

Use of Casting Simulation for Yield Improvement

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Abstract – This paper describes the “Use of Casting Simulation for Yield Improvement.” We need to increase the yield of casting without any casting defect. The main purpose of the casting simulation is to increase the yield and to increase the productivity and also to reduce the shop floor trials. Casting simulation techniques are widely used now a days in foundries and metal casting industries. Casting simulation simulates real casting phenomenon and gives virtual casting process as molten metal flow in mould cavity with respect to time and direction. It shows virtual process like mould filling, solidification and cooling and also predicts the location of internal defects like blow holes, shrinkage porosity etc. Casting simulation is used in the production of reliable, economical and high accuracy cast component. Although casting simulation becomes important tool, simulation cannot correct itself existing casting process or design. So for the application of casting simulation experienced and knowledge person is required. Reliability of casting component can be improved with the help of casting simulation software. In this review paper, the casting simulation, its importance, types of casting simulation software, application and case study of yield improvement is described.

Key words: casting simulation, AUTOCast-X, casting, casting yield, defects.

1. INTRODUCTION

Simulation simulates the real casting phenomenon using a computer program. The simulation program is consist of set of mathematical equations. Casting process simulation has become an essential tool in the production of economical and high performance cast component. Its application by experienced and knowledgeable operators leads to reduced casting defects, casting yield improvement, and reduced trial and error iteration in development of a casting's optimization. Increasingly casting simulation is being used as a collaborative tool between component designers and casting producers to reduce lead time, to develop casting friendly component designs, and to produce better castings.

2. NEED OF CASTING SIMULATION

2.1 Reduce shop floor trials: Reduces conventional trial and error methods, gives accurate results and reduce extra costings.

2.2 Quality Improvement: Improvement in quality improves the reliability of casting and reduces the excess cost of defective casting and other resources cost.

2.3 Yield Improvement: With simulation technique, casting process is optimized there will be very lesser wastage thus in results in yield improvement.

2.4 Rapid Development: Simulation of casting is virtual process so there is no scrap material and other wastages. Casting through trials eliminates the wastage of production resources.

3. PRESENT PRACTICES



Fig. No.1: Present theory and practices

MALATI FOUNDERS PVT. LTD. The industry which we approach, produces brake drums of vehicle. By using conventional casting methods, industry get yield of 66.57%.

4. LITERATURE REVIEW

From the paper of Mr. Rajesh Rajkolhe and Mr. J. G. Khan. We studied defects and causes occurs in the casting process. Casting is a process which carries risk of failure occurrence during all the process of accomplishment of the finished product. Hence

necessary action should be taken while manufacturing of cast product so that defect free parts are obtained. [1]

Casting defects can be classified as filling related defect, shape related defect, thermal defect, defect by appearance.

From the paper of Mr. Naveen Hebsur and Mr. Sunil Mangshetty. We studied that, the formation of various casting defects is directly related to fluid flow phenomenon during the mold filling stage and in the cast metal. The rate of solidification greatly affects the mechanical properties such as strength, hardness, machinability etc. [2]

As per the literature review many researchers reported that about 90% of the defects in castings are due to improper design of gating and risering system and only 10% due to manufacturing problems due to handling and storage of molds, improper pouring temperature and time etc. [3]

Lower casting yield and hence less productivity and lower profit and wastage of resources. For achieving higher productivity the casting yield must be higher and casting should be sound. It can be achieved by properly designing the gating system components. [4]

From the paper of Mr. Vishal S. Jadhao we studied the need of casting simulation in today's fast moving world. Simulation simulates the real casting phenomenon using a computer program. The simulation program consist of set of mathematical equations. Casting process simulation has become an invaluable tool in the production of economical and high performance cast components. [5]

5. PART USED FOR SIMULATION

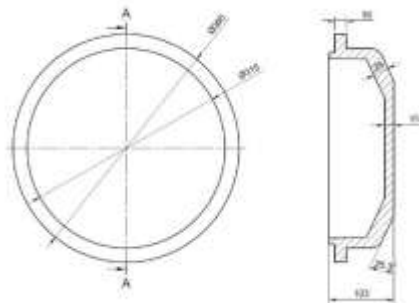


Fig. No.3: Part A

6. CALCULATIONS

For Part A

Maximum wall thickness: 25 mm

$$\begin{aligned} \text{Casting modulus: } & \frac{\text{wall thickness}}{2} \\ & : \frac{2.5}{2} \\ & : 1.25 \end{aligned}$$

$$\begin{aligned} \text{Riser modulus: } & 1.25 * 1.2 \\ & : 1.5 \end{aligned}$$

For Part A we refer KALMINEX chart, we decided to select the following riser dimensions.

Riser size: $\Phi 2.5 * 3''$

Where, $\Phi 2.5$ is the diameter of riser and 3'' is the height of the riser.

$$\begin{aligned} \text{Number of risers: } & \frac{\pi * D}{Dr + 12T} \\ & : \frac{\pi * 337}{64 + 12 * 25} \\ & : \frac{1058}{364} \\ & : 2.90 \\ & : 3 \text{ Nos} \end{aligned}$$

But as we used $\Phi 2.5 * 3''$ riser instead of $\Phi 2 * 3''$. Hence 2 number of risers are used.

7. MODIFICATIONS

7.1. Directional Solidification

Directional solidification means that solidification will start in one part of the mold and gradually move in a desired direction; it means that solidification will not start in some area where molten metal is needed to feed the casting. An effort is always made by the foundry-man to get solidification to progress toward the riser from the point furthest from the riser.

7.2. To avoid the blow holes in the casting we opted directional solidification. For this we use steel chills in the casting to give directional solidification.

7.3. To increase yield of the casting wastage of the material should be minimised.

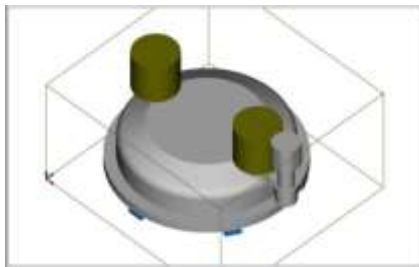


Fig. No.4: Position of risers, feeder and chills for Part A.

Gating system	Metal Poured (Kg)	Weight of casting (Kg)	Casting Yield (%)
Initial	34.2	22.77	66.57
Modified	27.87	22.77	81.68

Table No.2: Yield Table

Gating system	Initial gating	Modified gating
Choke area(mm ²)	6361.17	1017.87
Sprue well shape	Square	Semi-circular
Sprue well dimensions(mm ²)	140x140x52	πx36x36x54
Runner bar(mm ²)	490x30x52	470x25x54
Ingates No.	2	3
Shape of Ingates	Circular	Trapezoidal
Area of Ingates	1963.495	2125

Table No. 1: Dimensions of gating system



Fig.No.5: Solidification Process 1



Fig.No.6: Solidification Process 2



Fig.No.7: Solidification Process 3



Fig.No.8: Solidification Process 4

8. EQUIPMENTS

For 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 in Solidworks and for simulation purpose the casting simulation program AutoCAST-X flow plus is used for simulating the various models of casting.

9. RESULTS

From the simulation we get 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.

10. 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 34.2 kg and when modified gating system is used molten metal required is 27.87 kg. And weight of actual casting is 22.77 kg. Hence with the modified gating system the yield improved by 15.11% that the 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.

11. REFERENCES

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12. BIOGRAPHIES



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