

# An Analysis To Minimize The Defects In Casting Process

Rajesh Pandey, Prof. Rohit Srivastava

**Abstract**— Sand castings are used in order to manufacture complex shapes. The castings are bound to have one or more defect. The presence of defects may subject casting to rejection. The defect causes stress concentration. More time and money would be saved if it ever becomes possible to produce to hundred percent good casting. It may cause casting to fail in fatigue, impact etc. Defects can be minimized by taking precautionary measures in the casting processes. This thing can be achieved by predicting these defects prior to metal pouring.

**Index Terms**— Casting, Minimize, Defects, Blow holes

## I. INTRODUCTION

Casting is associate engineering producing method usually used for production within which materials in an exceedingly melted state square measure poured into a mould wherever they solidify. In this method, advanced components may be factory-made economically and quickly that alternativewise would involve heaps of your time if made by other strategies like shaping or cutting. Casting method may be used to supply an oversized kind of components that square measure utilized in totally different industries, starting from a little plastic toy to an oversized turbine blade.

### Selection of Casting Processes

Different casting processes are available for utilization, and their suitability is influenced by a number of factors including the following:

- Quantity of castings
- Manufacturing cost
- Product material
- Dimensional accuracy required
- Surface finish required

### Casting Processes

The major casting processes utilized in the producing business square measure the following:

#### Sand casting

Sand casting is often used for the assembly of enormous components, by filling a liquefied metal into

the mould cavity that has been formed from natural or artificial sand.

The cavity is formed by the use of a pattern, usually product of wood or metal that's of identical form and dimensions because the actual half.

The pattern is prepared slightly oversize due to which the cavity is also a little larger and compensates for the contraction of molten metal during cooling. Surface of the sand castings is normally rough with surface impurities for which a machining allowance is included.

#### Die Casting

In this method metal is forced into the mould at a high that ensures production of identical components, a better surface finish, and an increased dimensional accuracy.

Some components created by die casting even don't need machining when casting, or may require only a light machining to achieve the desired dimensions. Defects of porosity are found more often in large castings because of entrapped air and the solidification of melt before it reaches the boundaries of the cavity.

Parts with an even wall thickness are often additional accurately created by die casting.

Die casting molds square measure costly since these square measure made up of hardened steel and since a extended time period is needed for his or her production.

#### Centrifugal Casting

This is a casting technique that has an in depth vary of commercial applications together with the casting of machine fittings wherever sturdiness of the finished product is very important.

Television image tubes, spherical glass objects, pipes, flywheels, and boilers also are made by centrifugal casting.

As the molten metal is poured, a permanent mold spins at high speeds around its axis. The molten metal moves towards the mold walls due to centrifugal force, solidifies after cooling, producing a fine part.

The external diameter of the casting has fine grains, and is immune to region corrosion.

#### Investment Casting

Investment casting is an ancient producing method used for metals that area unit troublesome to be machined or made-up.

It is also used for the manufacture of parts that cannot be formed by usual manufacturing techniques like turbine blades or components of airplane that are subjected to high temperatures.

**Rajesh Pandey**, Master of Technology Scholar, Department of Mechanical Engineering, S R Group of Institutions, Lucknow (India)

**Prof. Rohit Srivastava**, Assistant Professor, Department of Mechanical Engineering, S R Group of Institutions, Lucknow (India)

This method provides a superb dimensional accuracy and surface end.

The pattern is made of wax or other substance that is melted, leaving behind a cavity which is filled with the material of the part being produced.

Casting is an engineering producing method typically used for production during which

materials in a very liquified state are poured into a mould wherever they solidify. In this method, advanced components may be factory-made economically and speedily that different wise would involve heaps of your time if made by other strategies like shaping or cutting. Casting method may be utilised to supply an oversized style of components that are utilized in totally different industries, ranging from a small plastic toy to a large gas turbine blade.

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Different casting processes are available for utilization, and their suitability is influenced by a number of factors including the following:

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### Casting Processes

The major casting processes utilized in the producing trade are the following:

#### Sand casting

Sand casting is often used for the assembly of huge components, by filling a molten metal into the mold cavity that has been shaped from natural or synthetic sand. The cavity is made by the employment of a pattern, generally made of wood or metal that is of the same shape and dimensions as the actual part.

The pattern is prepared slightly oversized due to which the cavity is also a little larger and compensates for the contraction of molten metal during cooling. Surface of the sand castings is normally rough with surface impurities for which a machining allowance is included.

#### Die Casting

In this method metal is forced into the mould at a high that ensures production of identical components, a better surface finish, and an increased dimensional accuracy.

Some components made by die casting even don't need machining once casting, or may require only a light machining to achieve the desired dimensions. Defects of porosity are found more often in large castings because of entrapped air and the solidification of melt before it reaches the boundaries of the cavity.

Parts with a regular wall thickness may be additionally accurately made by die casting.

Die casting molds are pricey since these are made of hardened steel and since an extended time period is needed for his or her production.

#### Centrifugal Casting

This is a casting technique that has an intensive variety of business applications together with the casting of machine

fittings wherever sturdiness of the finished product is vital.

Television image tubes, spherical glass objects, pipes, flywheels, and boilers are also produced by centrifugal casting.

As the molten metal is poured, a permanent mold spins at high speeds around its axis. The molten metal moves towards the mold walls due to centrifugal force, solidifies after cooling, producing a fine part.

The external diameter of the casting has fine grains, and is resistant to atmospheric corrosion.

#### Investment Casting

Investment casting is an ancient producing method used for metals that are troublesome to be machined or finished. It is also used for the manufacture of parts that cannot be formed by usual manufacturing techniques like turbine blades or components of airplane that are subjected to high temperatures.

This method provides a superb dimensional accuracy and surface end.

The pattern is made of wax or other substance that is melted, leaving behind a cavity which is filled with the material of the part being produced.

## II. LITERATURE REVIEW

This section describes the previous works and achieved results of various researchers on casting process using different techniques. Taguchi model is suitable for robust design such as designing processes or products for minimizing variation of components or environmental conditions or variation around a target value [3, 4]. Taguchi's method was used to determine the optimal process parameters for the green sand casting process in an automobile foundry industry, India. The authors observed that process parameters (i.e., moisture content, green strength, pouring temperature, mold hardness vertical and mold hardness horizontal) significantly affect the casting defects [5]. A process window approach was applied for minimizing the error of casting cast iron flywheel [6]. The researcher showed that casting quality involves with a large number of process variables in his gear blank casting process [7].

Taguchi's method was also used for optimizing the mechanical properties of the Vacuum Casting process [8]. The effect of transient heat transfer, foam degradation and liquid metal flow in casting process was studied through a simple mathematical model [9]. The author determined the optimal process parameters using the Taguchi's method for the green sand casting process. Control factors are the independent variables of any experiment that have various effects on the response or output variables at different levels of input variables. They can be subdivided into qualitative control factors and quantitative control factors. Noise factors are the uncontrollable variables that influence the output variables. This factors may or may not be known. For preventing the noise factors from interfering in the experimental results special attention should be given [11]. Recently researchers applied Taguchi approach for optimizing green casting process parameters for enhancing the quality of mild steel [12]. In Aluminum re-melting process

a robust design technique was applied for finding out the optimal settings of design parameters for increasing performance, reducing quality and cost [13]. Taguchi approach is applied in other casting 3 processes. In die casting for Aluminum alloy the authors analyzed different process parameters and achieved optimal levels of die casting parameters for improving casting yield [14]. Some other techniques such as artificial neural network was applied for identifying the complex relationship in hot-deformation process. Through this network, it reduced the number of experiments required to characterize a material's behavior and also the problems associated with empirical, semi-empirical models which involve with the evaluation of a great number of constants [15].

### III. RESEARCH OBJECTIVE

The main of this research work is:

- To identify various causes of occurrence of blowhole and put them together.
- To identify corresponding remedies and put them together.
- To develop a model for blowhole optimization.
- To develop a knowledge base related to blowhole.
- To use chlorine as catalyst for reducing blowhole defects.

### IV. RESEARCH METHODOLOGY

Step 1: Data collection about the casting,  
Step 2: Detailed analysis of defects in the casting process,  
Step 3: Selection of root cause,  
Step4: Chlorine fine particles as catalyst are used for dissolution of chemicals like hydrogen, nitrogen carbon or in combined form into less blowhole creating chemicals.  
Like  
 $FeO + C = Fe + CO.$   
 $Mn + FeS = MnS + Fe.$   
Step 5: Final implementation of the process.  
Step 6: Presentation of work.

Blowholes in Sand Casting

There area unit differing kinds of defects made in sand casting.

A high proportion of casting defects area unit caused thanks to evolution of gases.

One of the foremost casting defects caused thanks to gases is holes (gas holes).

Gas holes are pinholes and blowholes.

This designation belongs to size of the outlet and not its origin.

Blowhole is very prevalent cause of casting scrap. Figure 1 shows schematic of blowholes, showing blowholes near core, surface blowholes and casting strewn with blowholes.

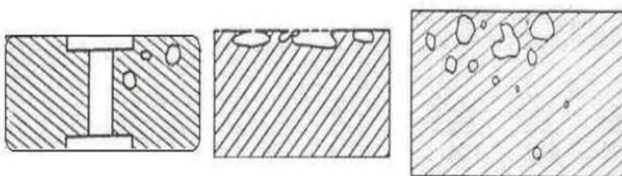


Figure 1 Schematic of Blowholes [1]

The blowholes are smooth walled cavities, essentially spherical, often not contacting the external casting surface. The largest cavities are often isolated. In specific cases, the casting surface can be strewn with blowholes. The interior walls of blowholes can be shiny, more or less oxidized or in case of cast iron can be covered with a thin layer of graphite [2].

### Types of Blowholes

When the hot metal is poured inside the sand mold, sand and sand contents gets heated and large amount of gases are produced inside the casting. The main gas producing processes in the mold are [2]:

- ⇒ Rejection of dissolved gases from the metal
- ⇒ Entrapment of core and mold gases evolved under pressure
- ⇒ Reaction of carbon in the metal with oxygen or oxides

The above classification of origin of gases leads to following cases of formation of blowholes [1]:

- ⇒ Blowholes due to high gas content of the metal
- ⇒ Blowholes from mold or core gases

They are also called as exogenous gas holes. These holes are caused due to excessive moisture in molds or cores, core binders which liberate large amount of gas, excessive amount of additives containing hydrocarbons and blacking and washes which tend to liberate too much gas.

### ⇒ Carbon oxygen reaction holes

The gas holes in this group may appear in variety of forms, but the gas responsible is carbon monoxide, produced by the reaction of oxygen containing substances with the carbon present in the cast iron.

### Mechanical entrapment of gas

- ⇒ They are additionally known as as exogenous gas holes or blowholes. These holes are caused thanks to short evacuation of air and gas from mould cavity and short mould or core porosity Hydrogen Blowhole.

Most cast iron melted in different furnaces has hydrogen content of 0.8 to 1.8 ppm, provided not exposed to some unusual source of hydrogen. Higher hydrogen content leads to defects depending on size of casting.

In large castings which cool very slowly hydrogen can usually escape by diffusion through outer skin of casting. But in smaller casting the solidification period is too short for hydrogen to diffuse in this way. Such castings produce rounded holes as shown in figure 2.1. The internal surface of these holes is usually clear and bright, that no air penetrated into cavities while the casting was hot. They frequently contain a shiny black film of graphite.

As the hydrogen content of free air is very low, it is obvious that any hydrogen dissolved must come from material containing hydrogen. Most common of these material used is foundry water. Water vapor will decompose to yield hydrogen, on contact with liquid cast iron and produce metal oxides. At the moment of decomposition this hydrogen is in the nascent or atomic form, and is therefore readily soluble in the liquid iron. The amount of hydrogen, which will dissolve

will depend upon partial pressure of water vapor in atmosphere in contact with the liquid iron.

### ⇒ Nitrogen Blowhole

The normal nitrogen content of most grey iron is between 20 and 80 ppm, while malleable iron may contain 100 ppm. When nitrogen contents above this level occur, nitrogen blowhole defects may be produced. Thick sections are more prone to defect, than thin section castings (here they differ from hydrogen). The reason most probably lies in the relatively low rate of diffusion of nitrogen through iron compared with that of hydrogen [3].

### ⇒ Combined effects of Hydrogen and Nitrogen

There are situations where combined presence of hydrogen and nitrogen produce blowholes. Though nitrogen alone is below levels at which defects would be expected to occur, defect due to combine effect of hydrogen and nitrogen are seen to concentrate into the center of casting. It is extremely unlikely that nitrogen blowholes will be found in cupola metal iron of carbon equivalent value higher than 2.9. It is not easy to differentiate between the blowhole due to hydrogen and nitrogen. But we can easily predict which one of two is a cause of blowhole formation in a particular casting [3].

### ⇒ Carbon Oxygen Reaction Blowholes

Under certain condition it is possible for oxygen to react with the carbon present in the liquid cast iron and to liberate carbon monoxide gas. If this gas gets trapped in the solidifying metal a blowhole will result. The most effective source of oxygen is any liquid iron oxide-rich slag, which has become trapped during pouring [3].

Formation of blowholes in sand casting is a very complex phenomenon. Once the blowhole occurs in casting, if it is not surface blowhole, then it is very difficult to repair it. The foundry rejection due to blowholes may reach up to 30%. Therefore, a system is needed, which will predict formation of blowhole prior to pouring of metal inside mold.

So that proper changes can be made accordingly either in sand contents, metal contents or casting process parameters.

There are many reasons for occurrence of blowhole, therefore it is very difficult to put collectively all the causes. Whatever work is done till now on blowhole, everyone studies a particular cause of blowhole and its remedy. It is necessary to put all things together. There is a lot of work done in casting defect area related to mold filling analysis, solidification analysis and design of gating system, risers etc.

When we consider, blowhole as a defect, very less work has been done for its mathematical modeling. A good number of commercial software are available in market related to mold filling simulation, solidification analysis, gating and mold design etc. They are generally used to visualize mold filling simulation along with prediction of defects like cold shuts and shrinkage cavities, rarely anyone might be having separate software for blowhole prediction. They claim that experienced person can judge occurrence of blowhole from simulation.

Considering all above things, this is an attempt to put all causes and remedies of occurrence of blowholes together. Further, this is an attempt to develop some mathematical model for blowholes, so that one can predict occurrence of

blowhole. So that one can easily analyse a particular case of blowhole or can analyse a particular shaped casting before going to cast it, and can check whether blowhole can occur or not.

Chlorine is being used as catalyst in the process of casting to reduce the gasses which results in the formation of blowholes, chlorine is being used in the form of fine particles to ensure the maximum coverage or surface area for reaction to occur. Chlorine is fast reaction and reacts with almost all of the major chemicals available.

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## V. RESULT & DISCUSSION

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## VI. CONCLUSION

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## VII. FUTURE SCOPE

This work will reduce the defects occurs in cating & will increase the efficiency of production in terms of quality, quantity & cost.

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