Reducing Porosity for Alloy Steel Casting

Jeet Desai
B.E.-G.H.Patel College of Engineering and Technology (Affiliated to GTU)

Vinit Parikh
B.E.-G.H.Patel College of Engineering and Technology (Affiliated to GTU)

Tejas Shah
B.E.-G.H.Patel College of Engineering and Technology (Affiliated to GTU)

Abstract

Metal casters try to produce perfect castings, however only few castings are completely free of defects. Modern foundries have sophisticated inspection equipment that can detect even small differences in size and variety of external and internal defects. Defects occur mainly due to human error due to environmental conditions or due to porosity in castings.

Among this, ***Porosity*** *may be the most persistent and common complaint of casting users. Forgings, machined parts and fabrications are able to avoid porosity with ingot cast feedstock, mechanical processing and automated inspection of simple shapes. Porosity in castings contributes directly to customer concerns about reliability and quality. Controlling porosity depends on understanding its sources and causes. Significant improvements in product quality, component performance, and design reliability can be achieved if porosity in castings can be controlled or eliminated.*

Porosity in castings is due to bubbles being trapped during solidification. Porosity sources include entrapped air during filling, centerline shrinkage that occurs during the final solidification, blowholes from unvented cores, reactions at the mould wall, dissolved gases from melting and dross or slag containing gas porosity.

This paper is an effort to articulate a framework for understanding and controlling porosity in castings.

1. Introduction

Shree Vallabh Alloy Steel Castings is a small scale industry established in year 1993 is certified by ISO 9001-2000. The organization is a small scale industry and is a job foundry. It makes alloy steel casting of various grades as per the client's requirement. Also they have developed their own method study cards. They produce the alloy steel castings weighing from 0.5 kg to 200 kg. of different materials like SS 304, SS 316, SS 316L, Carbon Steel products, that they make, are Couplings, Brake Drums, Rings, Hub, Bearing

Housing, Excel Box, etc. Most of these products are prone to have defects due to porosity.

It has been understood that **Porosity** plays an important role in castings. As casting involves gases, there are chances of defects due to porosity increases. Porosity seems to be a bigger problem when the humidity in surrounding environment (like one in monsoon) is more, or when metal is poured at very high temperature. It accounts almost **60 to 70 % defects** in monsoon season. Not only in monsoon, but even in normal environment with such unfavourable conditions, it creates trouble for casters. So, it is great to work on porosity to obtain such favourable conditions in order to get defects free castings.

However, one should also understand that one can never get rid of gases completely as different gases involve through various ways during casting . One can only get the optimum favourable conditions in order to reduce porosity. But of course, efforts has to be made for analysing the causes of porosity and also for reducing porosity in castings to bring the defect ratio as low as possible , which in turn decreases defect costs and increases Profit of company. Thus, in longer run of company, this analysis may be helpful in quality improvement.

2. Problem Statement and Synopsis

In Shree Vallabh Alloy Steel Casting we found that "POROSITY" is a biggest problem in casting industries. It is the formation of bubbles within the casting after cast product has been solidified. So we find the solution to minimize the porosity. So Reduction of Porosity in Alloy Steel Casting is the main aim.

3. Methods to Reduce Porosity

a) Ventilation

Initially we thought that due to humid problem gas in the mould is not able to release itself from mould, so by decreasing the humid atmosphere around mould, the porosity would decrease and the problem would be solved.

To decrease the humid temperature in the monsoon season, we provided ventilation through providing fans around mould, so ventilation increases. Keeping mould near fans increase the ventilation and humid weather decrease.

This method did not help in reducing the porosity. The rejection rate was still the same instead it increases the cost of power consumption.

b) Varying the curing time

Another method was to increase the curing time of the mould. The standard time that company was using was 8hours. So, company decided to increase the curing time. They made and tested with different types of curing time.

They used curing time like 12hours, 16hours, 20 hours and 24 hours. They started doing production alternative day so; mould can cure thorough out day.

Also, with increase in curing time, they provided ventilation through fans around mould to decrease the

humid atmosphere. So by combining them both general steps they try to reduce the porosity.

This method did not help also and the rejection rate was still the same. Their production rate was decreased and the power cost increased due to ventilation through fans. So, profit was lost and the burden on company was increased.

c) Varying the content of Resin in Sand

We found that resin content is higher than the standard resin content in sand. So, varying the resin content might help in reducing the porosity. Following samples were made and tested with different curing time to check the samples with varied resin content.

- Standard sample with 8hrs curing
- Standard sample with 12hrs curing
- Standard sample with 16hrs curing
- Standard sample with 24hrs curing

Table 1 Analysis For Varying Curing Time

Curing time	Effect of porosity (subjective)
8 hours	Very High
12 hours	High
20 hours	Moderate
24 hours	Low

We reduced the resin content to half of its original content in sand. Next we took samples with 1.5%-2% and performed the steps again.

Results were improved but still not sufficient
The amount of resin content is optimal here, so further changing the resin content might make it weak, hence we decided to keep resin content to 1.5%-2% in the sand.

d) Varying the content of Clay in Sand

The sand with 1-.5%-2% resin content and no clay content is called wash sand. Hence, using wash sand results in the solution of porosity. The solution for the reducing the porosity is the using wash sand available in market with 1.5%-2% resin content and no clay content in sand with original curing time 6-8hrs. The following table shows the comparison between the normal sand and with **wash sand**.

Table2: Contents of Normal Sand and Wash Sand

Normal Sand	Wash Sand
Resin: 3-4%	Resin: 2.15%
Clay: 1 to 1.5%	No use of clay
Humidity: 94%	Humidity: 64%
NO USE OF DEOXIDIZER	Deoxidizer: Si- 0.2%
	Zr - 0.9%

4. Conclusion

Initially, company was facing almost 40% rejection due to porosity. But, by varying clay content and resin content we reduce the porosity by more than 60%, and rejection rate is down to almost 2-5% as mentioned by industrial guide after production, which are satisfactory results and normal rejection rate. Also, company starts delivering to their customer on time which is essential to stay in business. It saves labour and power cost along with material. This makes sure that by implementation, u will be going to save some man hours and material.

Again, it is a hard to completely remove gases from any casting process, one can only think about reducing the **proportion** of gases in it. Thus, this could be the **drawback** of this project that even though performing

hard, we didn't get 0**% porosity** in alloy steel castings, but that can be reason of human error as mentioned by Industrial guide.

We conclude that using Wash sand instead of Normal sand reduces porosity to almost 60% giving the rejection rate to almost 2-5% which is normal rejection rate for castings and which can be reason for human error.

5. References

[1] *www.vallabhsteels.net*

[2] R. Monroe, "Porosity in Castings", Steel Founders' Society of America, Crystal Lake, Illinois.

.