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OPTIMIZATION OF GATING SYSTEM FOR REDUCING DEFECTS IN ELEVATOR PART (WHEEL) USING AUTO-CAST SOFTWARE AND NUMERICAL METHOD

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Abstract - Casting is a manufacturing process of making a complex metal shapes .Manufacturing of sound casting is the main aim for foundry men. To achieve this number of shop floor trial casting has carried out and one repetition can take up a week or more, which affects the regular production. Many researchers reported that about 90% of the defects in castings are due to wrong design of gating & risering system and only 10% due to manufacturing problems. Casting simulation process can able to overcome these problems. It has observed that various type of simulation software has used in foundry, out of which FEM and VEM based casting simulations are widely used in foundry. In the present paper, a Elevator part (wheel) model has considered for study the solidification behavior of green sand casting and detection of hot spots in castings with the help of mentioned above casting simulation softwares. The simulated results also compared with the experimental works.

Key words; Auto-cast, Sand casting, Mold filling, solidification, simulation.

Introduction

Casting, one of the economical manufacturing processes used in industries, is a complicated process, which involves considerable metallurgical and mechanical aspects. The location, size and shape of riser in a casting depend on the geometry of the casting, mold design and thermal properties of metal, old and other process parameters. Casting quality is heavily dependent on the success of gating/riser system design, which currently is conducted mainly relied on technicians' experience. Wrong designed of a elevator part (wheel) was used as the test sand casting to demonstrate the numerical optimization. the three-dimensional cad model of the test casting is shown in fig. 1. it has an x, y & z dimension is 419x419x100. this casting material is cast iron and the weight of elevator part (wheel) of casting model is approximately 56 kg. in existing gating system, side gating system was employed for casting. a pouring basin and tapered sprue were used and metal was introduced into the casting cavity through runner and two necks which were symmetrical to the center line. four feeder was used to feed the casting of the elevator part (wheel). two feeder of same size ie feeder(1-2) height-150, top diameter-80, bottom diameter-100 and feeder(3-4) height-150, top diameter-50, bottom diameter-70. the gating system of housing is controlled by four independent parameters, namely feeder height, neck size, runner bar, runner width, as showed in fig. 1. and the yield of this casting was 68% , feeding yield was 71%system and gating yield was 93%.

FIGURE 1 EXISTING GATING SYSTEM

Figure 2 show the Liquid to solid conversion of Elevator part (wheel). Simulation for mould filling and solidification analysis with existing gating system severe shrinkage porosities at outer side and inner portion of the casting as shown in figure 2

results either defective casting with shrinkage cavity or lower yield, as directional solidification has not achieved. Hence, proper design of risering system and good control over the process parameters are necessary for quality castings. From realistic considerations, the experimental routes are always better for design and development of mold and for arriving at the optimum process parameters. However, it is costly, time consuming, and may be impossible in some cases. Therefore, casting simulation process is a convenient way of proper design of risering system and analyzing the effect of various parameters. The objective of the research presented in this paper is to optimize gating/riser systems based on casting simulation software with the goal of improving casting quality such as reducing incomplete filling area, decreasing large porosity and increasing yield. The first objective is to evaluate cast ability of the casting design. Then runner and risers are presented parametrically. By varying each parameter, all models will be obtained. After analyzing simulation results, the original gating/riser system design will be optimized to improve casting quality. In this paper, Elevator part (wheel) is used to verify the effectiveness of the optimization method.

DESIGN OF EXPERIMENT

Existing Gating system design2.1.

Figure 2 Liquid- Solid conversion of Elevator part (wheel)

In this study, in order to evaluate the sound casting comprehensively, the optimization criteria for the Elevator part (wheel) casting sample were defined as: (1) casting quality, and (2) casting cost. The molten metal filling velocity and casting shrinkage porosity can demonstrate the casting quality; and the casting cost characteristic can be indicated by product yield.

$$\text{Yield= (Volume}_{\text{casting)}}\text{/(volume}_{\text{casting}} + \text{volume}_{\text{feeder}} + \text{volume}_{\text{gating)}}$$

Feeding yield= (Volumecasting)/Volumecasting+VolumefeederPrepare Your Paper Before Styling

In suggested gating system shown in figure 2, side gating system was employed for casting. A pouring basin and tapered sprue were used and metal was introduced into the casting cavity through runner and two neck which were symmetrical to the center line. Two feeder was used to feed the casting of the Diverter wheel. One feeder which is slightly larger than other one and it is know is primary feeder Hight-90, Top Diameter-115, Bottom Diameter-130. And second feeder which is know as secondary feeder Height-90, Top Diameter-83, Bottom Diameter-102 The gating system of Diverter wheel is controlled by four independent parameters, namely feeder height, neck size, runner bar, runner width, as showed in Fig. 1. And the yield of this casting was 77% , feeding yield was 80.13%system and gating yield was 95%.

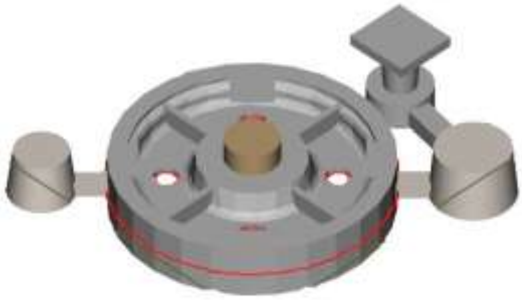

Figure 2 Suggested gating system

3. COMPARISON OF PROPOSED GATING SYSTEM AND EXISTING GATING SYSTEM BY OPTIMIZATION METHODOLOGY

3.1 Numerical Optimization Techniques

This is the main stage in casting simulation, wherein some more critical inputs are required from the user. The first is the correct generation of FEM mesh. The element size must be optimal, and the mesh must cover the entire model without gaps. The second set of inputs involves factors for various boundary conditions, like the interfacial heat transfer coefficients. There are three types of interfaces; metal-mould, mould-environment, and metal-environment (open feeder). The simulation module run depends on the functional module; solidification, solidification+cooling+stress, etc for specific metal process. A separate post-processing module converts the data into colour-coded values for visualization of results.

A)For Existing gating

I)Feeder yield= $(Volume_{casting})/(volume_{casting}+volume_{feeder})$

=(56)/(56+22)

= 0.7179 =**71.79**

ii) Casting yield= $(Volume_{casting})/(Volume_{casting})+(Volume_{feeder})+(Volume_{gating})$

=(56)/(56+22+3.7)

=0.6834 = **68.34%**

iii**)** Gating yield =$(Volume_{casting})/(Volume_{casting})+(Volume_{gating})$

=(56)/(56+3.7)

=0.9380 = **93.80** %

iv) Pouring time = √(weight of casting)+(risering)+(Gating)

= √56+22+3.8 = **9.04 sec**

B)For Suggested Gating system:-

i) Feeder yield= $(Volume_{casting})/(volume_{casting}+volume_{feeder})$

=(56)/(56+13.31)

= 08065 =**80.65**

ii) Casting yield= $(Volume_{casting})/(Volume_{casting})+(Volume_{feeder})+(Volume_{gating})$

=(56)/(56+13.31+2.85)

=0.7744 = **77.44%**

iii**)** Gating yield =$(Volume_{casting})/(Volume_{casting})+(Volume_{gating})$

=(56)/(56+2.85)

=0.9511 = **95.11** %

iv) Pouring time=√(weight of casting)+(risering)+(Gating

=√56+13.14+2.8 = **9.50 sec**

Table 1 Simulation result of Existing gating & proposed gating system

	Existing gating	Proposed gating
Casting yield	68.2%	77.5%
Feeding yield	71.11%	80.9%
Gating yield	93%	95%
Pouring time	4.7 sec	7.8 sec
No of feeder	4	2

Table 2 Numerical result of Existing gating system & proposed gating system

	Existing gating	Proposed gating
Casting yield	68.34%	77.44%
Feeding yield	71.69	77.44%
Gating yield	93.80%	95.11%
Pouring time	9.04sec	9.50sec

CONCLUSION

1. A new method of casting defect analysis is proposed and studied which is a computer aided casting simulation technique (Auto-Cast software) for analysis of rejection of casting due to defects related to sand, molding, methoding, filling and solidification in green sand casting.
2. For analysis of defect like shrinkage porosities computer aided casting simulation technique (Auto-Cast software) is the most efficient and accurate method. The quality and yield of the casting can be efficiently improved by this technique in shortest possible time and without carrying out the actual trials on foundry shop floor.
3. By comparing the simulation result of optimized casting model with that of the original model, it can be concluded that the defects decreased by roughly 20% and the yield increased by about 9%.
4. The application of computer aided methoding, solid modeling, and casting simulation technologies in foundries can able to minimize the bottlenecks and non value added time in casting development.

References

[1] F. Bradley, S. Heinemann, A hydraulics-based optimization methodology for gating design, Applied Mathematical Modeling, 17 (1993)Pg no 406–414.

[2] B.H. Hu, K.K.S. Tong, F.C. Yee, D. Sudheeran, K.T. Tan, Process diagnosis and optimization in pressure die casting, Proceedings of the Third International Conference on Die and Mould Technology, Taipei, Taiwan, Vol. A, 1995, Pg no. 137-142.

[3] K.K.S. Tong, B.H. Hu, F.C. Yee, Industrial application of computer simulation in mould design for pressure die casting, Proceedings of International Conference on Mechanics of Solids and Materials Engineering, Singapore, Vol. A, 1995, Pg no. 235-240

[4] Durgesh joshi Technical Paper Review foundry (March/april 2010)Pg no 27

[5] B Ravi, Metal Casting:Computer aided design and simulation, PHI India, New Delhi, 2005-2008, ISBN 81 203 2726 8.

6] Advanced Reasoning Technologies, Auto cast software user manual and case study. http://www.autocast.co.in, 2009.

[7] B Ravi, "Casting Simulation and Optimization: Benefits, Bottlenecks, and Best Practices, "Indian foundry journal 54(1), jan2008.

[8] Carlos E.Esparza Nemak S,A . de C.V& Martha P.Guerrero-Mata December 2004 in Mexico

[9] L.A Dobrzanski, M. Krupinski, J.H. Sokolowski, A. Wfodarczyk-fligier, Methodology of analysis of casting defects. Journal Achievement in Material & Manufacturing Engg volume 18 issue 1-2 sept-oct 2006 Pg no 267-270.

[10] L.A. Dobrzaski, M. Kowalski, J. Madejski: Methodology of the mechanical properties prediction for the metallurgical products from the engineering steels using the artificial intelligence methods, Journal of Materials Processing Technology, Vol. 164–165, 2005, Pg no. 1500–1509.

[11] N.A.Dukare,Dr.R.M.Metkar etl: Optimization of gating system for reducing the defects in diverter wheel using mold flow software:A Case Study, Internation Journal Engineering Science and Management,Volume 5(2),pp 93