International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

Yield Improvement and Minimization of Sand Inclusion Defect in Steel Casting

R.Arjunraj[1]; A.Gokulkumar[2]; M.Rajkumar[3]; S.Ravirahul[4]& P.Venkatesh[5]

[1]Assistant Professor, [2,3,4,5] UG Scholars, Department of Mechanical Engineering,
Nandha Engineering College, Erode, Tamilnadu, India-638052.
arjunukl@yahoo.co.in

Abstract

Yield plays a prominent role as most of the metal casting is wasted during pouring process. This also includes conduction, convection and radiation heat losses from the furnace, stack loss (flue gas), and metal loss. This could be reduced by changing the runner, riser of the mould cavity. Most of the rejection occurred in major foundry is because of the sand inclusion defects, which need to be concentrated to improve quality and reduce rework time. This could be increased by doing detailed review on the design and implementation in the pattern and the runner, riser design. Rearranging the length of the runner and riser we could drastically increase the yield. In runner implementing one chock which helps to collect the sand impurities separately.

Keywords:
Sand inclusion, Runner, Gating system, Riser.

1. Introduction

The Sand Casting (Green Sand) moulding process utilizes a cope (top half) and drag (bottom half) flask set-up. The mould consists of sand (usually silica), yellow sand and oil (Sodium + vanaja oil). When oil is added, it develops bonding characteristics of the yellow sand which binds the sand grains together. And, when applying pressure to the mould material, it can be compacted around a pattern which is either made of metal or wood, to produce a mould having sufficient rigidity to enable metal to be poured into it to produce a casting. The process also uses coring to create cavities inside the casting. After the molten metal is poured and subsequently cooled, the core is removed.

The material costs for the process are low and the sand casting process is exceptionally flexible. A number of metals can be used for castings in sizes from ounces to many thousand pounds. The mould material is reclaimable, with between 90 and 95% of the sand being recycled, although new sand and additions are required to make up for the discarded loss. These features, combined with the relative ease of mould production, have ensured that the green sand moulding process has remained as the principal method by which castings are produced. V.Gopinath [1] employed a plate casting of dimension 240x150x25 mm with the combination of different riser dimensions. Cylindrical riser of hemispherical bottom with H/D=1 were taken for his analysis. Solidification simulation was made with ANSYS software, then the solidification time and optimal riser diameters were compared with experimental results.

Manjunath Swamy H M [2] optimized the gating and risering system by using casting simulation software ADSTEFAN. Through several simulation iterations, it was concluded that defect free casting could be obtained by modifying the initial gating ratio 2:2:1 to 2:1.76:1, by shifting the location of sprue from centre to end and by providing the risers at location prone to formation of shrinkage porosity which led to the decrease in size of the shrinkage porosity about 97%.

M. Masoumi [3] experimented a direct observation method in which he showed various flow patterns resulting from different gating designs and they were recorded by a video camera and further analyzed by a computerized system. The experimental results indicated that the geometry and size of the gate and the ratio of the gating system could have a great influence on the pattern of mould filling.

Naveenkumar [4] developed a simulation tool and its application to a pump casing that was

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

manufactured by using a sand casting route. A simulation software called ADDSTEFEN was used to design optimization of riser system by fluid flow and solidification for pump housing through several simulation iteration, it was concluded that defect free casting could be obtained by modifying the initial riser system i.e.by location of riser from outer circumference to inner side which is prone to formation of shrinkage porosity and lead to elimination of shrinkage porosity.

P.Prabhakara Rao [5] discussed a newly developed simulation tool and its application to a crusher component that was prototyped via sand casting route. Results of casting trials showed a high level of confidence in the simulation tool known as ProCAST. ProCAST is a three dimensional solidification and fluid flow package developed to perform numerical simulation of molten metal flow and solidification phenomena in various casting processes, primarily die casting (gravity, low pressure and high pressure die casting) and sand casting.

Vipul M Vasava [6] investigated and described in his paper about the porosity formation in the casting component of Housing. He felt that in the current environment, many casters still use the trial and error approach for process development. The capability to produce sound casting component of high quality and at the same time, reducing product costs & development times is the most challenging job for the foundry today. By his simulation, he observed that porosity can be reduced by changing appropriate gating system, riser design and modification.

2. Problem formulation

Sand inclusion is one of the most frequent causes of casting rejection. It is often difficult to diagnose, as these defects generally occur at widely varying positions and are therefore very difficult to attribute to a local cause. Areas of sand are often torn away by the metal stream and then float to the surface of the casting because they cannot be wetted by the molten metal. Sand inclusions frequently appear in association with CO blowholes and slag particles Sand inclusions can also be trapped under the casting surface in combination with metal oxides and s machining. If a loose section of sand is washed away from one part of the mould, metallic protuberances will occur here and have to be removed. With bentonite-bonded moulds, sand inclusions can be caused by cod and edge disintegration, sand crust formation or erosion. The latter results in the inclusion of individual sand grains. Sand crust inclusions and individual sand grains can also be detached from resin bonded moulds, and are then included in the casting.

Figure 1 Sand inclusion in valve casting

To understand this concept, data for occurrence of defects are collected from our company.

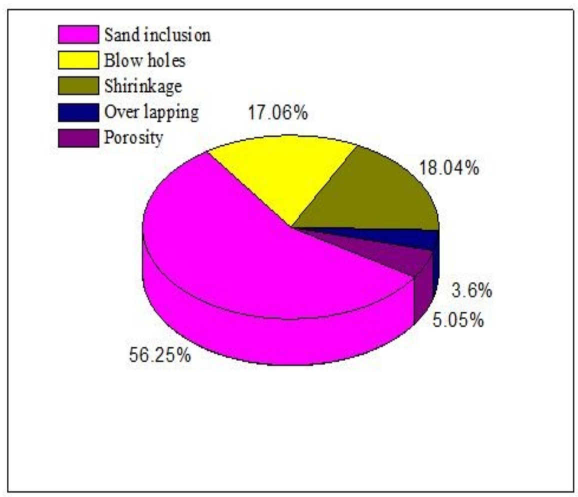

Figure 2 Possible contribution of defects in valve castings

From this data, chart has been prepared which further helps to identify occurrence major defects in castings. These data further help to prepare the chart for occurrence of defect. The details are shown in table below:

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

Table 1Different defects quantity in castings

Defects	Rejected Qty	Defects	Rejected Qty
Sand	205	Sub. Contract	10
Crush	188	Fettling Fault	10
Knock Crack	165	Run out	7
Blowhole	123	Hard	7
Bad Mould	42	Slurry	4
Scab	40	Low Hardness	3
Crack	32	Core Scab	1
Shrinkage	31	Swell	1
Cores	16	Sink	1
Mismatch	13	**Total Quantity**	**855**

3. Methodology

3.1 Design of choke

An ideal optimum Choke system should:

- Fill the mould quickly.
- Fill the mould with a minimum of turbulence.
- Establish thermal gradients, which promote soundness.
- Avoid re-oxidation of metal in the gating system.
- Remove slag and dross from the metal as it flows through the gating system.
- Not distort the casting during solidification.
- Maximize casting yield.
- Be economical to remove.
- Be compatible with the pouring system used.

Table 2 Summary of Choke System Design Parameters

Parameter	Values
Casting Weight	As per size of mould
Density of molten metal	AL-2500 kg/m^3
Density of molten metal	CO-7000 kg/m^3
Sprue type	Circular cross section
Pouring Time	2-6 seconds
Gating Ratio	1.2 : 1.1 : 1
Sprue Area	2500 mm²
Casting weight	5 kg
Height of Sprue	20 cm
Area of Sprue	2.5 cm^2

3.2 Existing Method

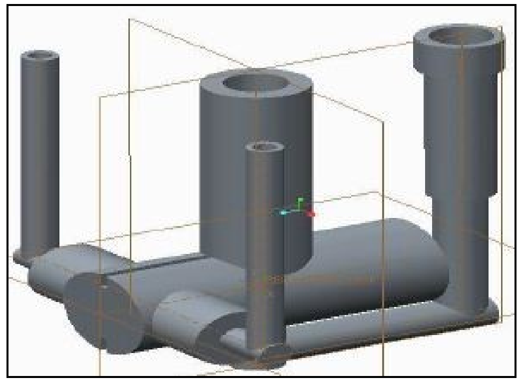

Figure 3 Existing model

3.3 Gating system

In the previous case, possibility of sand inclusions in the final casting was more as the molten metal used to directly hit the core and there was also a chance of sand wash due to flow of molten metal. In the suggested modification molten metal does not hit the core directly.

In the present system molten metal is poured directly to the mould through gate which causes ultimate damage to the sand and at the same time it may be broken. In order to avoid this new sprue is provided which will act as a storage tank for molten metal and smooth flow to the mould is assured.

After incorporating the suggestions it was observed that the rejection rate was reduced. It was noticed that the rejection rate falls within the accepted limit. It is shown in the bar chart (Rejection in Valve Casting).

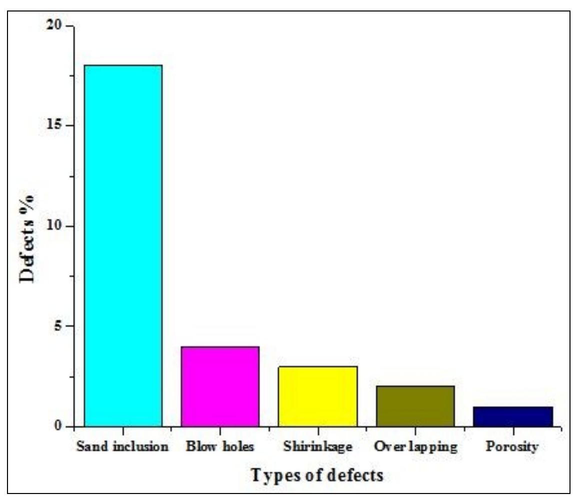

Figure 4 Defects in existing system

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

3.4 Proposed Method

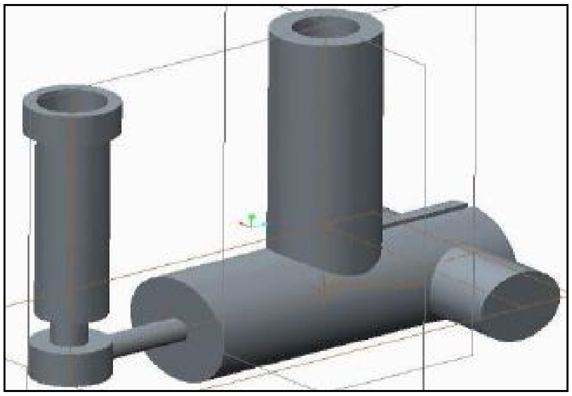

Figure 5 Proposed model

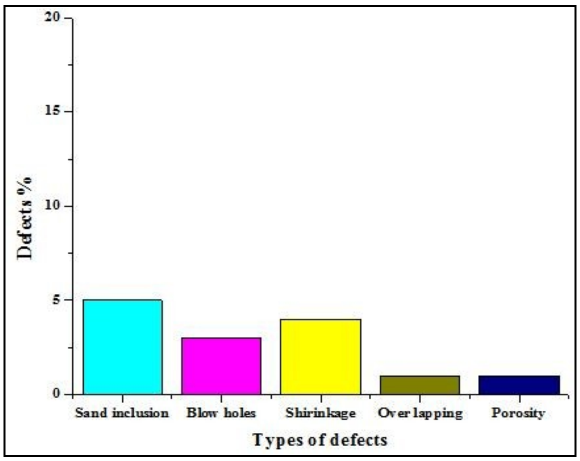

Figure 6 Defects in proposed system

The percentage of rejection in the existing system is 20%. After the suggestion the percentage of rejection has come down to 10%. Before the suggestion the percentage of rejection has come down. Thus there is a savings of 10 %.

Table 3 Comparison for existing and suggested system

Particulars	Existing system	Suggested system
Strength	45 kg/mm^2	55 kg/mm^2
Permeability	120	150
Binding property	Less	More
Cost	More	Less

3.5 Advantages in implemented model

Choke are tapered to a smaller size will create a choke that will help to keep the metal to fill in it.

This constriction decreases turbulence and prevents bubbles from entering the mould. The bottom of the choke should be flat which help to collect the sand particles. The percentage of rejection in the existing system is 20%.

After the suggestion the percentage of rejection has come down to 10%.Thus there is a savings of 10% Comparison of existing and suggested gating system. Direct flow of liquid into the mould that gives better results due to least atmospheric contact and self curing of mixed liquid. Increasing yield up to 10%.

Improved the grade level of sand inclusion, crack, blow holes, shrinkage. Pouring time and cost can be reduced. High refractoriness and Withstands high temperatures up to 1450°C. No attrition during metal pouring eliminating refractory contamination.

4. Results and discussions

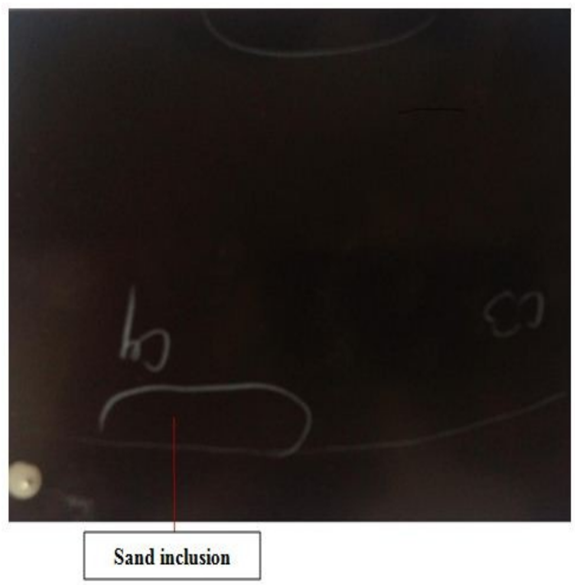

Figure 7 Sand inclusion occur (existing model)

Figure 8 No sand inclusion (proposed model)

5. Summary

The sand inclusion defects have been regarded as relatively unavoidable defect in mould product that leads to rejection of product in foundry. It needs to rework the product and it affects the quality of product; the manpower needed to repair them, as well as the machining margins. A choke area in gating system is implemented and reduced the sand inclusion by20% in mould product. Thus improved the quality of product in the foundry and the number of products reworked is reduced by this method. Metal being poured per unit quantity is reduced from 2000 kgs to 1850 kgs, which works out 10% of metal reduction.

References

[1] V.Gopinath, N.Balanarasimman, "Effect of Solidification Parameters on the Feeding Efficiency of LM-6 Aluminium Alloy Casting", IOSR Journal of Mechanical and Civil Engineering , Volume 4, 2012, pp. 32-38.

[2] Manjunath Swamy H.M, J.R.Nataraj, C.S.Prasad, "Design Optimization of Gating System by Fluid Flow and Solidification Simulation for Front Axle Housing", International Journal of Engineering Research and Development, volume 4, 2012, pp.83-88.

[3] M. Masoumi, H. Hu, "Effect of Gating Design on Mould Filling", Transactions of the American Foundry Society, Volume 113, 2005, pp.185-196.

[4] Naveenkumar, Bharat.S.Kodli, "Design Optimization of Gating System by Fluid Flow and Solidification Simulation for Pump Casing by Sand Casting", International Journal of Research in Engineering & Advanced Technology, Volume 2, 2014.

[5] 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, Volume 1, 2011.

[6] Vipul.M.Vasava, Prof.D.R.Joshi, "Identification of Casting Defects by Computer Simulation-A Review", IJERTTV, Volume 21, 2013.