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Reduction of Shrinkage Defect in Valve Body Casting Using Simulation Software

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Abstract

The ability of fluid to assume the shape of its container is exploited by casting process, which involve melting and pouring liquid metal into a mould and allowing it to solidify, solidify piece known as casting. The flow of molten metal in the mould and subsequent solidification affect casting quality. Foundry need to produce components without defect and have good mechanical properties. Casting defect can be predict and remove/minimize by simulation software.

Keywords: Sand casting, Methoding, Shrinkage defect, Simulation..

Introduction

Casting is process of producing metals/alloy component parts of desired shapes by pouring the molten metal/alloy into a prepared mould(of that shape) and then allowing the metal/alloy to cool and solidify. The solidify piece of metal/alloy is known as a casting. The modern casting industries demand a less defect and dimensional accuracy of component. They need to produce components without defect and good properties. In manufacturing casting is the one of the most economical processes. So it is required to produce accurate components.

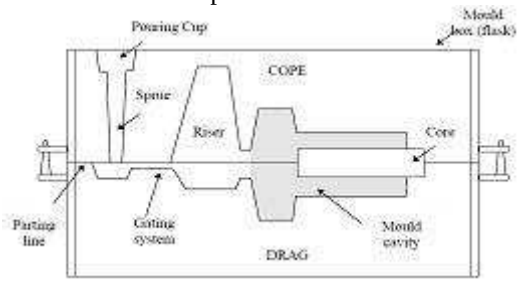

Figure:1 Cross section of typical casting.

Shrinkage Defect in Casting

Casting process have number of complex stages. One of the most important and complex stages of manufacture of casting is the formation of solid casting from or molten metal phase. When poured into mold cavity, The various complex transformation that occurs during the process including physical, chemical, metallurgical and geometric changes which influence on the quality and the cost of the final product of the casting. The casting process is essential solidification of liquid metal in the mold cavity such as a phase change from liquid to solid state, involves the phenomena like changes in fluidity, volumetric shrinkage, segregation evolving of gases absorbed and the size of the grains, which have profound influence on the quality of the final casting. Sand castings are used to manufacture complex shapes. Complex castings are likely to have one or more defect. The presence of defects leads to casting rejections. Shrinkage related defects in shape casting are major cause of casting rejections and rework in the casting industry. Classification of shrinkage porosity in castings by the size of the pores is macro porosity and micro porosity and by the cause for the pores forming shrinkage porosity and gas porosity.

Case Study

In of the foundry, they are producing valve body casting using green sand casting method in which they observed shrinkage defect after completing machining. due to shrinkage defect rejection rate is about 15% which is not acceptable and they wanted to reduce rejection rate by reducing shrinkage defect.

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Figure: 2 Cast and Machining part.

in casting foundry prime requirement is producing defect free casting to achieve this many trails have to be conducted on shop floor which affects the regular production and take more resources. many researcher reported that 90% of the defect in casting are due to wrong methoding and 10% due to manufacturing.
Figure 3 shows the gating system used in foundry to produce valve boy casting. There is a possibility of shrinkage defect to arise due non-uniform solidification.

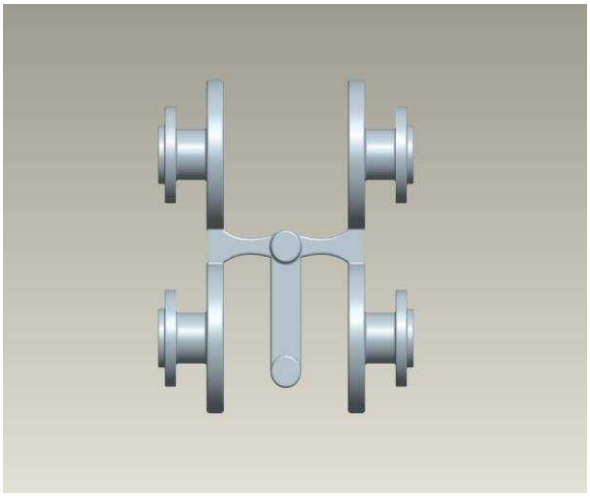

Figure: 3 Gating system used for production.

A little consideration shows that to reduce the shrinkage defect in this valve body casting, some modifications are needed in the design of gating system. there are some proposed designs for reducing the shrinkage defect. one possible solution is location of ingate should be in the back side of the part as shown in figure 4.

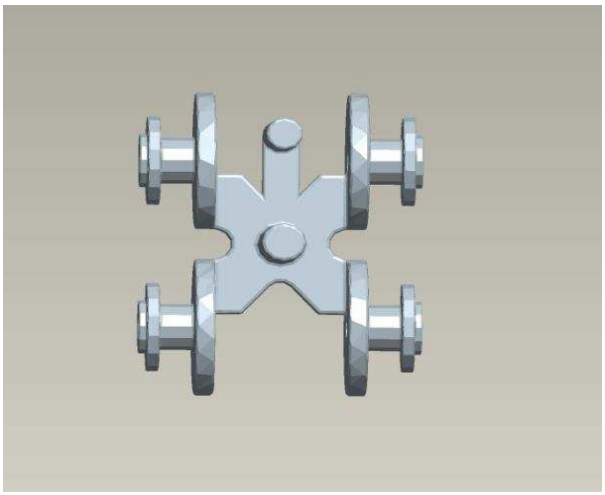

Figure: 4 Modified design of gating system.

Back surface location of ingate is form uniform solidification by this shrinkage shift in gating system. This possible solution will be implemented or not that can be proved by simulation software. Simulation is a tool which can predicts the shrinkage defect without taking any shop floor trail.

Simulation for Gating Design

Simulation software is based on the radically new Vector Method for casting solidification analysis. Unlike the Finite Element Method (volume elements) and the Boundary Element Method (surface elements), it uses vector elements to analyse the progress of solidification inside a 3D casting model. There six basic steps for doing simulation to predict shrinkage defect in casting process.
STEP-1 Converting a .STL file into .SDF format.
STEP-2 File Load (Casting).
STEP-3 Coring effect applied.
STEP-4 Select section for temperature map.
STEP-5 Computation of temperature map and hotspot.
STEP-6 Analysis Results.
The 3d thermal analysis outputs in simulation software are displayed in the form of hotspots and section temperature maps.

A) Hotspot

The most important information generated by a simulation software is the location of the hotspots. Hotspots are the last freezing zones in a casting. Simulation software accurately locates all hotspots in the casting, and displays them in order of their intensity level 1 (low) to level 9 (high) on intensity scale. Figure 6 shows the major hot spot in intensity level 9 which is in cast part. modified gating design shift major hotspot in gating from cast part.

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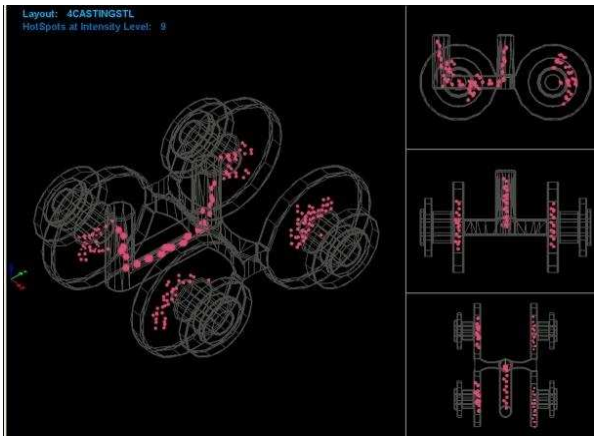

Figure: 6 Major hotspot at intensity level 9 in initial gating design.

B) Temperature map

The temperature maps within the casting, as seen through the section temperature analysis in simulation software. A range of colures is used to depict the relative temperature band.. simulation software enables the user to take sections through the casting, in any of the three orthogonal planes: xy, yz, or zx as shown in figure 7.

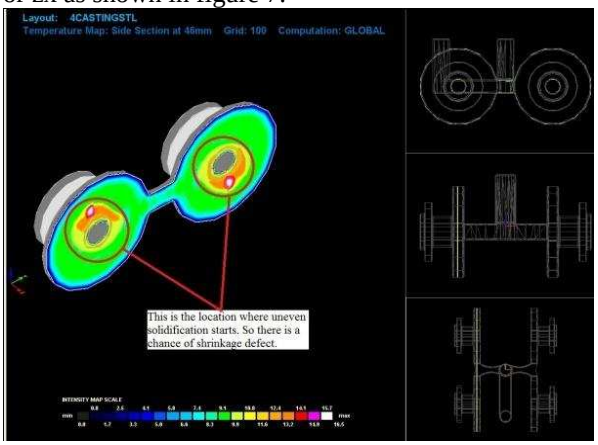

Figure: 7 Temperature map side section at 46 mm in initial gating design

In a foundry, gating design which is used in production is wrong that can be seen in initial design simulation and modified design simulation show that shrinkage defect can be minimized by simulation without number of shop floor trail as shown in figure 8 and 9. Figure 9 shows that there is no major hotspot in cast part. Figure 8 shows temperature analysis in which no hot zone is surrounded by cooler zone.

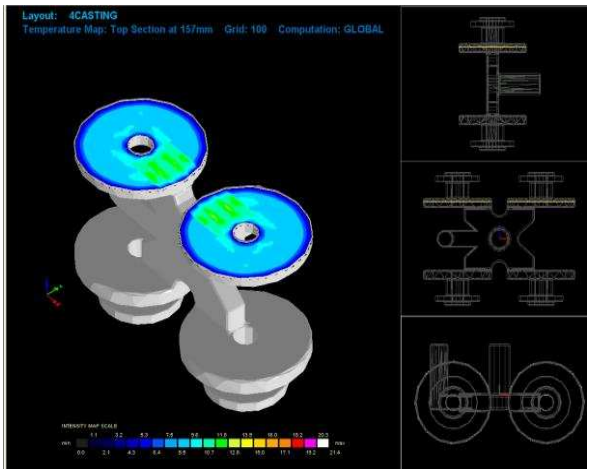

Figure: 8 Temperature map top section at 157 mm in modified design.

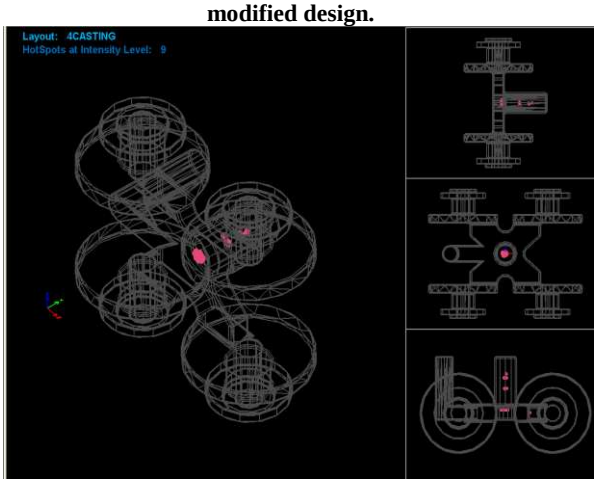

Figure: 9 Major hotspot at intensity level 9 in modified design.

Conclusion

It can be conclude that the simulation software is powerful tool to predict the shrinkage defect in valve body part and it reduces the shop floor trial and uses less resources in terms of money and cost.

Modification in gating design system by changing location of ingate at back surface of part, shift the shrinkage from cast to gating system.

Scope of Future Work

To increase production a newer design can be used. Instead of using four casting, six casting will give an additional benefit to increase production with minimum defect and it can be verify by simulation software.

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References

[1] B.R. *Jadhav "Investigation and analysis of* cold shut casting Defect and defect reduction *by using 7 quality Control tools",* International Journal of Advanced Engineering Research and Studies, pp.1 to 3, 2013

[2] *Uday A. Dabad, "Casting Defect Analysis* using Design of Experiments (DoE) and Computer Aided Casting Simulation *Technique", Elsevier B.V. , pp. 1 to 4, 2013.*

[3] *B. Ravi, "Casting Simulation and* Optimization: Benefits, Bottlenecks, and Best *Practices." , Indian Foundry Journal, pp. 1* to 8, 2008

[4] B Ravi *and Durgesh Joshi, "Feedability* Analysis and Optimisation Driven by Casting *Simulation", Indian Foundry Journal, pp.1* to 14, 2007.

[5] B. Ravi, R.C. Creese and D. Ramesh, *"Design for Casting* - A New Paradigm for *Preventing Potential Problems."* , Transactions of the American Foundry Society, 107, pp. 1 to 11, 1999.

[6] P. Prabhakara Rao , G. Chakraverthi, A.C.S. *Kumar, B. Balakrishna, " Application of* Casting Simulation for Sand Casting of a *Crusher Plate.", International Journal of* Thermal Technologies, Vol.1, No.1, pp. 107 to 113, 2011

[7] *Rabindra Behera, Kayal.S., Sutradhar.G.,"* Solidification behavior and detection of Hotspots in Aluminium Alloy castings: Computer Aided Analysis and experimental *validation.", International journal of applied* engineering research, Vol. 1, No 4, pp. 715 to 726, 2011

[8] *B. Ravi, "Casting simulation-best practices."* , Transactions of 58th of IFC, pp. 10 to 29, 2010