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Casting Defect Reduction in a Manufacturing Industry

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Abstract- Many researchers have conducted experiments to find the sand process parameters to get better quality castings. They have successfully reduced the casting defects considerably up to 6% by proper selecting sand parameters. DoE is the technique which can be implemented in any processing industry. In India there are number of small scale industries which can implement such techniques to improve the yield, give standard process parameter and increase the effective capacity of the unit. The present work is carried out in foundry to minimize casting rejection due to major defect. Quality analysis is carried out which includes the Root cause analysis to find out actual reasons behind occurring the blow holes. Quality control tools such as Pareto analysis, Cause and Effect (Ishikawa) diagram, and Why-why analysis are used for analysis. Accordingly corrective actions and preventive measures are suggested and implemented.

Keywords- Quality control tools, Cause and Effect (Ishikawa) diagram, casting defect reduction.

I. INTRODUCTION

Production of casting involves various processes such as pattern making, moulding and assembly, sand preparation, core making and melting, pouring, shakeout etc. The overall casting process becomes very critical for complex parts. Based on various researches find best foundry process in which included all the activity.

Casting process is the most widely used process in manufacturing industries. The activities involved in casting process are, Pattern making for creation of mould box, Core making for insertion in mould assembly, fitting of pattern, gating system and sand for mould preparation, remove prepared mould and placed for pouring, fill the mould cavity with molten metal, allow it to solidify and at last, remove the cooled desired casting.

These activities are commonly used because of its simplicity in process, economic to operate and easy to produce small size castings. Casting is a process which carries risk of failure occurrence during all the process of accomplishment of the finished product. Casting process involves complex interactions among various parameters and operations related to metal composition, methods design, moulding, melting, pouring, shake-out, fettling, machining like grinding and inspection etc various operation carried out.

Understand current scenario of foundry industry. in now a day's foundry industry produce product different types like ferrous and non- ferrous , this case study mainly focuses on steel foundry, present china provide casting product good quality with less time .various types of casting process like melting, moulding, core making, melting, pouring, shake out.

Study about various casting defects occur in foundry industry like shrinkage, blow hole, porosity, pinhole, sand inclusion, cold shut, miss run, surface discontinuity, mould break, flash etc. Give idea about how to occur defects and which types of precaution taken in future. process mapping means flow process chart – material types in which shows all activity from raw material to finish goods with time, find non value added activity and remove it.

Tools & technique used in foundry industry based on quality and productivity aspect like 7 QC –tools, DOE, Taguchi method, method study, TQM, TQC, just in time, casting simulation techniques, six sigma – DMAIC method etc. Understand implementation of this technique in foundry industry at last which types of benefits occur after implement methodology.

Many researchers have conducted experiments to find the sand process parameters to get better quality castings. They have successfully reduced the casting defects considerably up to 6% by proper selecting sand parameters. DoE is the technique which can be implemented in any processing industry. In India there are number of small scale industries which can implement such techniques to improve the yield, give standard process parameter and increase the effective capacity of the unit.

From the study of all the research paper we conclude that six sigma is a breakthrough improvement methodology with the use of six sigma it is confirm that we get a min.50% improvement, if we work hard and top management involvement is good.

It can also be concluded that DMAIC methodology is mostly used by the industries for their performance improvement. This study will help small scale foundry to initiate Six Sigma projects in their organizations and improve their performance in terms of customer satisfaction as well as financial benefits with increase in competitiveness in worldwide market of foundry.

II. RESEARCH METHOD

In all processes the smallest variation in quality of raw material, production conditions, operator behaviour and other factors can result in a cumulative variation (defects) in the quality of the finished product. DMAIC approach aims to eliminate these variations and to establish practices resulting in a consistently high quality product.

Therefore, a crucial part of DMAIC work is to define and measure variation with the intent of discovering its causes and to develop efficient operational means to control and reduce the variation. The expected outcomes of DMAIC efforts are faster and more robust product development, more efficient and capable manufacturing processes, and more confident overall business performance.

Present study was done at on application of DMAIC methodology and Selection of tools and techniques for problem solving, because of its high rejection rate.

The present company is facing a casting rejection due to some defect, after observing data of the company most frequently rejected casting identified were Bearing housing, Blower hub, Outer rings, Flingers, Adaptor and Terminal box. Out of these blower hub was identified as most severely affected casting, hence it was considered for detailed investigation.

Casting defect can negatively impact the bottom line of a foundry. A defect in a casting deteriorates casting surface quality and mechanical properties. It is responsible for loss of profitability, quality level and productivity of component. So it is preferably necessary to reduce it as much as possible by appropriate analysis.

The present work is carried out in foundry to minimize casting rejection due to major defect. Quality analysis is carried out which includes the Root cause analysis to find out actual reasons behind occurring the blow holes. Quality control tools such as Pareto analysis, Cause and Effect (Ishikawa) diagram, and why-why analysis are used for analysis. Accordingly corrective actions and preventive measures are suggested and implemented.

III. RESULTS AND DISCUSSION

1. Pareto Chart:

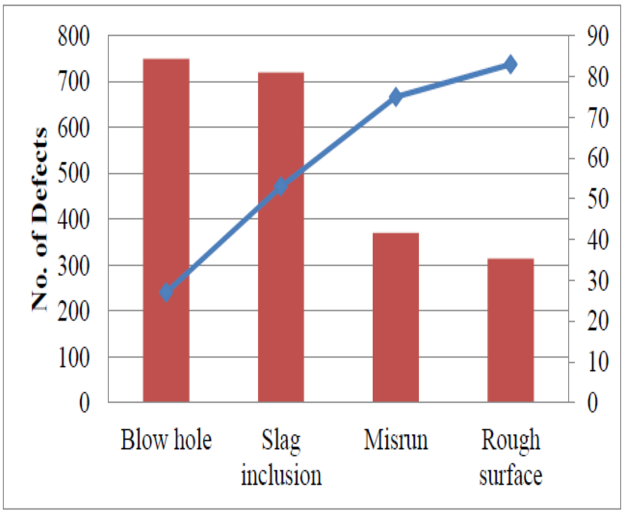

Fig 1. Pareto chart of bearing hub for last four months.

The Pareto diagram shows the total number of defects on Y axis and Nature of defect on X axis. From the diagram, we can identify the critical defects by 80-20 Rule. Following is the pareto analysis made to identify the major defects those are contributing in major percentage rejection.

Blow hole is identified as one of the four major defects. It was necessary to find out the actual reasons behind the blow hole defect, to find the reasons behind the defect use of Ishikawa diagram was made which is also called as root- cause analysis.

2. Root- Cause Analysis for Blow Hole:

Root cause analysis is the process of identifying causal factors using a structured approach with techniques designed to provide a focus for identifying and resolving problems. First of all brainstorming session was carried to identify the probable causes of the problem. As a result of brainstorming session some probable causes were identified.

These probable causes were then bifurcated into groups of man, machine, material and die with the help of cause & effect diagram shown in Fig. 2.

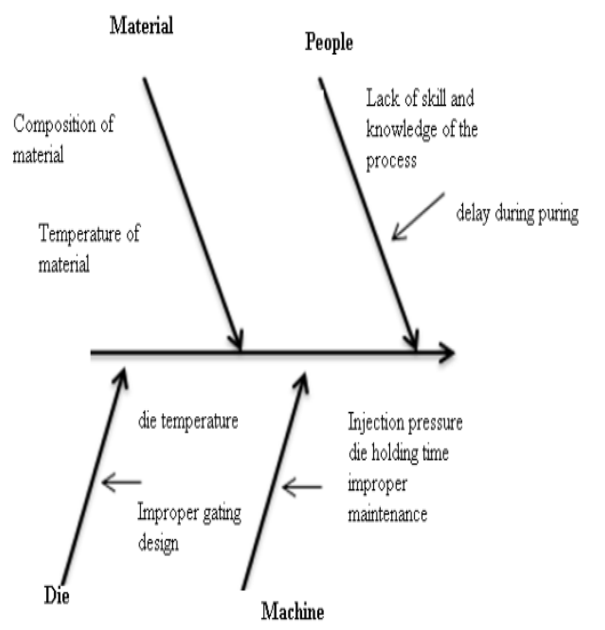

Fig 2. Cause & effect diagram.

The two major causes are pouring temperature; high moisture and low permeability are responsible for blow holes defects. In sand casting process, to produce the quality products it is required that metal should be poured at required temperature.

To see the effect of change in pouring temperature on rejection, data collection was carried out for temperature and % rejection as shown in below table 5.6.

This data was then used for regression analysis to see the relation between % rejection and pouring temperature and after that design of experiment will use to find out the optimum pouring temperature.

3. Regression Analysis Of Addition Of New Silica Sand Vs % Rejection:

The industry was using 5 % of new silica sand and 95 % of reuse sand. After performing the test with 100 kg of sand sample, it was found that percentage of moisture was high and percentage of permeability was low. Therefore to improve the blow holes defects it was necessary to increase the percentage of new silica sand to reduce the moisture and increased the permeability. The different results have been obtained by increasing the new silica sand as below.

To see the effect of addition of new silica sand on rejection, data collection was carried out for % rejection. This data was then used for regression analysis to see relation between % rejection and addition of new silica sand and after that design of experiment will use to find out the optimum percentage of silica sand.

Regression analysis using above data was carried out with the help of MINITAB 17 software. Result of regression analysis is shown below.

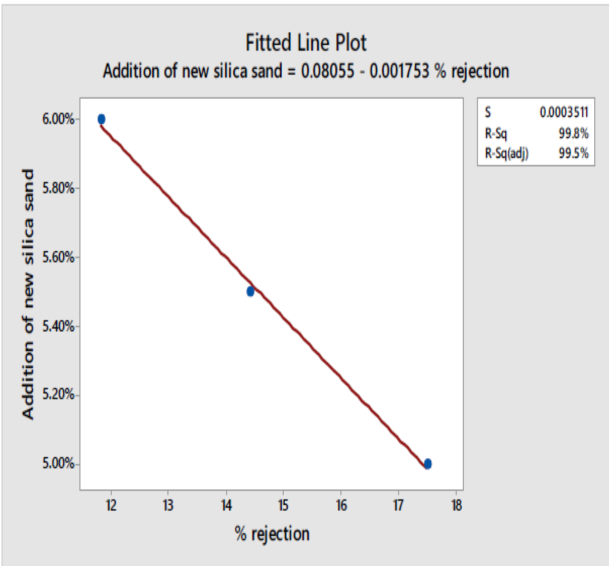

Fig 3. Addition of silica sand vs % rejection.

3.1 Regression Equation:

% rejection = 45.87 - 569.0 Addition of new silica sand.

3.2 Coefficients:

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	45.87	1.56	29.40	0.022	
Addition of new silica s and	-569.0	28.3	-20.11	0.032	1.00

3.3 Model Summary:

S	R-sq	R-sq(adj)	R-sq(pred)
0.200042	99.75%	99.51%	96.67%

3.4 Analysis of Variance:

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	16.1880	16.1880	404.53	0.032
Addition of new silica sand	1	16.1880	16.1880	404.53	0.032
Error	1	0.0400	0.0400		
Total	2	16.2281			

From the above analysis it is to be noted that since p value (0.032) is less than 0.05 which indicating that above regression model is significant but since linearity is only 99.75 %, we conclude that variation in addition of silica sand is linearly and causes % rejection.

IV. CONCLUSION

In sand casting process it is required that the ladle cup which is used for pouring molten metal into shot cylinder should be specific to that product so that required amount of metal can be poured. Operators were using another product's ladle cup when the cup is damage which is having higher weight so it leads to assumption based pouring which results into rejection of products. So one arrangement was carried to keep one extra ladle of so that whenever it will damage they can use the ladle instead of another products ladle.

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