Quality improvement in casting for improving productivity using statistical tool: A literature review

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***Abstract*:** Casting is very versatile process used in a number of engineering applications.But due to poor quality of the foundry industry it has become difficult to meet defect free and strict delivery schedule in the production process .Casting process is still state of art with experienced people, but these experience needs to be transformed in engineering knowledge for the better growth of the foundry industries. In India are many foundry have followed conventional and manual operations. Today's competitive environment has, lower manufacturing cost, more productivity in less time, high quality product, defect free operation are required to follow to every foundry man. Casting defects generally occurs due to improper sand properties, improper gating system and labor skills. Due to such high rejection rates the confidence of the customer on the product is lost. This paper deals review of research works carried out in foundry to minimize casting rejection due to major defect. This study shows the systematic approach toward quality control tools like Cause and Effect Diagram are used to identify and classify the reasons for defects in the production system and reduce them by using various remedial measures as cause and effect diagram,Pareto Chart, design of experiments and root cause analysis, etc.

Keywords: -Casting Defects, Cause and Effect Diagram, Gating system, Quality Control Tools,Taguchi Method, ANNOVA

Introduction:

Casting is a very versatile process and capable of being used in mass production. Casting process is known as process of uncertainty. Even in a completely controlled process, defects in casting are observed which challenges explanation about the causes of casting defects. Foundry industry suffering from poor quality and productivity while ensuring quality and productivity due to the large number of process parameters, and shortage of skilled workers compared to other industries. Quality analysis is the process of finding the root cause of occurrence of defects in the rejection of casting and taking necessary corrective actions to reduce the defects and to improve productivity. Techniques like Design of Experiments (DoE), Casting simulation, and artificial neural networks (ANN) are used by various researchers for analysis of casting defects.

Objective of this research work is to carried out quality analysis by implementing some conventional Quality Control(QC) tools such as Pareto analysis, Cause and Effect diagram, and Why-why analysis in process to get root cause behind the occurrence of defects. Also recommend and evaluate the effectiveness of corrective actions and preventive measures. Finally create an implementation plan to control the standard practices in order to reduce rejection level of defects. Aconsiderable research work in the field of casting rejection control through defect minimum of casting using various techniques.

A brief Review of some selected references on this topic is presented here as literature review.

II. LITERATURE REVIEW:

1. VIVEK V. YADAV and SHAILESH J. SHAHA(2016), Studied systematic approach for minimizing blow holes in sand casting of cylinder head. They noticed that Blow hole on rocker face of single cylinder head is major defect. To overcome this, Pareto Analysis is used to collect data and different qc tools like Defect Location, Kaizen Improvement Principle, Brainstorming Session, Why-why Analysis, Corrective Actions and Preventive Measures are used to find out root cause of blow holes. They suggested both Central vent cleaning practice before mould box assembly and pasting of wet green sand on central gas vent to overcome blow hole defects. To overcome these defects they introducing quality control tool due to this productivity is improved by 8.60%,and blow hole rejection is reduced by 5.93%,due to this they reduce in total revenue loss due to blow hole by Rs. 2,76,642.08/-

2.A CHAMYELEH A. KASSIE and SAMUEL B. ASSFAW (2013), Analyzed steel casting defects like shrinkag,gastarp.In order to minimize theses defects they select four process parameters like binder ratio, Mold permeability, Pouring Temperature and De-oxidant .For experimentation nine trials are taken and optimization taguchi method is use. They suggested sand binder ratio, mold permeability, pouring temperature and de oxidant amount are the leading parameters for optimizing the process in order to minimize the casting defects.

3. HARDIK SHETH ET AL investigate casting defects and identification of remedial measures . They found five prominent defects in casting rejections which are sand drop, blow hole, fin, and rough surface and cold shut. They notice that these defects were frequently occurring at different locations. Overcome these defects lean manufacturing, six sigma statistical tools are used. They suggested that in organization culture must change,developthe new approach towards production, employee must get proper training and education.

4. PRATEEK BHATT and ROHIT SINGLA (2017), select trumpet housing casting which is used for supporting the right and left hand axle shafts in tractor. but due to poor quality it is difficult to maintain quality. hence to eradicate this situation they introduce quality control tool to get desired reasult.They observed defects such as Shrinkage defect, Blowholes, Cold Shut, Misrun, Gas Porosity, Mismatch,Cracks, Sand Burning, Fin, Sand Drop which makes the production of molds inefficient and leads to higher rejection rates in the products. To overcome these defects they focused on production process, and they observed that cause of blow holes are wet sand, too much binder,insufficuent venting,insufficuent sand permiability.They observed various reasons responsible for sand drop due to improper molding sand properties, foreign material in molding sand, improper mold cleaning, improper mixing of sand,excess clearance between mixer and mixer door. To eradicate these situation they introduce quality control tool to get desired result and they reduce blow hole rejection rate to 1.92% from 4.54% with total saving of Rs 3,10,800/-and sand drop reduced to 0.81% from 1.74 with total Rs 1,11,000/-

5. B. R. JADHAV, SANTOSH J JADHAV (2013), analyzed the single defect i.e. cold shut. They used seven quality tools such as Check sheets, Pareto chart, Ishikawa diagram, Flow chart, Control chart, scattered diagram and histogram. Check sheet issued to collect the data, Pareto is used to sort major defects, Ishikawa is used to find possible causes, and Brain storming issued to find root cause, Control chart is used to get graphical representation of collected data. They did different trials on temperature range and Si and P percentage to reduce the cold shut defect. They used all the quality tools mentioned. Systematic approach to find the root cause through seven quality tool reduced cold shut defect to 50%.

6. DABADE and BHEDASGAONKAR (2013), have followed the Taguchi method with L18 array to find the optimum values of green sand parameters like moisture content, green compressive strength, permeability and mold hardness having effect on casting surface. Simulation technique is used to study the mold filling and solidification to control the rejection due to shrinkage. Initially the rejection was around 10% after optimization it came down to around 3.59%.

7.PAWAN JAGLAN ETAL suggested that Six Sigma is a powerful world class improvement business strategy that enables companies to use simple but powerful statistical methods to define, measure, analyze, improve and control (DMAIC) processes for achieving operational excellence. They thought multiple gains achieved by Six Sigma efforts over different productivity problems in a company amply prove the usefulness of this strategy for small industries as well. Project by project application of Six Sigma in SSI sector can strengthen the understanding about this strategy along with consolidating gains from it. Six Sigma among the small industries is a much awaited movement, which can strengthen their bottom lines besides contributing to uplifting global economy. The real requirement is to believe in Six Sigma and prepare a road map for its implementation and proceed earnestly to derive benefits out of it in real sense.

8. DEEPAK and DHEERAJ DHINGRA(2016) conducted a case study in a bicycle industry to improve quality of bicycle rims... The various process parameters such as heating voltage, temperature of heated water, time of chemical coating processes, chemical composition of the material and quality of heated water etc. which have influence of the quality of final product have to be controlled in order to reduce the wastage and also there has been observed a need of improvement in guide mechanism and storage methods to reduce the problems that results from manufacturing process. The rusty boiler tubes and rusty pipelines also need proper cleaning at regular intervals .Optimization in process operational cost and variations in product. They used Quality tools such as Pareto chart, Fishbone diagram have been applied to improve the quality of the products. From pareto diagram it is seen that major rejection are due to blow holes and sand drop and after applying tools it is observed that rejection of blowholes rate has been reduced to1.92% from 4.54% with a total savings of Rs.3,10,800and Rejection rate due to Sand drop has been reduced to 0.81% from 1.74% with a total savings of Rs.1,11,000

9. RAJKOLHE, KHAN (2014) carried out a study of different parameters of green sand and the combinations of different values of the same parameters. They used Taguchi method supported by L9 orthogonal array. After getting results of different combinations they have calculated the signal to noise ratio to get optimum combinations. ANOVA technique is used then to finalize the optimum values of parameters viz. sand particle size, mold hardness, green compression strength and permeability.

10. BHUSHAN SHANKAR KAMBLE (2016) carried a review on analysis of sand casting defects on medium scale foundry. Upon surveying a medium scale foundry, he noticed that the foundry had not standardized its production processes in different areas. In his review several casting defects help in analyzing the defect and remedies to overcome them. Casting Rejection on the basis of the casting defects should be as minimum as possible for improved quality. One can continuously control rejections by taking in to consideration different parameters at every stage of production. so it is essential for a metal caster to have knowledge on the identification of type of defect and be able to identify the exact root cause, and their remedies.

BHUSHAN SHANKAR KAMBLE,(2016), Analysis of Different Sand Casting Defects in a Medium Scale Foundry Industry - A Review, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 2, February 2016.

11. JATOTH RAMACHANDER (2016), studied Casting Defects With Respect To Indian Standards On Cast Iron IN Foundry. The guide lines and diagnosis chart are definitely helpful in improving the quality and yield of the casting. If castings are inspected with technologically advanced way, it keeps foundry men to alert condition for control of rejections and it will be within limit specified by the Indian standard. He found that the quality of castings depends on quality of sand, method of operation, quality of molten metal and environmental conditions etc., Rejection of the casting due to casting defects should be reduced for better quality. he suggested that using the modern method and suitable techniques, it is really a boon for the foundry sector to produce quality casting to satisfy the customer requirement. Continuous improvement and monitoring of foundry process as specified in the Indian Standard, it is possible to achieve the overall foundry rejection percentage of less than five percentages.

12. SHANTANU JOSHI, PROF. B.R.JADHAV (2015), HAVE followed the Taguchi method with L9 array to find the optimum values of shell mounding like AFS, Hot Tensile strength, Build Up having effect on casting surface. With Taguchi optimization method the percentage rejection of castings due to sand related defects is reduced from 3.2 % to a maximum up to 1.5%. They suggested that 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.

13. S.S.JAMKAR and M.J.DESHMUKH (2014*),* have followed review, in green sand casting process, the Taguchi method helps to improve the quality of a product by minimizing the effect of the causes of variation without eliminating them. Taguchi method has proved its success in prediction the optimum casting parameters to reach the best properties green sand. In this methodology, the design desired is finalized by selecting the best performance under conditions that produce a consistent performance. The Taguchi approach provides systematic, simple an efficient methodology for the optimization of near optimum design parameters with only a few well-defined experimental sets and determines the main factors affecting the process.

14.JITENDRA A PANCHIWALA1, PROF. DR. DARSHAK A DESAI(2015) have summarized 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 . he discussed about 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 . The Tools and 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.

15. NIMBULKAR and DALU, worked on gating system design to know last solidifying region in casting and eliminate these defects. They simulate old gating system for productivity and defect. Modification carried out in present gating system and new gating system created by using Auto-CAST X1 simulation software. They found that initial vertical gating system was not suitable for thick casting components hence proposed horizontal gating and feeding system so that molten metal flow becomes uniform, gases escape easily in to atmosphere. Feeding related defects had been reduced by 30%.

16.MANE V. V ET AL carried out casting defect analysis by using techniques like cause-effect diagrams, design of experiments, if-then rules and artificial neural network. Researcher describes 3-step approach to casting defect identification, analysis and

rectification. The defects are classified in terms of their appearance, size, location, consistency and discovery stage and inspection method. This helps in correct identification of defects. For defect analysis, the possible causes are grouped into design, material and process parameters. The effect of suspected cause parameters on casting quality is ascertained through simulation. Based on the results and their interpretation, the optimal values are determined to eliminate defects.

Conclusion:

The casting quality depends on, method of operation, quality of sand and quality of molten metal etc. To produce rejection less casting attention has to be focus on controlling process parameters. Most of the researchers in their study used Pareto principle and hence seven quality control tools to identify and evaluate different defects and causes for these defects responsible for rejection of components. Some of also use FMEA, Six sigma, and value stream mapping to control process. Many researchers have conducted experiments on sand process parameters using design of experiments method such as Taguchi method and proved that the reduction in casting defects due to sand process. Researchers also studied simulation software like Autocast, Procast, solid cast etc. to control defects in casting. Using Simulation software defects like shrinkage, porosity are eliminated and time required is very less for simulation as compared to the conventional method of design researcher also suggested that Simulation software plays vital role in yield improvement through modification in gating system and riser.Visualization of mould filling phenomenon makes the process easy to understand to the user.

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