casting is one of the earliest metal shaping methods known to the human being. Casting process is extensively used because of its many advantages. Molten material flows into any small section in the mold cavity and as such an any intricate shapes internal or external can be made with the casting process.it is possible to cast practically any material be it ferrous or non-ferrous. Further, the necessary tools required for casting molds are very simple and inexpensive.as a result, for trial production or production of a small lot, it is an ideal method.it is possible in casting process ,to place the amount of material where exactly required.as a result, weight reduction in design can be achieved. casting are generally cooled generally from all sides and therefore they are expected to have no directional properties. there are certain metals and alloys which can only be processed by the casting and not by any other process like forging because of metallurgical considerations.

Casting of any size and weight, even upto 200 tons can be made. However the dimensional accuracy and surface finish achieve by normal sand casting process would not be adequate for final application in many cases. To take this cases into considerations, some special casting processes such as die casting have been developed. In all the processes that have been covered so far, a mold need to be prepared for each of the casting produced. For large scale production, making mold for every casting to be produced, maybe difficult and expensive. Therefore, a permanent mold, called “die” maybe made from which a large number of castings, anywhere between 100 to 250,000 can be produced, depending on the alloys used and the complexity of the casting. The process is called permanent mold casting or gravity die casting, since the metal enters the mold under the gravity.

1.1 Classification of casting processes:

Table -1: Classification of casting processes

Process	Advantages	Disadvantages	Examples
Sand	Wide range of metals, sizes, shapes, low cost.	Poor finish, wide tola ence	Engine blocks, cylinder heads
Shell mould	Better accuracy, finish, higher production rate	Limited part size	Connecting rods, gear housing
Expendable pattern	Wide range of metals, sizes and shapes	Pattern have low strength	Cylinder heads, brake components
Plaster mould	Complex shapes, good surface finish	Non-ferrous metals, low production rate	Prototypes of mechanical parts
Investment	Complex shapes, excellent finish	Small parts, expensive	Jewellery
Permanent mould	Good finish, low porosity, high production rate	Costly mold, simpler shapes only	Gears, gear housing
Die	Excellent dimensional accuracy, high production rate	Costly dies, small parts, non-ferrous metals	Precision gears, camera bodies, car wheels
Ceramic mould	Complex shapes, high accuracy, good finish	Small sizes	Impellers, injection mold tooling
Centrifugal	Large cylindrical parts, good quality	Expensive, limited shapes	Pipes, boilers, flywheels

1.2 Gravity die casting:

Gravity die casting is a permanent mould casting process, where the molten metal is poured from a vessel or ladle into the mold. the molud cavity fills with no force other than gravity,filling can be controlled by tilting the die.

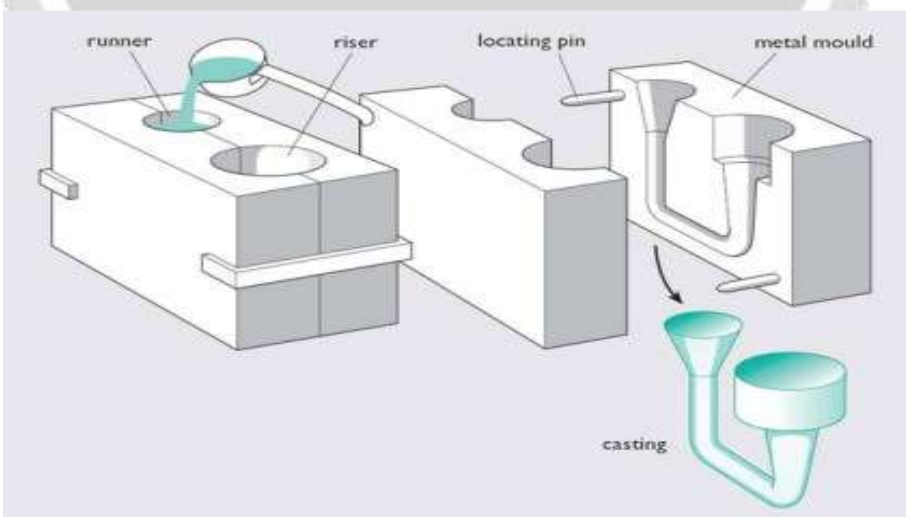


Fig. 1 Gravity die casting

1.3 Materials of casting

Aluminium: - Aluminium is reusable material. Which is reused up to 95% . Good conductor of electricity. High weight to strength ratio. High Strength at low temperature. Non-toxic and odourless. Shrinkage allowance for aluminium is 13 mm/m. aluminium is used as a deoxidiser in steels. It is most effective in the inhibiting grain growth. Aluminium have excellent thermal conductivity (053 cal/cm/℃), low mass density (2.791 cm^3). Aluminium have low melting point (658℃). Aluminium is non-toxic.

Brass: - brass is economical and offer wide range of shapes and sizes. Its parts are strong and have a long life span. It can be used to make complex shapes with great dimensional accuracy and stability than other mass production method. Shrinkage allowance for brass is 15.5 mm/m.

Lead antimony alloy: - The lead antimony alloy is the good conductor of electricity. It is reusable. It is used for making battery caps. Its melting point is 480-680^F. the antimony is added into lead to increase its hardness and ductility. Atomic number of lead and antimony is 82 and 51.

Zinc: The melting temperature of zinc is 419.4℃. Zinc has high corrosion resistance. The zinc has lack of dimensional stability under ageing condition. The disadvantages of zinc are mainly reduction in the impact strength at low temperature. Zinc cannot be used for service above a temperature of 95℃ because it will cause substantial reduction in tensile strength and hardness. It has good machinability.

2. CASE STUDY:

2.1 Problem Defination:

In Sai Samrat Industries Pvt. Ltd, sangamner, MIDC the batteries are manufactured. The battery cap is manufactured by the process called gravity die casting. They manufacture two battery terminals i.e. positive terminal and negative terminal which is shown in below figure.


Fig.2 Positive terminal **Fig.3** Negative terminal

When they use gravity die casting process for manufacturing of battery cap, there are some major problems occurred in casting component. Casting is not produced as per requirements, so the mass production is affected. The cause of all these problems is occurrence of blow holes in the casting component. The blow holes mainly occurred in the upper half of the component. There are two types of blow holes occurred in the component i.e. external blow holes and internal blow holes. The pattern of blow holes occurred in component are shown in below fig.


Fig.4 Internal blow holes in component **Fig.5** External blow holes

Due to blow holes the die which is used for manufacturing of component is currently not in use. Because of this the production for above component is stopped. Now a day they are using the old die for manufacturing of component. The design of component is different from above component which is shown in first figure. The currently used component is shown in below fig.


Fig.6 Positive terminal **Fig.7** Negative terminal

The weight of currently used component is135g for round component and 130g for square component. The weights of component in which blow holes occurred are 80g for square component and 84g for round component. In currently used component the wastage of material is more as compare to new component because the requirement of material for manufacturing of currently used component is more. This is also one of the major problem. We are going to manufacture the new die to reduce the weight and to remove the blow holes.

2.2 ANALYSIS:

We are going to solve the above mentioned problems by designing and manufacturing the new die. In the new die they manufactured four parts at a time, two for positive battery terminal and two for negative battery terminal. For melting the lead antimony alloy they use the electric furnace. The melting point of lead antimony alloy is 329℃ and the boiling point is 1700-1800℃. The antimony is used in the lead because it increases the strength and maintains the grain structure of the lead. Flow rate is one of the most important parameter. The flow rate changes with atmospheric conditions for e.g. when we pour the material by using ladle into die from more height then flow rate decreases and when we pour the material with no height then flow rate is increases. The electric furnace is used to melt the material because its maintenance is easy and it acquire less space. Cost of the electric furnace is less as compare to other furnaces. The die material is mild steel.

When we observe the die we analyse that there was blow hole is a major problem. As per our observation we found that there is no riser in the die for passing the air, so that the air is not passes properly during pouring and solidification. They used sprue for passing the air but the air during pouring and solidification is not passed properly. The die in which defects occurred like blow holes is shown in below fig:

Fig.8 New component die

We are going to redesign and manufacture the above given die. In redesign there are four risers, two for positive and two for negative. The location of riser is at the top of the upper half of the component for passing the air without any obstacle. There are two sprues for material feeding. Sprue is provided between the two components.

2.3 DESIGN:

2.3.1 Design of round component:

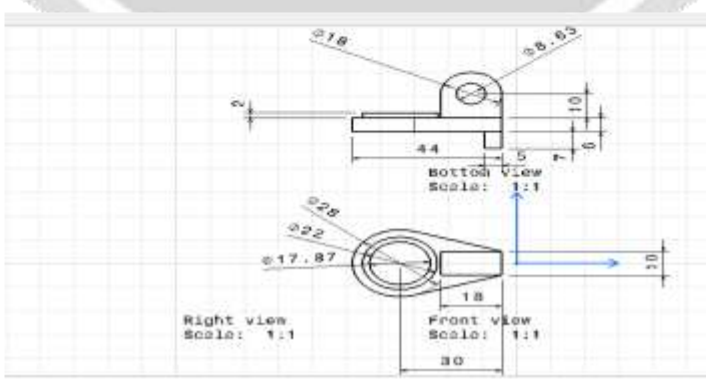


Fig.9 (a)2d Design of round component

2.3.2 Design of square component:

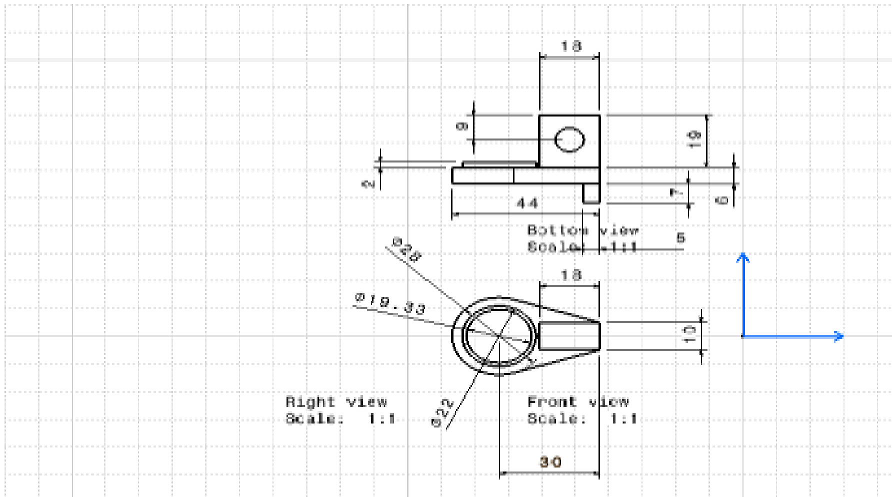


Fig.10 (b) 2D Design of square component

2.3.3 Mould design

1)Assembly Design:

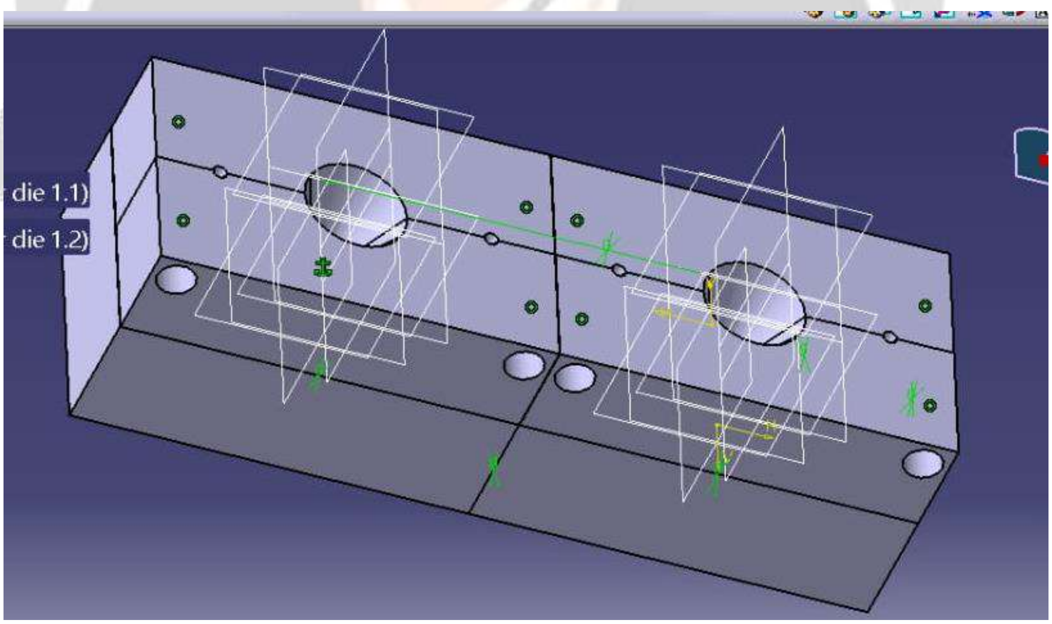


Fig.11 3D Assembly Design

2) Cut section of Assembly Design

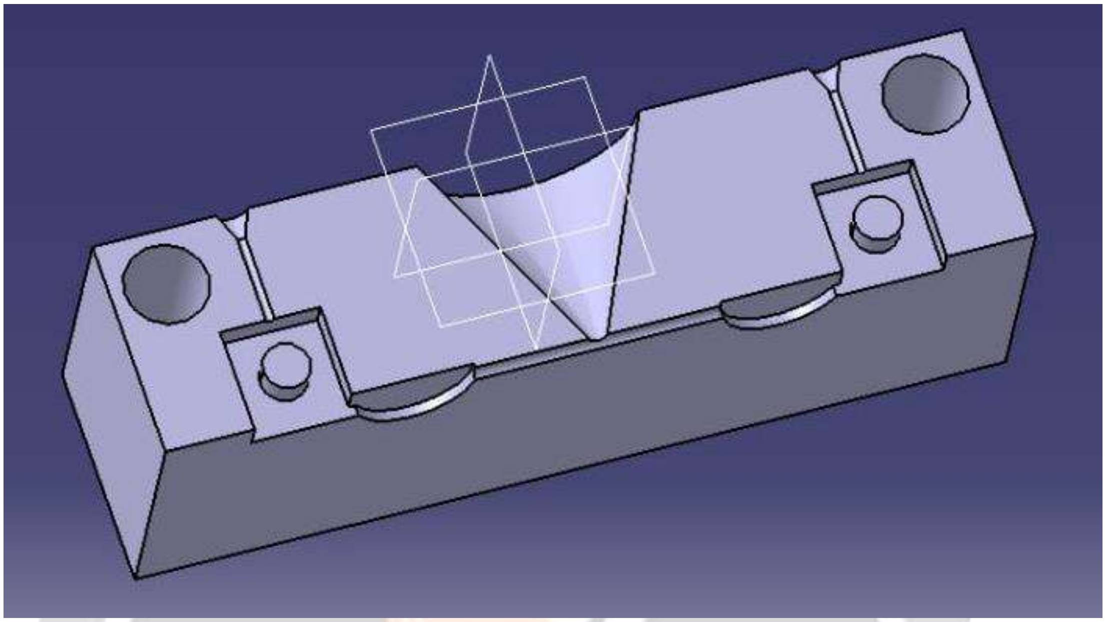


Fig.12 Upper half cut section

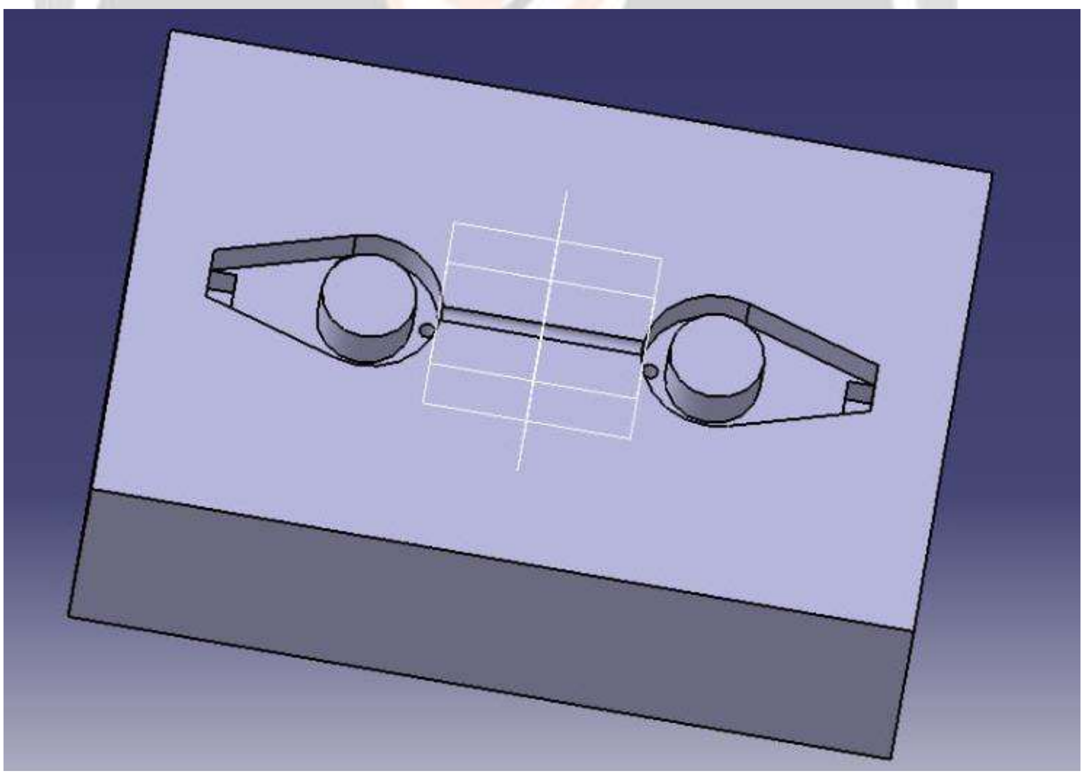
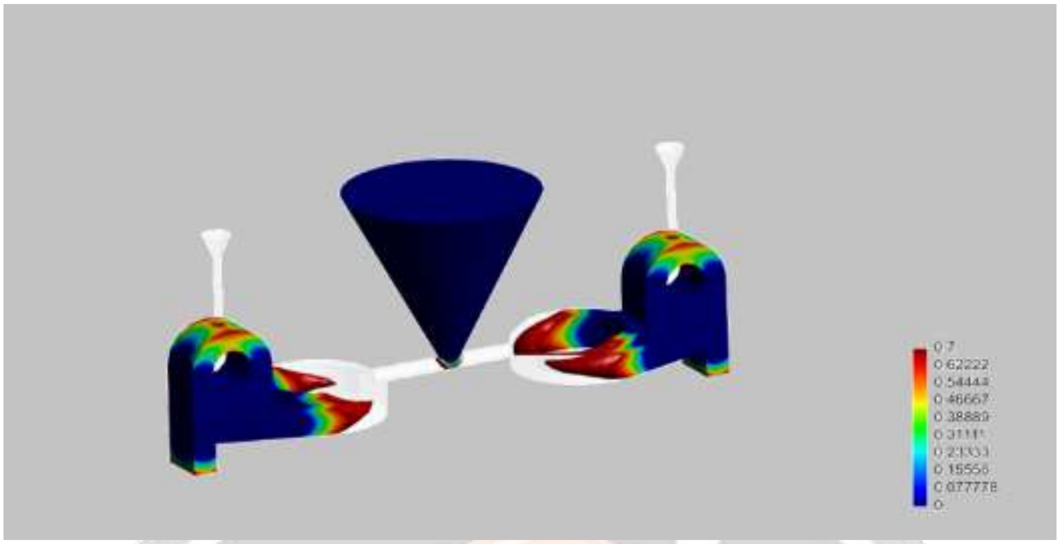


Fig.13 Lower Half section

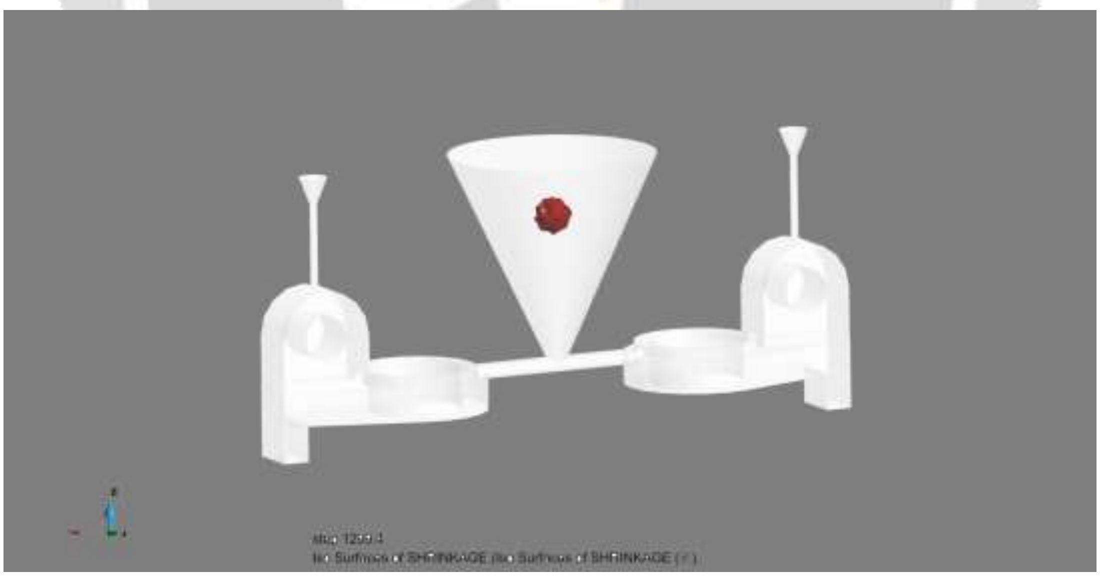
2.4 SIMULATION RESULT:-



LIQUID FRACTION:

Liquid Fraction displays the last areas to solidify (liquid material) in red so you can predict shrinkage porosity. Liquid Fraction is useful for analyzing the behavior of the liquid during solidification. Unlike in gravity casting, overflows and runners won't feed the part during solidification because of the thin ingate sections.

Liquid Fraction and Mold Temperature results will provide you with valuable information to help you design cooling channels.



To remove/reduce/relocate shrinkage defects in high pressure die casting:

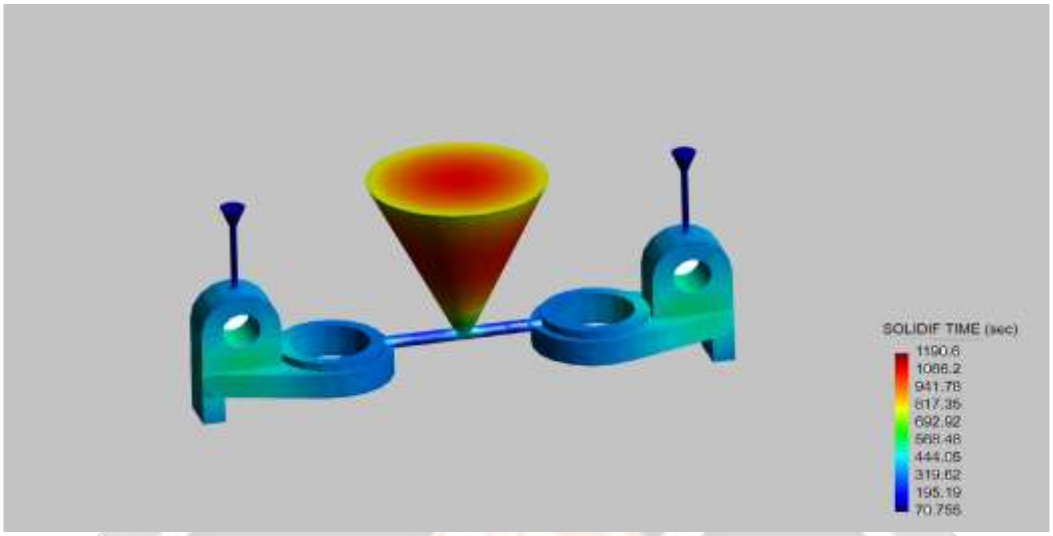
- Reduce the area of the critical zone to obtain a faster cooling rate.

- Place runner gates close to the critical zone.

- Enlarge the gate and/or runners to feed the critical zone. Add ribs to the cast walls to improve feeding.

- Increase pressure on the metal.

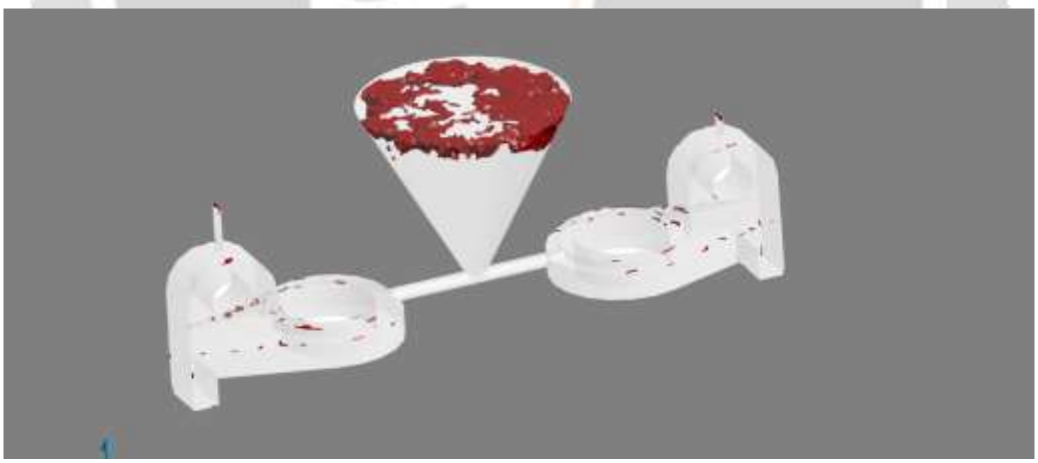
- Place cooling channels to cool the critical zone



SOLIDIFICATION TIME:

Areas in the casting that cool rapidly generally have a more favorable grain structure and therefore tend to have better mechanical properties. Areas that cool more slowly generally tend to have poorer material properties.

The Solidification Times result will help us to understand time differences in our component to control the microstructure of the final product and optimize the desired properties.



AIR ENTRAPMENT:

Flow Front shows you how the material behaves as it enters the mold, so you can detect where air is being trapped during filling.

The Air Entrapment option shows the last step before air bubbles disappear. Analyze the red areas along with the Flow Front to understand which bubbles will remain and which bubbles will continue to flow during filling.

COLD SHUTS:

Cold Shuts shows in colored areas where two fronts of material meet and what the temperature difference is.

Cold Shuts provides information about potentially poor welding and, more importantly, turbulence during filling. Remember, turbulence can generate air bubbles that can remain in the casting.

3. CONCLUSION:

In this Paper we have studied what is the actual problem of company and to solve this problem we studied on mold design. The problem of die is the blow holes and for this we have studied about their die and found out what is the reason behind this problem. We prepared new design of the mold and carried out its simulation. According to simulation result the filling time affect the all other parameters.

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