

## Identification of Defects during Sand Casting Process and Their Preventive Methods

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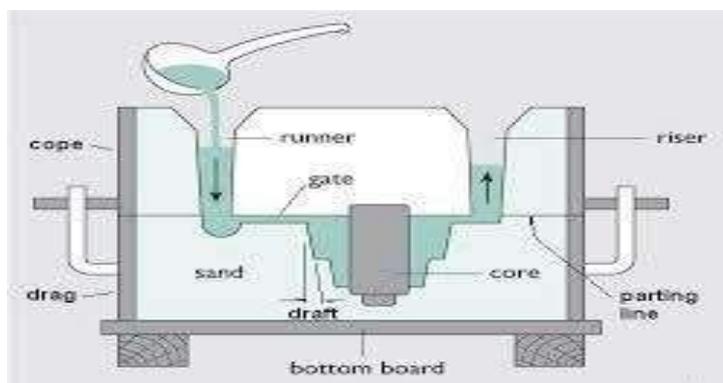
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**ABSTRACT:** Casting is a very versatile process and capable of being used in foundries for mass production. Nowadays, foundries play a major job in manufacturing industries as they are an essential source of castings. The ultimate goal of the manufacturing industry is to produce defect-free castings with minimum manufacturing prices. A defect in the casting is an undesired imperfection in a metal casting process. Several variables involved in the process are contributing to the defects. Few defects can be endured while others can be repaired, or else they can be wiped out with proper molding practice. These defects arise due to a few steps in the production cycle that do not get properly controlled. Deficient casting affects the quality of the sand casting enterprise. The demanding situations of casting defects are to be identified and minimized for powerful castings. The quality of the foundry industry can be extended with the aid of minimizing the casting defects throughout production. The main goal of this study is to identify the crucial casting defects and analyzing the preventive methods to minimize the defects. In this study, efforts are made to gain technically possible treatments for reducing numerous casting defects and enhancing the quality of castings.

**KEYWORDS:** casting defects, defect analysis, foundry, preventive methods, and quality.

### I. INTRODUCTION

Casting is a term utilized mostly by metallurgists and foundries. It covers a wide range of material properties and behavior, which together depict the ability of a metal to be successfully conveyed into a mold and to form a dimensionally accurate casting of acceptable soundness and integrity. Sand casting is one of the former manufacturing processes which uses sand as a refractory material to enhance productivity and satisfactory of castings. This method is appropriate for casting any steel or alloy regardless of any form, shape of the casting. A huge number of metal components in designs we utilize every day are manufactured by castings. The casting process is most widely used in the automotive, aerospace and toys industry to manufacture various parts. Now day's foundries can't survive unless they produce new products or existing ones with better quality and lowest cost.



Casting defect:

Generally casting defect is described as an observable and unplanned version of the specification. A lot of defects occur during the process of casting. Defect diagnosis is a very important task for metal casters. The most challenging phenomenon in front of manufacturers is identifying the root cause of defects in casting rejection and taking the necessary steps to reduce defects.

**CONTRIBUTION FACTORS FOR CASTING DEFECTS:**

1. Improper pattern equipment
2. Inaccurate molding box
3. Improper melting and pouring practice,
4. unskilled labor
5. Inefficient gating system
6. Improper molding and core practice
7. Insufficient melting temperature and pouring rate.
8. Inexpert post melting treatments like shakeout, fettling, etc.

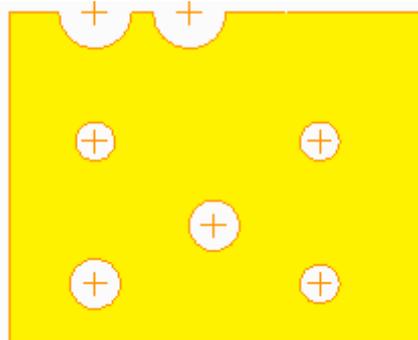
Based on various parameters the defects in the castings can be categorized into 6 types. Those are

1. Defects caused due to the evolution of gases
2. Defects caused due to pouring of the melt
3. Defects caused due to metallurgical factors
4. Defects caused due to molding material
5. Defects caused due to other factors
6. Defects caused due to shrinkage

Defects caused due to the evolution of gases: It means gases used to occur from various sources. Some of the defects falling in this category are blowholes, pinholes, open hole, blister. Gas trapping during solidification of the metal creates holes in the casting.

Blowhole:

During metal solidification gases trapped on the casting surface creates a round or oval cavity is called



blowhole. These defects will present always inside of the cast. Generally, these are larger than pinholes

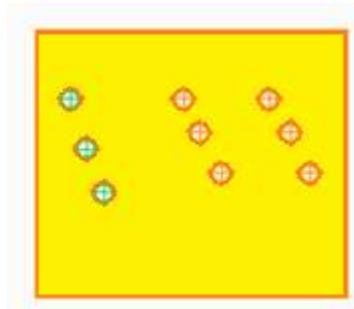
Causes:

1. Excessive moisture content present in the sand
2. The low permeability of the sand
3. Excessively fine grains of sand
4. Sand that is too rough or rammed

Prevention:

The sand moisture content must be managed and maintained at the desired level. Use of high permeability sand

The appropriate grain size of sand should be used. Pinholes:

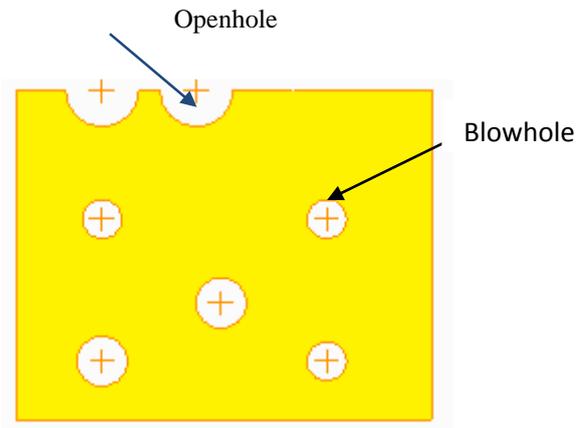


These are very tiny holes about 2mm and usually appear on the top portion of the mold. Typically they appear together in large numbers either on the surface or just below the casting surface. There is no need for any equipment to identify the pinholes because they are always visible

Causes:

1. utilization of high dampness content sand
  2. absorption of hydrogen or carbon monoxide gas by the molten metal
- Prevention:
1. usage of good melting practices
  2. Controlling the dampness content in the sand.

Open holes:



These holes appear on the surface of the cast and they are very easy to detect compared to blowholes

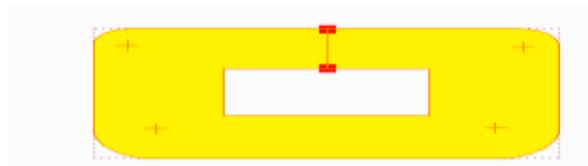
- Causes:
1. Inadequate drying of molds and cores
  2. Low venting of molds and cores

Prevention:

1. Before usage only dry out the molds and cores

Defects caused due to improper pouring of the melt: these defects will occur due to improper flow of the molten metal. Some of the defects falling in this category are cold shut, Misrun, slag inclusion, elephant skin

Cold shut: when the liquid metal reaches the mold from two gates and when these two streams of molten metal meet at a low-temperature junction, they do not fuse and appear as a line in the casting

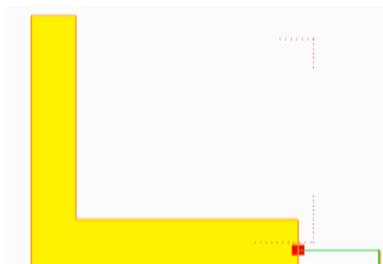


Causes:

1. Insufficient molten metal temperature
  2. Poor gating system design
- Prevention:
1. By maintaining high metal temperature
  2. Proper gating design

Misrun:

If the molten metal is cold or the segment is very thin, the metal may not fill the entire surface of the mold cavity



Causes:

1. The Fluidity of the molten metal
  2. Improper gating design
  3. Improper mold design
- Precautions:
1. Improving the pouring temperature of the molten metal which increases the fluidity
  2. Avoiding too thin sections

Slag inclusion: when the liquid metal containing slag particles are poured into the mold cavity and allowed to solidify these defects will occur.

Causes:



Pouring of molten metal with slag particles Prevention:

1. Remove the slag particles before pouring
2. Adding chemicals to the mixture to allow slag to float to the top where it can be easily seen and removed before being poured.

Elephant skin:



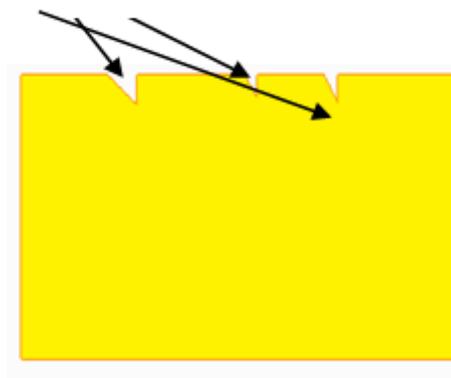
Causes:

Poor molds and Prevention:

Defects caused due to metallurgical factors: These defects will occur due to the weakness of the metal when it is hot. Some defects which come under this category are hot tears, hot spots

Hot tears: when the metal is hot, due to tensile stress in the material defect will occur like cracks on the section

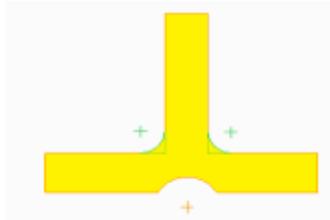
**HOT TEARS**



Causes: 1. improper design of molds  
Precaution:

1. Effectivemolddesignwilleliminatethesetypeofdefects
2. Minimizingtheresidualstressforthematerial
3. Removesuddenchangesinthecross-section ofthecasting

Hotspots:thesedefectswilloccurwhensomeareainthecastingcoolsfasterthantheremaining.Hotspotsoccurintherapidcoolingarea.



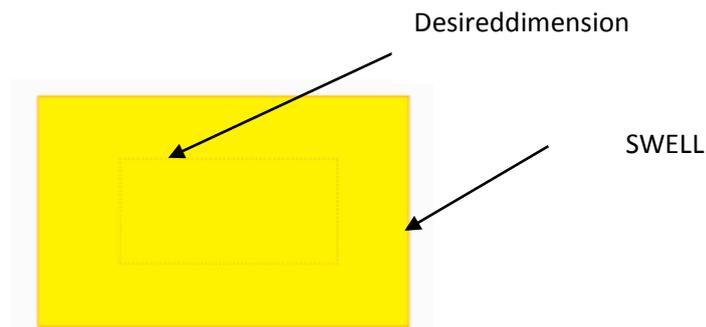
Causes: rapidcoolingrate

Prevention:propercoolingratewillreducethisdefect

Defects caused due to molding material: defects will occur due to molding sand. some defects which comeunderthiscategory areCutandwashes, swell,drops,metalpenetration,rattail

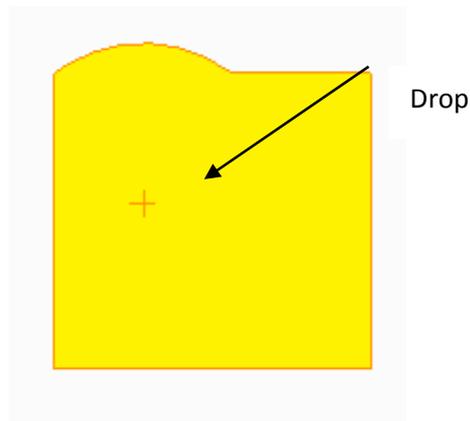
Swell:Dueto themoltenmetal pressure,enlargementtakesplaceinthemold cavity

Causes:improperramming

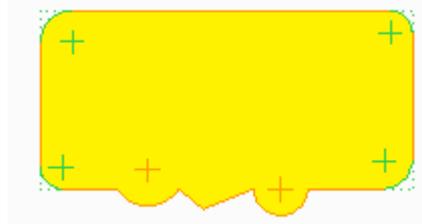


Prevention:rammingshouldbedoneevenly

Drop:whencrackingoccursonthetopthesurfaceofthesandandsandpiecesfallintothe moltenmetalthisdefectwillhappen.



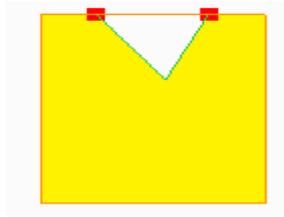
Causes: inadequate fluxing of molten metal Prevention: sufficient flux  
Cuts and washes: due to excess metal this defect will exist



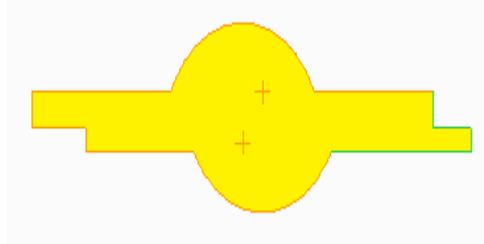
Causes: if the molten metal flows with more velocity then it allows more metal to flow through the gate Prevention: efficient gating system  
Rattail: it occurs on the bottom of the mold surface and appears as a line or crack



Causes: poor strength of the sand Prevention: maintain proper ramming Usage of good strength of sand  
Defects caused due to shrinkage: Because of volumetric contraction, the creation of the cavity in the casting is called a shrinkage cavity.



Causes: high pouring temperature Improper solidification of molten metal Prevention: usage of chills  
Defects caused due to other factors: mismatch Falls under the category Mismatch:



Causes:

Cope and drag parts of the mold that do not remain in their proper position cause seam mismatch.

**Prevention: use the right molding box**

**Simulation:** in today's competitive manufacturing environment, simulation is an essential method that enables foundries to obtain accurate and high quality cast components. Casting simulation software allows designer to see how their models would result after casting without doing the casting process. To study mold filling, solidification and assessing the location and type of internal defects simulation software became a very effective and reliable tool. It is extremely useful for foundry applications.

**These sequence of steps for using casting simulation software is as follows:**

1. Create a casting design model using CAD and save it as .STL file
2. Upload the STL file in procast software
3. Define the input required for computation
4. Define the gating system
5. Run the software
6. Analyze the results

**II. CONCLUSION:**

In this present paper, various types of defects during the sand casting process and their preventive methods to overcome these defects were analyzed. To improve the quality of the casting, the defects in the casting should be as less as possible. Rejections can be continuously regulated by taking various parameters into account at every stage of production. It is therefore important for a metal caster to identify the form of the defect and to provide sound free castings.

**REFERENCES:**

- [1]. Kabnure, B. B., Shinde, V. D., & Patil, D. C. (2019). Quality and yield improvement of ductile iron casting by simulation technique. *Materials Today: Proceedings*. DOI:10.1016/j.matpr.2019.09.022
- [2]. Nurjaman, F., Shofi, A., Herlina, U., Prilitasari, N. M., & Triapriani, Y. (2018). Simulation for grinding balls production using sand mold-gravity casting. *IOP Conference Series: Materials Science and Engineering*, 285, 012029. DOI:10.1088/1757-899x/285/1/012029
- [3]. Bejaxhin, A. B. H., Paulraj, G., & Prabhakar, M. (2019). Inspection of casting defects and grain boundary strengthening on stressed Al6061 specimen by NDT method and SEM micrographs. *Journal of Materials Research and Technology*, 8(3), 2674–2684. DOI:10.1016/j.jmrt.2019.01.029
- [4]. Nandagopal, M., Sivakumar, K., Sengottuvelan, M., & Velmurugan, S. (2019). Review on ferrous and non-ferrous casting defects and their analysis. *International Conference On Materials, Manufacturing And Machining 2019*. DOI:10.1063/1.5117953
- [5]. Sithole, C., Nyembwe, K., & Olubambi, P. (2019). Process knowledge for improving quality in sand casting foundries: A literature review. *Procedia Manufacturing*, 35, 356–360. DOI:10.1016/j.promfg.2019.05.052
- [6]. Wang, T., Shen, X., Zhou, J., Yin, Y., Ji, X., & Zhou, Q. (2018). Optimal Gating System Design of Steel Casting by Fruit Fly Optimization Algorithm Based on Casting Simulation Technology. *International Journal of Metal Casting*, 13(3), 561–570. DOI:10.1007/s40962-018-0291-7
- [7]. Sunanda, A., & Jagannadha Raju, M. (2021). Simulation for prediction analysis of defects in pulley casting using sand casting process. *Materials Today: Proceedings*. doi:10.1016/j.matpr.2021.01.734