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# A REVIEW PAPER ON SAND CASTING DEFECTS

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**Abstract:** *Foundry plays key role in the current Scenario. This Research work involves study of various types of sand casting defects like Blowholes, Porosity, Sand Inclusions, Cracks, Run out and Leakages. In this Research work Basic defects are identified and their root cause is identified. This Research paper also includes the use of some of the optimization methods like Taguchi method and neural network method and genetic algorithm. This paper prescribes review of Work relevant with the minimization of sand casting defects and optimization of sand casting process.*

***Key words:*** *Blowholes, Porosity, Taguchi method, Sand Inclusions, genetic algorithm*

## Introduction

Indian foundry industry faces the problem of scrap castings and they are planning to reduce the scrap rate. The scrap rate can be reduced by minimizing the casting defects and by optimizing the controllable process parameters. Defective castings will results into reduction of profit margins

## Literature Review

**Sharban kumar singha and Simran jeet singh(2015)** studied about Application of ANN in minimization of sand casting defects. They used MATLAB toolbox for studying the application of ANN in minimization of sand casting defects. With the use of trained network in ANN they minimized the sand casting defects. The final values of sand casting defects is 6.23 % for expansion defects , 7.28% for gas defect, 5.74% for Weak sand defect. They selected critical parameters like Moisture, Permeability, Loss on ignition, Green strength, volatile content, vent holes, Pouring time and mould pressure. They optimized the selected process parameters using ANN . They trained the network in MATLAB. They developed Back propogation neural network to predict the optimum values of process Parameters. **[1]**

| Sr.No. | Optimum casting defect | Value | Input parameters | Value |
|---|---|---|---|---|
| 1 | Expansion defect | 6.23% | Moisture | 3.67% |
| 2 | Expansion defect | 6.23% | Permeability | 180 |
| 3 | Expansion defect | 6.23% | Pouring temperature | 1400 |
| 4 | Expansion defect | 6.23% | Green compressive strength | 2.242 |
| 5 | Expansion defect | 6.23% | Number of vent holes | 9 |
| 6 | Gas defects | 7.28% | Moisture | 4.12 |
| 7 | Gas defects | 7.28% | Permeability | 180 |
| 8 | Gas defects | 7.28% | Pouring temperature | 1400 |
| 9 | Gas defects | 7.28% | Green compressive strength | 2.242 |
| 10 | Gas defects | 7.28% | Number of vent holes | 11 |
| 11 | sand defects | 5.74% | Moisture | 3.9 |
| 12 | sand defects | 5.74% | Permeability | 180 |
| 13 | sand defects | 5.74% | Pouring temperature | 1400 |
| 14 | sand defects | 5.74% | Green compressive strength | 2.242 |
| 15 | sand defects | 5.74% | Number of vent holes | 8 |

 

**Ganesh G Patil and Dr.K.H.Inamdar (2014)** had done their Research in optimization of sand casting process using ANN approach. They identified major defects like sand drop, blowholes, leakage and bad mould in the current sand casting process. They identified some critical process parameters like GCS, Permeability, Moisture, Metal composition and Metal temperature. They trained the neural network based on existing available data. They collected 84 test data samples for training and testing of neural network. Out of 84 data sets they selected 65 samples for training of the network and remaining 19 samples for testing purpose. They trained the network in such a way that it predicts the casting defects. Amoung the predictions for defects like misrun and crack the trained network was accurate and for other defects it was not so accurate. Momentum rate was set around 0.7 and learning rate was set around 0.5 . The error goal was set as 0.01.

The following were the parameters were selected:

- Green compressive strength
- Green shear strength
- Permeability
- Moisture content
- Carbon percentage in charge
- Manganese percentage in charge
- Silicon percentage in charge
- Sulphur percentage in charge
- Phosphor percentage in charge
- Chromium percentage in charge

Molten metal temperature in Celsius

**Rasik Upadhyaye and Dr Ishwar P Keswani[2012]** studied optimized the sand casting process parameters by maximizing signal to noise ratio and minimizing the effects of noise factors. They used the Taguchi method for optimization of the sand casting process. They considered several critical parameters like moisture, sand particle size, Green compressive strength, Mould hardness, Permeability, Pouring temperature, Pouring time and pressure test as critical parameters. They selected three different levels for experimentation based on Taguchi Approach. The major internal defects were observed like sand blow holes, pinholes, scabs, mould crack, sand drop. They used L18 Orthogonal array for the analysis. They calculate signal to noise ratio for all iterations. And Identify the optimum parameters. [2]

**Prof. B.R.Jadav and Santosh J Jadav[2013]** studied the effects of critical factors like Low pouring temperature, Low % of si and P, Slow pouring, Slow ladder carrying and damaged pattern. They identified systematic approach of root cause analysis of some major defect like Cold shut. Total rejection rate reduced to 6.6 % from 12.3 %.

**Rathish Raghupathy and K.S.Amirthagadeswaran** [2014] studied Response surface methodology and Box Behnken Design in optimization of sand casting process. They identified critical parameters like clay, moisture and mould hardness as input parameters. Critical process parameters were optimized using Box behnken's method Each parameters were optimized using 3 different levels. The optimized parameters was determined by using Design Expert software. The optimized values of process parameters were 2% for clay, 4% for moisture and 5.45 $Kg/Cm^2$for mould hardness.

**Lameck Mugwagwa , Lungile Nyanga** studied Continuous casting process. They designed neural network model for continuous casting process. Training is performed using Levernberg –Marquardt algorithm . They developed the model using MATLAB and sigmoid function. The model is validate using MATLAB simulink. The output from the neural network in the form of either 1 or 0

**Ravneet Kakria Chandandeep singh and Priyavrat thareja** studied Quality improvement of Aluminium Alloy Casting using Taguchi method. They identified 5 different parameters Bentonite clay, AFS Grain fineness number, Moisture, Pouring temperature and coal dust. They used L8 orthogonal array.

**Defect Diagnostics study**

| Defects | Appearances | Causes | Remedy |
|---|---|---|---|
| Misrun | Holes in the thin section of casting | Low Pouring temperature | Increase Carbon and phosphorus |
| | | Low fluidity | Avoid excessive ramming |
| | | Inadequate venting | Keep Runner full of metal during pouring |
| | | Faulty pouring practises | |
| | | | |
| Shrinkage | Rough cavities entering on heavy sections | Incorrect gating and feeding | Use Risers to feed heavy sections and ensure that they are filled with hot |

 

| | | | |
|---|---|---|---|
| | | | metal. |
| | | Unsuitable Composition | Adjust silicon or carbon equivalent in case of C.I. |
| | | | |
| Slag Inclusions | Pitted surface found on machining | Dirty metal and dirty ladle lining | Remove all slag from metal before pouring |
| | | Incorrect gating causing turbulence | Incorporate skim gates in runner system |
| | | Excess of sulphur with high manganese and low pouring temperature | |
| | | | |
| Porosity | Machined surface show cavities in thick section. | Wrong Composition of metal | Reduce silicon and phosphorous content |
| | | Incorrect running and feeding system | Use proper risering |
| | | Oxidized metal | Improve venting |
| | | | |
| Hard metal | May occurs on scattered hard spot. | Wrong composition of metal with high sulphur and low manganese | Increase Silicon content |
| | | High Moisture | Reduce moisture |
| | | Incorrect pouring practises | |
| | | | |
| Scabbing | Rough excretions on the surface of the casting | Hard or uneven ramming | Avoid hard rammed areas |
| | | Mould poured too slowly | Increase ingate areas. |
| | | Sand grain not uniform | Reduce moisture content |
| | | Excessive moisture | Improve sand with clay addition |
| | | | |
| Cracks | Hairline cracks showing on casting. | High dry strength of sand | Ram softer to allow casting to contract |
| | | Cores too hard | Modify pattern design |
| | | Casting strains | |
| | | | |
| Blowholes | Rough shaped holes occurred on the surface of the casting | Insufficient Permeability | Increase permeability |
| | | Hard Ramming | Avoid excess ramming |
| | | High Moisture content | Reduce Moisture |
| | | Insufficient venting | Increase pouring temperature |
| | | Too low pouring temperature | |
| | | | |
| Dirt | Rough cavities and pits in the casting surface | Dirty ladles | Increase green bond with clay additions |
| | | Strength of sand is lower | Ram evenly |
| | | Loose Ramming | Use well designed runners and ingates. |
| | | Poor finish of gating system | |

**Uday A. Dabade and Rahul C. Bhedasgaonkar** analyzed the optimized levels of selected process parameters obtained by Taguchi method are: moisture content (A): 4.7 %, green compression strength (B): 1400gm/cm2, permeability number

(C): 140 and mould hardness number (D): 85. With Taguchi optimization method the % rejection of castings due to sand related defects is reduced from 10 % to a maximum upto 3.59 %. Design of experiments method such as Taguchi method can be efficiently applied for deciding the optimum settings of process parameters to have minimum rejection due to defects for a new casting as well as for analysis of defects in existing casting.[3]

**Sachin(2011)** have analysed the rotational sand moulding process using DOE with significant parameters. Based on discussions researchers attempted to optimize the sand casting process parameters by conducting ANOVA experiments on Taguchi's concept to minimize the defects in the casting process. RSM is the collection of statistical and mathematical technique for developing improving and optimizing a process. The objective is Quality improvement ,reduction of variability, improving process and product performance are accomplished by directly using RSM.

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