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Application of Casting Simulation for Die Casting of Hollow Cylindrical Section of Aluminium Alloy

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ABSTRACT

The project titled "Application of casting simulation for die casting of hollow cylindrical section of aluminium alloy" manages improvement in the structure of throwing delivered by perpetual metal mouldgravity pass on throwing process. In this task a mechanical gravity throwing kick the bucket creating imperfect hollow cylindrical castings is examined and dissected for end of defects utilizing throwing simulation programming's SOLIDCast and FLOWCast. Alterations in Die configuration is done dependent on the quantity of simulations performed for various gating and risering framework plans to take out the defects. The best structure is chosen dependent on the aftereffects of simulations and kick the bucket is changed according to the plan and castings are created to check the nature of the components. The delivered castings are seen to be of good quality and improved throwing yield. The castings were additionally tried to check interior defects by Helium& Pressure hole testing process and Radiography procedure. The castings were seen to be sound, henceforth it is confirmed that solidification simulation helps in finding the defects, disposing of them and at last improving the nature of castings with no shop-floor trails.

INTRODUCTION

Casting is the process of delivering metal into a decided shape by dissolving strong metal into fluid structure, emptying it into a form and giving it a chance to set into the ideal shape. The form is a negative duplicate of the throwing process offers the amplest scope of plan and process parameters regarding material, weight, shape intricacy, bunch size and nature of an item. Many years of involvement in assembling an assortment of cast components has been grouped and very much reported. Be that as it may, the structure of castings with the go for ideal usage of material, vitality and different assets while guaranteeing deformity free items is as yet a difficult assignment inferable from the huge number of reliant geometric, material and process parameters included. In assembling process [1], throwing is one of the most affordable generation processes, which includes extensive metallurgical and mechanical viewpoints. In throwing process, the rate of solidification influences the microstructure of cast metal to a great extent, which thusly controls the mechanical properties, for example, quality, hardness, machinability and so forth of the cast metal. The best possible plan of riser/feeder required to accomplish directional solidification is significant in light of the fact that inappropriately structured riser results either imperfect throwing with shrinkage cavity or lower yield. Subsequently, legitimate structure of risering framework and great authority over the process parameters [2] are essential for quality castings. In any case, the test courses are in every case better for structure and improvement of shape and for landing at the ideal process parameters. In any case, it is exorbitant, tedious, and might be incomprehensible now and again. Accordingly, throwing simulation process is an advantageous method for legitimate plan of risering framework and breaking down the impact of different

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parameters. As of late the utilization of throwing simulation programming is expanding everyday in Indian foundry as it basically replaces or limits the shop-floor preliminaries to accomplish sound castings at the most noteworthy conceivable time. The fundamental contributions for the throwing simulation programming are 3D geometry of the form depression with gating and risering framework, thermo-physical properties of the shape and cast material. An assortment of strategies have been concocted to ascertain the riser size expected to guarantee shrinkage free castings, for example, Shape factor strategy, Geometry method,Modulus strategy. In this present work we have considered the hollow cylindrical throwing of aluminum amalgam (LM25) metal. Thickness of riser is additionally shifted if there should be an occurrence of various investigations. The required distance across and the stature of risers are determined by modulus strategy and the castings are delivered by gravity bite the dust throwing technique [3].

The plan computation was done and simulation technique was utilized to watch the solidification of liquid aluminum combination. In view of the simulation information, the gating framework and riser structure of the throwing are settled.

PROBLEM STATEMENT

There are different kinds of defects that may happen in a casting. There are likewise many casting simulation programming programs in the market these days. Distinctive casting simulation programming projects and modules may anticipate a few sorts of defects that may happen in the casting. The exactness of the simulation depends both on the program and the info esteems it gets from the client. The client should likewise realize how to decipher the outcomes from the simulation so as to recognize what defects may happen and where they may occur. A contextual analysis was led to check the utilization of SOLIDCast in an industry casting condition. The chose contextual analysis was an enclosure configuration produced using aluminum amalgam (LM 25) by ACMI INDUSTRIES [4].

Figure 1: Existing Casting Design

Figure 2: Complete Casting

Defects in Existing Casting System

Figure 3: Various defects occurring due to Improper Gating Design

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There were defects like blow openings, porosities and inappropriate solidification in the said casting because of ill-advised structure of gating and sustaining frameworks. To wipe out these defects legitimate gating and bolstering frameworks were structured, reenacted and results were dissected to choose the best possible gating and nourishing framework so as to get sound castings without defects [5].

PROJECT OBJECTIVES

1. To Study the current defects happening in casting because of ill-advised gating framework.
2. To calculateproper gating and encouraging frameworks dependent on material properties of segment.
3. To model the new gating and encouraging framework on a CAD modellingsoftware.
4. To perform Simulation preliminaries of new casting plan.
5. To modifythe existing Die dependent on Simulation results.
6. To test the casting for defects utilizing Helium break testing and Radiography system

METHODOLOGY

The SOLID Cast program can recreate various kinds of casting composites, yet solid metal is by all accounts the main sort of material which has uncommon capacities to ascertain and anticipate the attributes of a specific cast iron compound. For instance, the Gray Iron and Ductile Iron adding machine catches in the Curves tab for altering the temperature bend, the VDG Iron Properties Calculator for modifying the shrinkage bend and the set focuses for the basic portion strong point and Niyama point. Indeed, even an extra Riser Design Wizard program was incorporated with the VDG Iron Properties Calculator for structuring risers for a cast iron casting.

This theory is keen on demonstrating solid metal sand castings utilizing SOLIDCast. Sand casting is perhaps the least difficult strategy in casting and cast iron is one of the most prevalent casting amalgams in the casting business. Sand casting needs minimal exertion in setting up for simulation contrasted with other casting techniques. The casting configuration picked for the contextual analysis is a train cylinder produced using dim iron by sand casting [6].

Starting SOLID Cast

Prior to drawing or stacking any shape into the program, the client must set the framework parameters so as to get the right outcomes and anticipate any issues which may happen from these settings. The framework parameter setting is situated in the Tools menu. There are 5 tabs, which are; “Alloys Curves”, “Model Colors”, “Model & Sim”, “Directories” and “FLOWcast”.

Alloy Curves Tab

In the Alloy Curves tab, the client would set the default esteems for the default basic division strong rate, for the most part at 60 percent, default Niyama point rate, for the most part at 65 percent (the rates in the two cases mean the percent of solidification in the bends diagram) and default solidification shrinkage, as a rule at - 7 percent. The negative sign methods volumetric withdrawal of the metal. This worth is really the net development/withdrawal of the metal. In the bends diagram, the volumetric shrinkage line would straightly slope or decay from 0 percent to the net an incentive at 100 percent of solidification [7].

The basic part strong point is the guide accepted toward be the finish of nourishing or metal development for a cast amalgam. It implies if fluid metal achieves this point, it will never again be able to stream any longer despite the fact that it has not totally cemented. The Niyama point in the program is the point which the Niyama worth is determined. The Niyama estimation of a solitary hub is the temperature inclination separated by the square base of the cooling rate when it achieves its Niyama point in the cooling bend. It is a worth utilized as a marker of the level of directional solidification and the probability of shrinkage development; the lower the worth, the more prominent potential for shrinkage arrangement. It is regularly set at 5 percent after the basic division strong point. Figure 4.1 demonstrates the Alloy Curves tab in the Systems Parameters window [8].

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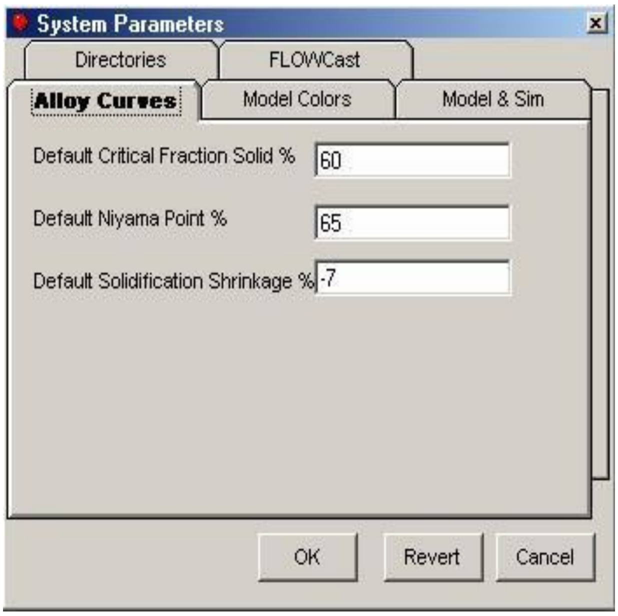


Figure 4: The Alloy Curves tab in the Systems Parameters window.

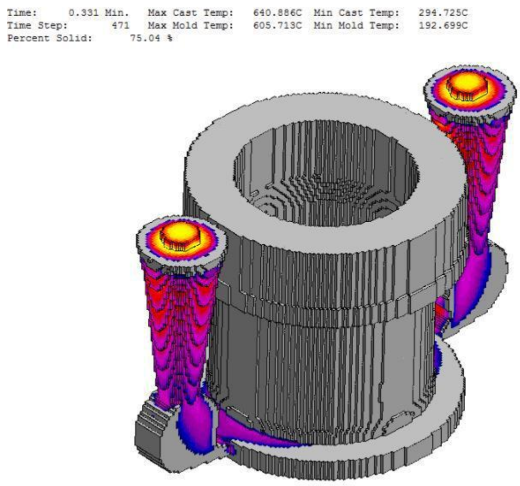
SIMULATION & EXPERIMENTAL WORK

Simulation Trials

In order to eliminate the defects which were occurring due to improper gating and feeding systems, both were modified based on calculations and simulated to study the solidification and redesign the gating and feeding system designs.

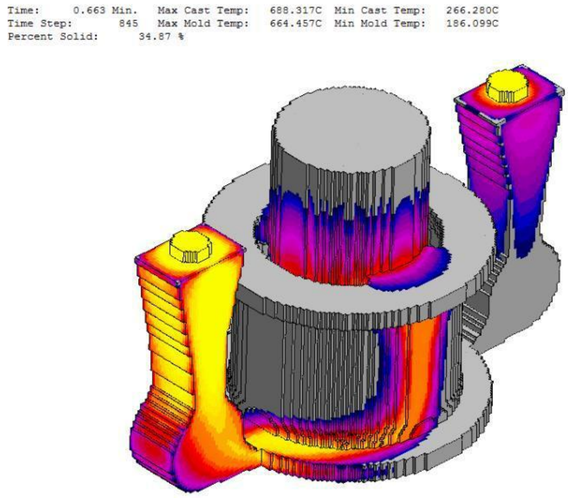
The following simulations of different gating and feeding designs were done on the SOLIDCast software

Trial 1



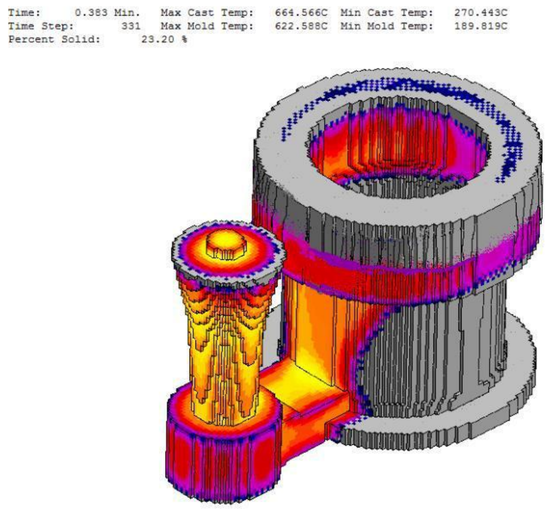
In trial 1, two circular gates and a hollow feeder was used. In The resulting simulation, the riser solidified before casting. Which may result in defects in the casting.

Trial 2



In trial 2, two gates and a solid feeder was used. In The resulting simulation, the flow of metal from riser to component was not uniform. And, the solidified before casting. Which may result in defects in the casting.

Trial 3



In trial 3, A single gate and a hollow riser was used. In The resulting simulation, the flow of metal from riser to

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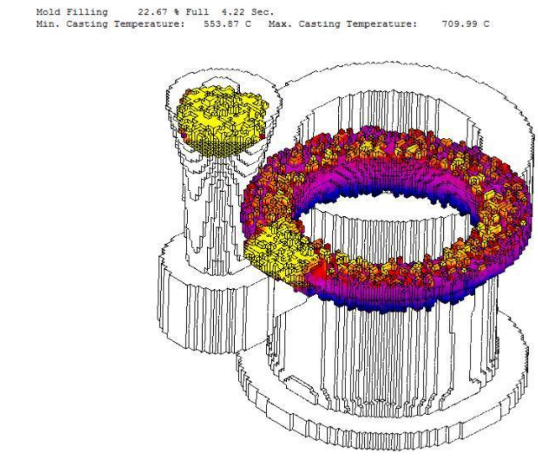
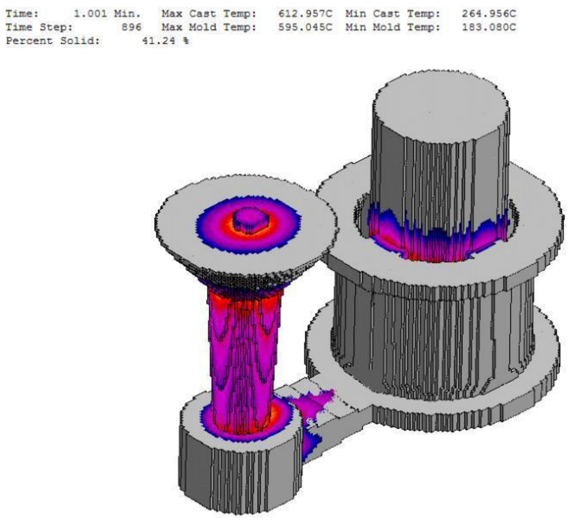
component was not uniform. Which may result in non-uniform solidification of casting.

Trial 4



In trial 4, A single top gate and a hollow riser was used. In The resulting simulation, the metal solidified before filling the cavity. Which may result in improper solidification of casting.

Trial 5



In trial 5, A single calculated gate and a solid feeder was used. In The resulting simulation, the flow of metal from riser to component was uniform. And, the component solidified before solidification of riser. Which results in sound castings with no defects.

Die Modification

The casting design was modified based on the simulation results. The design with proper solidification (solidification of riser after solidification of casting) was selected and the die was modified based on the resulting design of the gating and feeding system

Figure 5: Die at machining facility

Figure 6: Both left and Right Dies after installation of new gating system

Pouring

After modification of die, aluminium alloy (LM 25) was poured in the die. The temperature of molten metal was 720º and,the die was preheated to the temperature of 200º. After solidification, the casting was removed from mould after removal of cores.

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Figure 7: Pouring of molten metal

After solidification of casting, the component was machined as per product specifications.

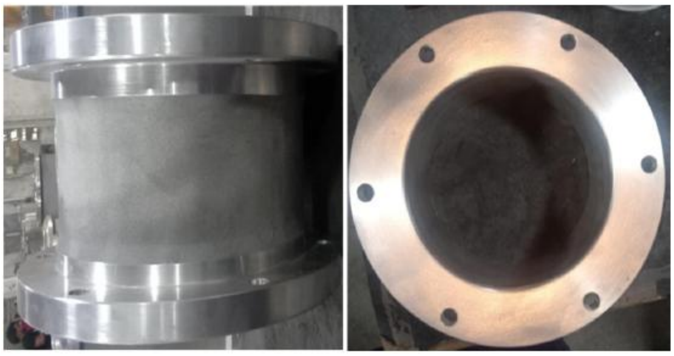


Figure 8: Finished component with no defects

Figure 9: Component in production after Die modification

Testing for defects

The casting was then tested for defects by performing Radiography technique at an outside facility. And was also tested by performing Helium leak test at inhouse facility.

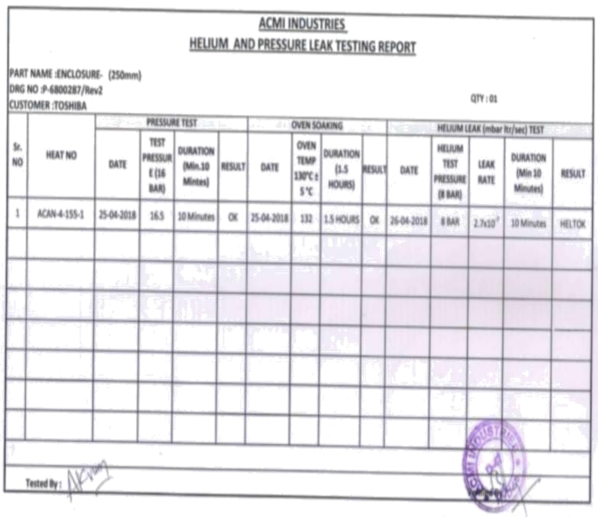
DECCAN
NDT & DT TESTINGS

RADIOGRAPHIC INSPECTION REPORT

Client: M/s. ACMI INDUSTRIES

Approved by Department of Industries T.S. Regd. TS 09D0007661

Figure 10: Radiography test report



ACMI INDUSTRIES
HELIUM AND PRESSURE LEAK TESTING REPORT

PART NAME :ENCLOSURE- (250mm)
DRG NO :P-6800287/Rev2
CUSTOMER :TOSHIBA
QTY : 01

Sr. NO	HEAT NO	PRESSURE TEST				OVEN SOAKING				HELIUM LEAK (mbar ltr/sec) TEST				
		DATE	TEST PRESSURE (16 BAR)	DURATION (Min.10 Mintes)	RESULT	DATE	OVEN TEMP 130°C ± 5°C	DURATION (1.5 HOURS)	RESULT	DATE	HELIUM TEST PRESSURE (8 BAR)	LEAK RATE	DURATION (Min 10 Minutes)	RESULT
1	ACAN-4-155-1	25-04-2018	16.5	10 Minutes	OK	25-04-2018	132	1.5 HOURS	OK	26-04-2018	8 BAR	$2.7x10^{-?}$	10 Minutes	HELTOK

Tested By:

Figure 11: Helium and pressure leak test report

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RESULTS & CONCLUSIONS

It can be concluded that the casting simulation has become a powerful tool to predict the location of defects and eliminate them by visualizing mould filling, solidification and cooling. It can be used to trouble shoot the existing castings or to develop new castings without shop-floor trails by using fewer resources which reduces cost and time to market. Modification in risering system design by changing riser dimensions eliminates the defects from the cast part. Simulation showed that the new design provides a homogeneous mold filling pattern and the last filled area was transferred from part to the riser. The results of simulation are in good accordance with that of experimentation.The defects like solidification shrinkage, cracks, unfilled riser and incomplete mould cavity are completely eliminated from the casting. The casting was also tested for defects by Helium leak testing and Radiography technique, no defects were found. So, zero defect casting has become a reality owing to computer aided design of casting, by using which it is possible to produce casting right first time and every time.

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