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# Application of 3D Cad Modeling and Casting Simulation to Eliminate Casting Defects.

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***Abstract:*** **As we know foundry industry is main supplier to the various mechanical industries. Human being knows the casting technique from ancient time. From the ancient time there is continues knowledge addition in foundry technology. Still considering present market scenario as well as globalization and liberalization polices , it is big challenge to achieve sound casting with higher casing yield which is important to survive in market.**

**The research is carried out to get sound casting of pump cover which is preliminary associated with the various flow related defects. Defective casting is analyzed to get causes of defects. It is clear that defects are due to the improperly designed feeding system and gating system. hence for complete elimination of these defects gating system and feeding system components are redesigned with the help of theoretical knowledge , feeding rule , past experiences and gating rules. Various designs are made and for each design 3D CAD model of casting with feeding and gating is made as per design and it is simulated using simulation program AutoCAST-X flow plus. From the results of AutoCAST-X respective changes are made in design of feeding system and gating system , the procedure is repeated to get required casting. Finally the best design is selected and validated using actual casting process.**

***Key words*** **: AUTOcast-X, casting, 3D CAD modeling, sound casting.**

## I. 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 increases.

## II. 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 critical task to Indian and Global manufactures. The main objective of a gating system is to lead clean molten metal poured from pouring basin to the casting cavity, which should result into uniform and smooth flow to complete filling of mould so as to get sound casting. . As gating and feeding systems are secondary components of casting hence it should be lean in volume so as it will require less metal and hence result into higher casting yield and ultimately casting process becomes more economical and profitable. To pursue this target, care should t o be taken for designing feeding system and gating system. Improperly designed gating system and feeding system should result into various flow related defects namely blow holes, cold shunt , misrun , porosity , crack , hot tear surface sink etc. hence the properly designed gating system and feeding system are essential to get sound casting as well as higher casting yield.

### *A. 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 Feeders

| Feeding System | Diameter In mm | Height In mm | Nos. | 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. |

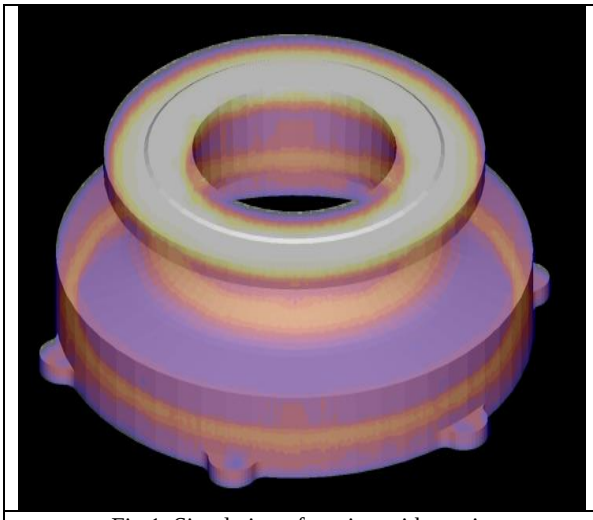

Fig.1. Simulation of casting without riser

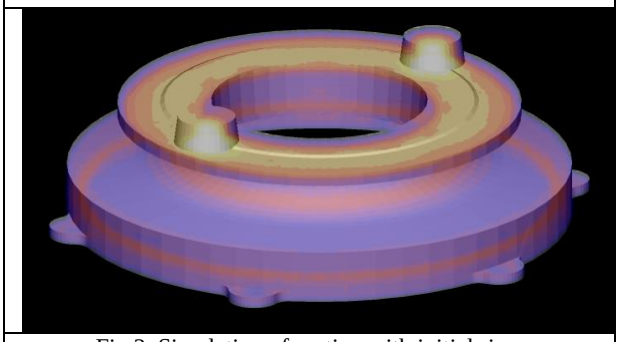

Fig.2. Simulation of casting with initial riser

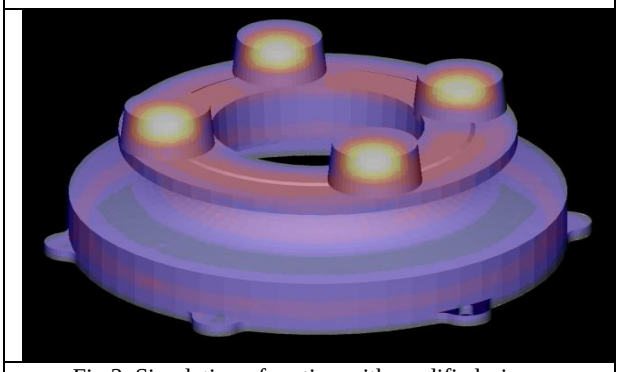

Fig.3. Simulation of casting with modified risers

## III. 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 . This 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

| . 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 |

## IV. EQUIPMENTS

For the research the main requirements are general foundry tools which are essential for casting operation and also the special requirements are as 3D CAD Modeling Software used is Solidworks 2013 and for simulation purpose the casting simulation program AutoCAST-X flow plus is used for simulating the various models of casting

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.

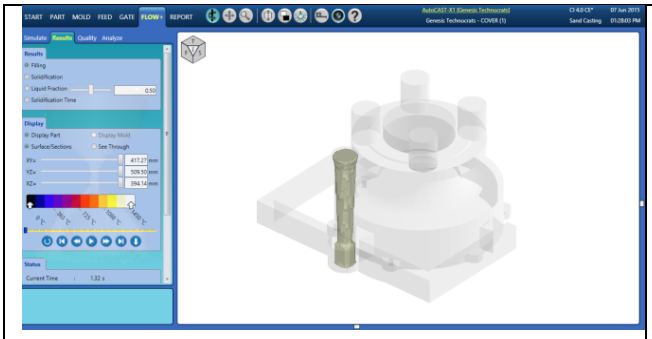

Fig.4.Mould filling at 5%

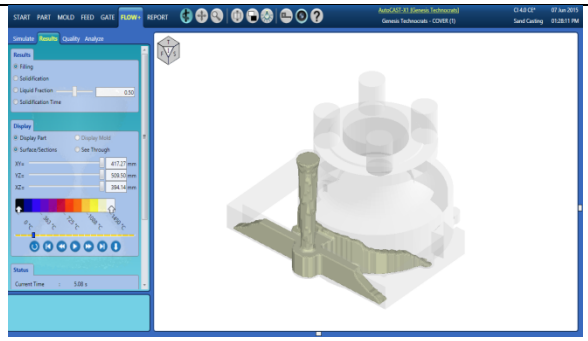

Fig.5. Mould filling at 10%

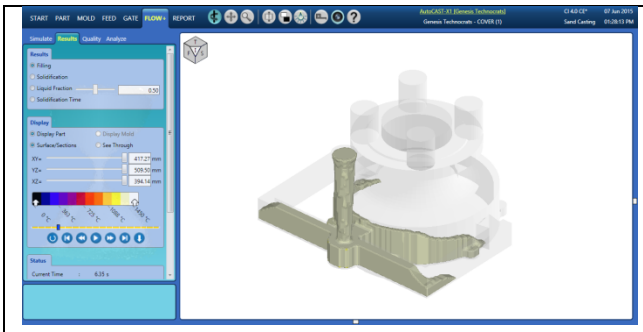

Fig.6. Mould filling at 20%

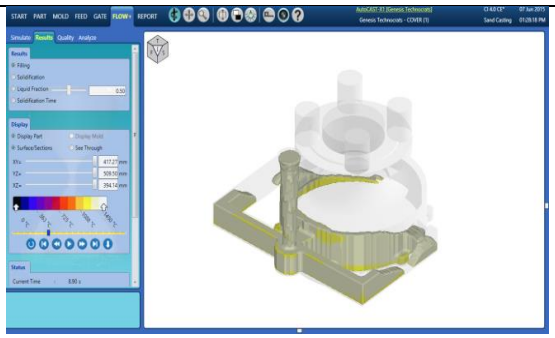

Fig.7. Mould filling at 40%

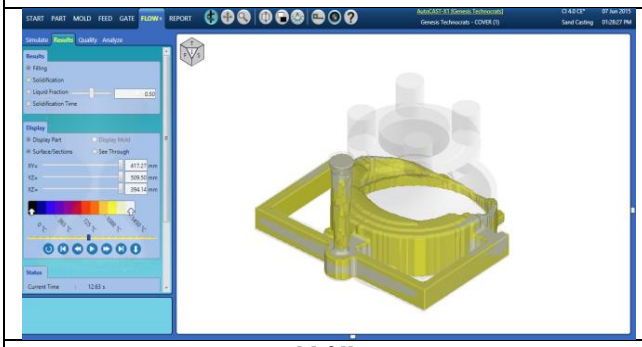

Fig.8. Mould filling at 60%

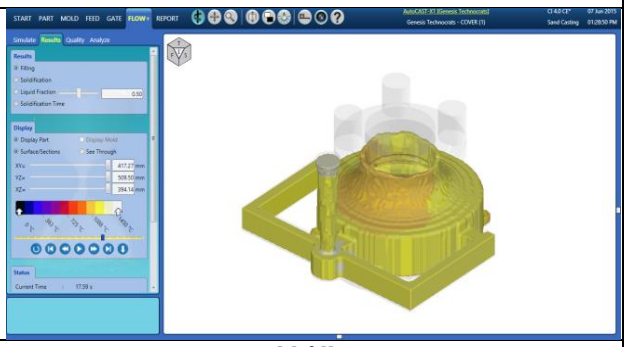

Fig.9. Mould filling at 80%

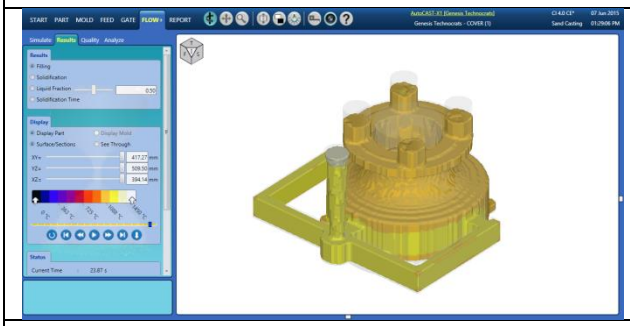

Fig.10. Mould filling at 90%

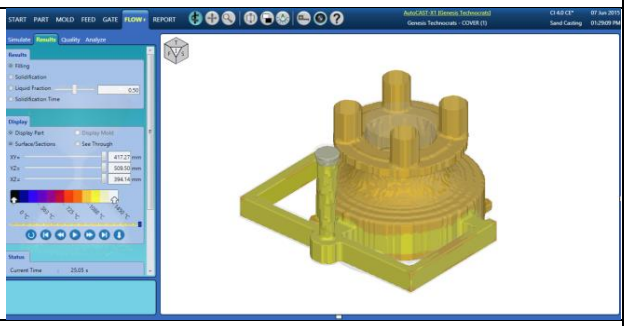

Fig.11. Mould filling at 100%

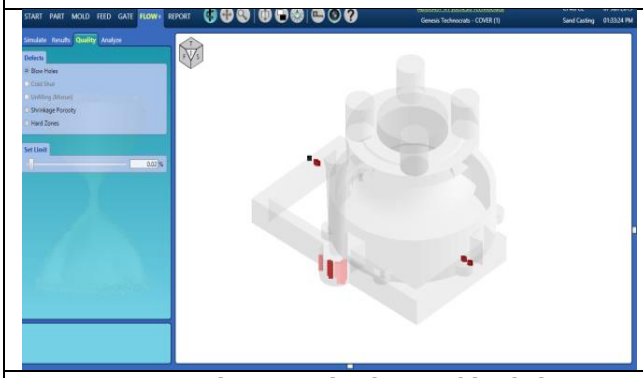

Fig.12. Simulation results showing blowholes

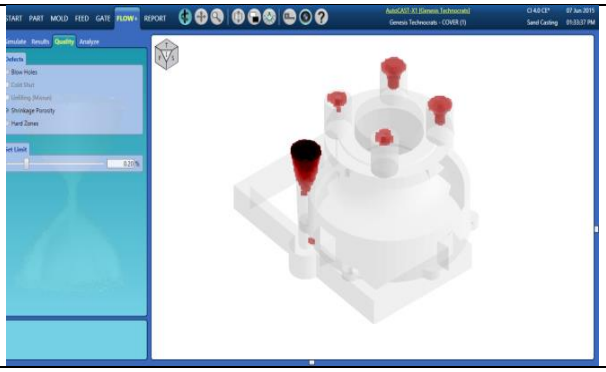

Fig.13. Simulation results showing microporosity

## V. RESULT OF SIMULATION AND EXPERIMENTATION

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.

*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.

*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.

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

## VI. 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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