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Analysis & Simulation of Casting to Eliminate Casting Defects

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ABSTRACT

As the foundries are primary suppliers to the manufacturing industries like automobile, Pumps, transport, heavy equipment, machine tools, plant machinery, machines, households, aerospace, defence. Although lots of research has been carried out in foundry technology, yet achieving higher casting yield with the sound casting (defect free casting) is major challenge to the manufacturers. For obtaining high quality of casting which is a customer prime requirement manufacturers are making compromise with the casting yield. Which results into the increases production cost and decreases profit. In the research pump cover casting is analyzed which is associated with the various defects. Defective casting results due to improperly designed gating system and risers. For eliminating the defects the gating system components such as sprue , sprue well ,ingates and risers are redesigned using the feeding rules , gating design procedure, theoretical knowledge , practical considerations and casting simulation results . The various designs of the gating system components are made and 3D CAD model of each design is made and analyzed using casting simulation software AutoCAST-X flow plus. After analyzing the simulation results if required goal is not achieved, then the respective changes are made in design and 3D CAD model and it is again simulated. The procedure is repeated until the required results are obtained. Finally redesigned gating system and risers are used to achieve sound casting i.e. defect free casting.

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I. INTRODUCTION

As the foundries are primary suppliers to the pump industries also casting is widely used as one of the economical method of manufacturing pump components. Although lots of research has been carried out in foundry technology, yet achieving defect free (sound) casting with optimal utilization of material, energy and other resources is a big challenge to Indian as well as Global foundries.

The main objective of a gating system is to lead clean molten metal poured from ladle to the casting cavity, ensuring smooth, uniform and complete filling which results into the sound defect free casting. As this are secondary components of casting, it should be minimum in volume so as it must consume less metal and the casting yield is higher, which makes the process economical. To achieve this goal, the gating should be properly designed so as to work properly and efficiently. If gating is not designed properly it would results into the various flow related defects such as cold shunt , misrun, blow holes, slag and sand inclusion. As riser is also essential component of gating system. riser are used to overcome defects due metal shrinkage such as porosity , hot tear , crack , micro- porosity, surface sink etc Hence proper design of gating system is essential for sound casting with higher yield.

A. Problem definition:

The research is carried out in Thorat Industries in Kirlosarwadi dist- sangli Maharashtra. The pump cover casting is associated with the various defects such as blow holes, micro porosity and cold shunts. Due to defective casting manufactures having the problems and rejection rate is also higher.With the initial gating system not only castings produced are associated with defect but also yield is lower. This defects are due to improper gating system components. Gating system and process was initially made using past experience and trial and error method . Improperly designed gating system components will results into defective casting and lower casting yield and hence less productivity and lower profit and wastage of resources.For achieving higher productivity the casing yield must be higher and casting should be sound. It can be achieved by properly designing the gating system components. Design of gating component should be such that it should consume optimum material as well as it will produce sound defect free casting. As yield increases profit increase.

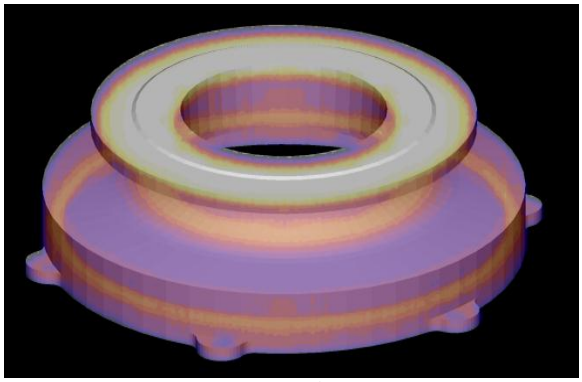

Fig.1. Simulation of casting without riser

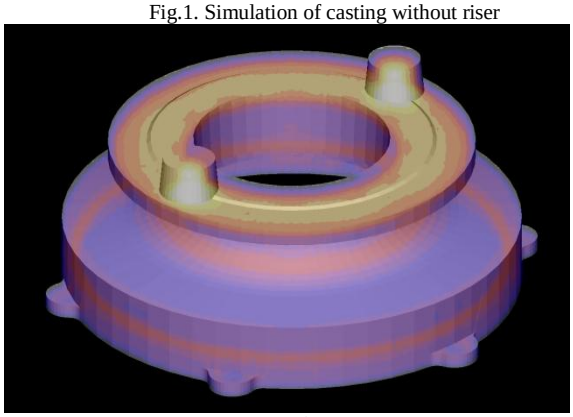

Fig.2. Simulation of casting with initial riser

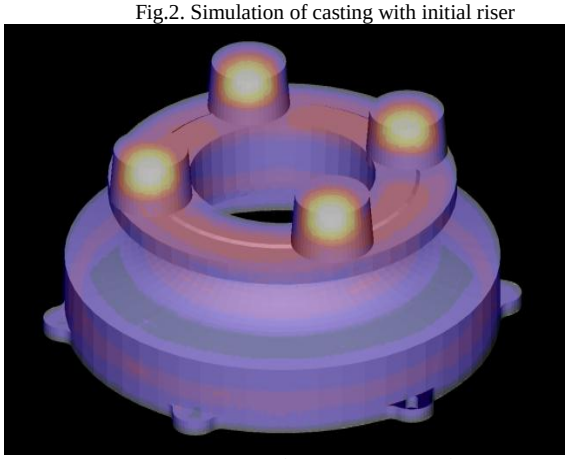

Fig.3. Simulation of casting with modified risers

B. Analysis of casting:

For the research purpose , the all necessary study of given problem is done . for solving the given problem the method used is virtual casting process (B.Ravi) is used . Initially 3D CAD model of given casting is made using SolidWorks2013 . Model is stored in .STL format and using E-Foundry simulation lab it is simulated without feeder, with initial feeder

And finally with modified feeder . feeders are redesigned and modified with help of feeding rules , feeder design procedure , casting simulation results and foundry men's experience. The detail dimension of risers as follows

TABLE I

Detail Dimensions of Feeder

Feeding System	Diameter In mm	Height In mm	No.s	Simulation results
Initial	20	50	2	Hot spot seen in upper part of casting
Modified	30	68	4	No hot spot In casting , hot spots are shifted in feeders.

II. MODIFICATION OF GATING SYSTEM

As discussed in introduction with the initial gating system the casting produced is associated with the defects such as blow holes and micro porosity . hence for achieving the sound casting .The gating system components such as ingates , runner , sprue well , sprue etc are designed using gating design procedure , feeding rules , gating rules , theoretical knowledge , practical considerations and patternmakers experience . Considering all this aspects all gating components are designed and 3D CAD model of each component is made. These gating systems models are used for given casting of pump cover. With the help of Casting simulation software AutoCAST-X Flow plus , Simulation results are obtained . and comparing this various gating design model the best suitable design is selected so that the casting produced is defect free (sound casting) also it should have higher casting yield so that process should be more economical and productivity and profit should be higher.

the table given below gives the detail comparison of initial gating system and modified gating system.

TABLE II

Comparison of Initial and Modified Gating System

Gating system	Initial gating	Modified gating
Choke Area (mm^2)	6361.17	1017.87
Sprue well Shape	Square	Semi-circular
Sprue well Dimensions (mm^3)	140 × 140×52	π ×36 ×36 ×54
Runner bar (mm^3)	490×30×52	470 × 25 × 54
Ingates No.	2	3
Shape of Ingates	Circular	Trapezoidal

Area of Ingates	1963.495	2125

The simulation results using AutoCAST-X flow plus are given below which gives the complete idea regarding mould filling and also results shows the quality of casting

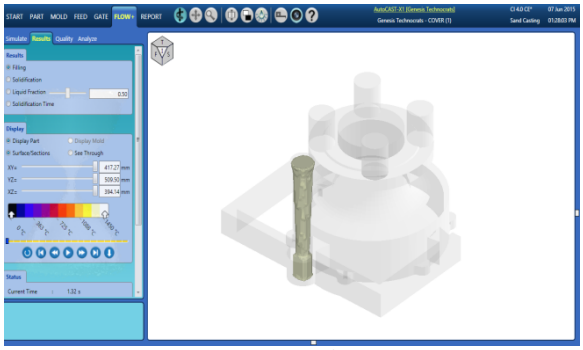

Fig.4.Mould filling at 5%

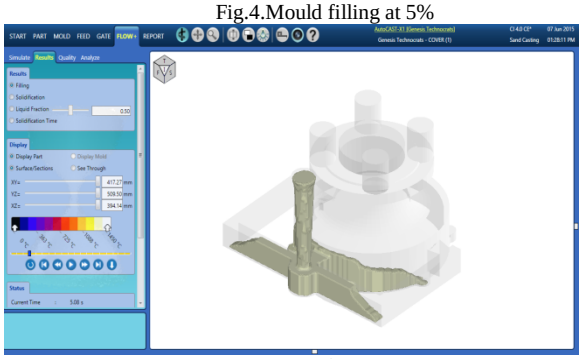

Fig.5. Mould filling at 10%

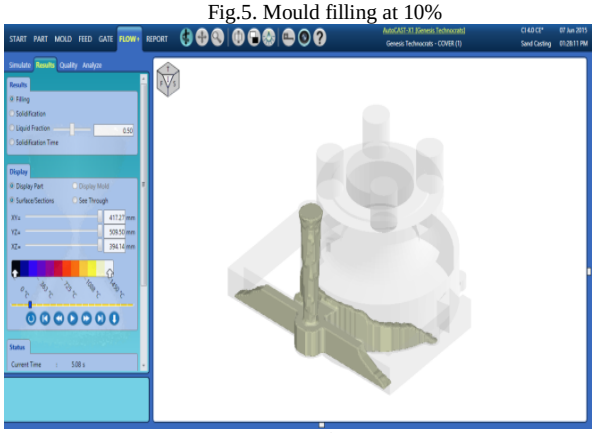

Fig.6. Mould filling at 20%

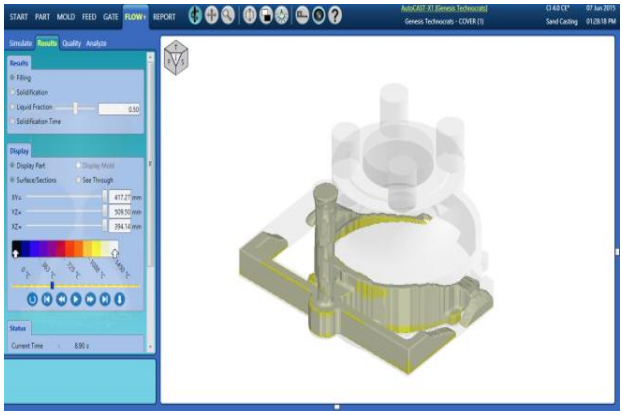

Fig.7. Mould filling at 40%

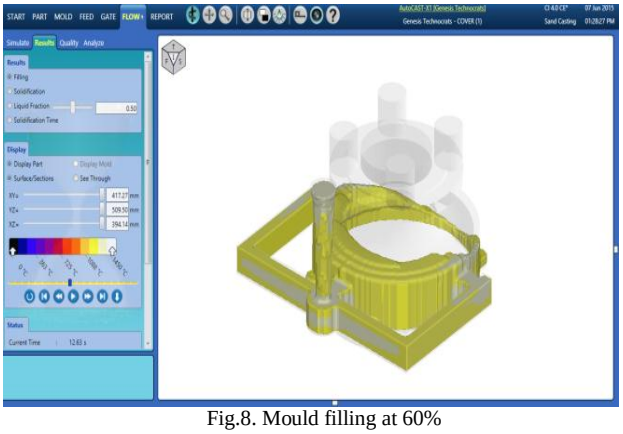

Fig.8. Mould filling at 60%

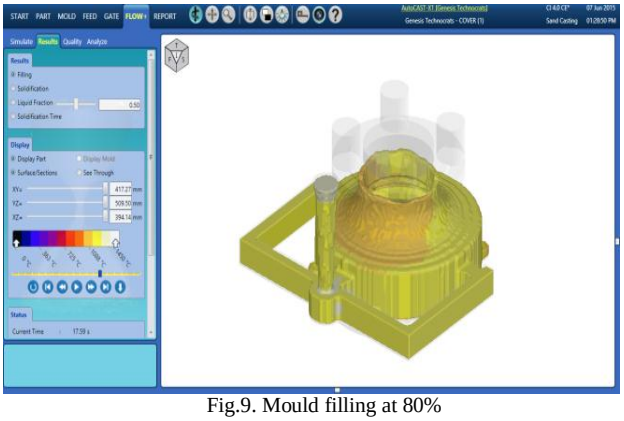

Fig.9. Mould filling at 80%

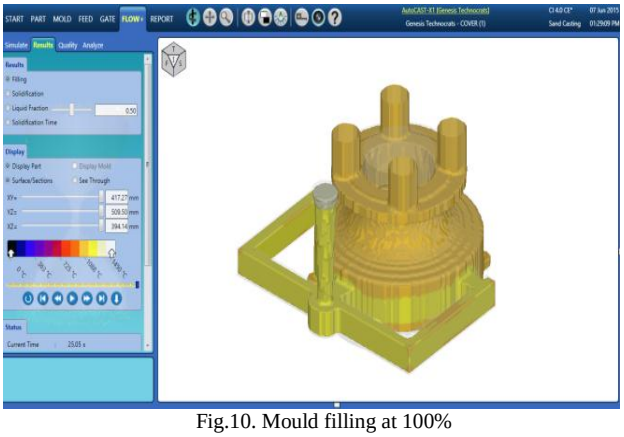

Fig.10. Mould filling at 100%

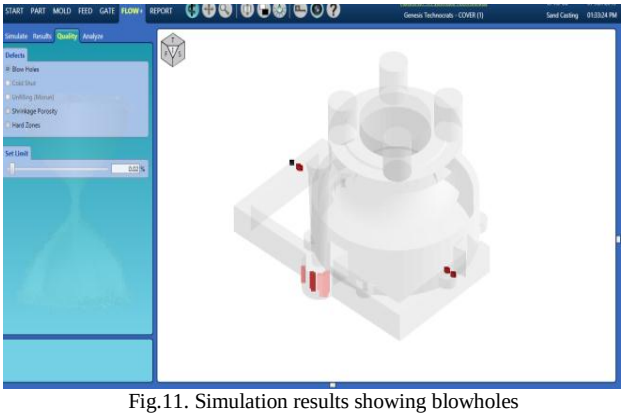

Fig.11. Simulation results showing blowholes

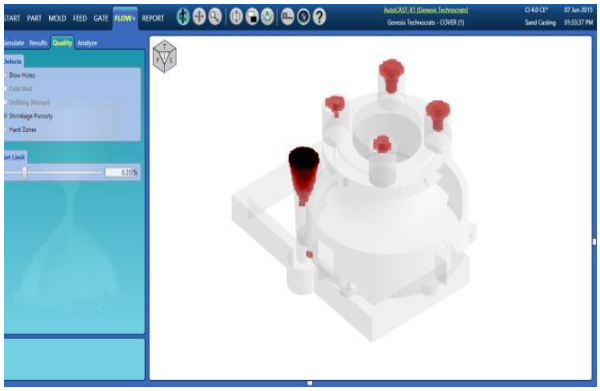

Fig. 12. Simulation results showing microposity

III.. RESULT OF SIMULATION AND EXPERIMENTAL VALIDATATION

From the simulation we get the clear idea about how mould cavity fills from sprue to riser. Also from the result of simulation it is clear that micro porosity is seen but it is occurring in upper part of sprue, which is secondary component of casting and it is cut-off and remelted. Also blow holes are seen into gating components not in actual casting. Hence the casting is defect free and higher yield can be achieved. Hence this gating is used for actual experimentation.

A. Actual experimentation test for yield calculation:

For actual experimentation the initial gating system components and feeders are removed and then pattern is equipped with modified gating system components and feeders. Mould cavity is made and molten metal is poured. And finally after cooling casting is analyzed for defects. After analysis of casting by foundry men casting found defect free casting i.e. sound casting are achieved with comparatively higher yield.

B.Calculation of Improved yield:

Initially liquid metal required is 57.104 kg but after gating modification metal required is 47.847 kg. total saving per casting is 9.257 kg . the table gives detail idea regarding yield of casting

TABLE III
Casting yield comparison of Initial and Modified gating systems

Gating system	Metal Poured (kg)	Weight of casting (kg)	Weight of scrap (kg)	Casting Yield (%)
Initial	57.104	28.980	28.124	50.7
Modified	47.847	28.980	18.867	60.56

IV. CONCLUSION.

It is cleared that from experimental results and casting simulation that modified gating system can be used to get sound casting. initially defects such as micro porosity and blow holes are absent in the casting . yet initially molten metal required is 57.104 kg and when modified gating system is used molten metal required is 47.847 kg . and weight of actual casting is 28.980 kg . hence with the modified gating system the yield improved by 10% that of yield with initial gating system. Due to yield improvement saving of energy and resources required for melting and recycling is also done. As saving of energy is there productivity increases and as productivity increases profit increases.

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