ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 12, pp. 22470-22473, December, 2017

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

CASTING QUALITY IMPROVEMENT AND REJECTION CONTROL METHODOLOGY USING STATISTICAL TOOLS: A LITERATURE REVIEW

***Sidhant Arvind Karnik[1]., Bhatwadekar S. G[2] and Bhushan S. Kamble[3]**

[1]B.Voc (Foundry Technology), Vivekanand College, Kolhapur, Maharashtra, India 416003
[2]Department of Mechanical Engg. Sanjay Ghodawat Group of Institutions, Kolhapur, Maharashtra, India 416118
[3]Department of Production Engg., KIT's College of Engineering, Kolhapur, Maharashtra, India. 416234

DOI: http://dx.doi.org/10.24327/ijrsr.2017.0812.1271

ARTICLE INFO

Article History:

Received 18th September, 2017
Received in revised form 10th October, 2017
Accepted 06th November, 2017
Published online 28th December, 2017

Key Words:

Metal Casting, Virtual Process Simulation, Optimization, Taguchi Techniques, Design of Experiment.

ABSTRACT

In the present global and competitive environment foundry industries needs to perform efficiently with minimum number of rejections. Also they have to develop casting components in very short lead time. 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. Some foundries are working with trial and error method and get their work done. Defect free castings with minimum production cost have become the need of the foundries. 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. This study is aimed to get solution for minimizing various casting defects and to improve the entire process of casting manufacturing. Different quality tools are used to control the casting rejection as SQC, Parato charts, Taguchi Method, ANNOVA etc.

INTRODUCTION

Metal casting is one of the direct methods of manufacturing the desired geometry of component. The method is also called as near net shape process. It is one of the primary processes for several years and one of important process even today in the 21st century. The process of manufacturing a casting involves creating a cavity inside a sand mold and then pouring the molten metal directly into the mold. Casting is a very versatile process and capable of being used in mass production. Generally, foundry industry frequently faces challenges while ensuring quality and productivity due to the large number of process parameters, and shortage of skilled workers compared to other industries. A considerable research work in the field of casting rejection control through defect minimization of casting using various techniques. A brief Review of some selected references on this topic is presented here as literature review.

Joshi and Jugulkar (2014) helped a foundry to control their rejection. They focussed on the manual metal casting operations such as pouring, sand preparation, mold making, shakeout etc. They used different quality control tool such as Pareto analysis and Cause and Effect diagram to sort the defects and identify the root cause respectively. The defects are like mold shift, shrinkage, mis-run/cold shut, blow holes and porosity etc. Accordingly they suggest remedial actions by studying the roots of defect like automation at some stages e.g. change manual shakeout to vibratory shakeout system and use of automatic monorail. Initially the rejection was around 30%, after taking preventive actions it came down to around 10%.

Siekański and Borkowski (2003) have used Ishikawa diagram and Pareto analysis to detect the root cause of different non conformities. The paper shows some simple techniques which can be used in identification of the main course of defects in production of castings for heavy industry. It proves that the basic influence on castings quality have material factors, accepted technology and as well as human factor. Ishikawa's diagram represents in a complex manner, factors which are responsible for examined problems - large quantity of defects are caused by material and negligence of employees and technology. Their main focus was on the defects occurring due

Corresponding author:* **Sidhant Arvind Karnik
B.Voc (Foundry Technology), Vivekanand College, Kolhapur, Maharashtra, India 416003

to negligence of human while working. By correcting human factor they posted 2% reduction in present percentage of rejection.

Vijayaram *et al*., (2005), explain some of solutions and quality control aspects in a simplified manner to eliminate the unawareness of foundry industrial personnel who work in casting manufacturing quality control department. They have focused on the awareness of quality of the final casting. They have used the statistical quality control tools to reduce the non-conformities. Careful supervision with effective motivation of individual will reduce the rejection and scrap. The authors have concluded that final quality of casting has a share of each individual working in an organization.

Borowiecki *et al*., (2011), described the use of Pareto method to distinguish between major defects leading to higher casting rejection. The analysis of causality of formation faults in castings was showed, that a few dozen per cent of casting faults can arise by reason of incorrect construction of gating system. Gating system is the main reason for many defects. The authors have suggested a suitable solution to each defect. Inadequate gating system construction can be of cause of various casting defects, such as misrun of casting, porosity, slag inclusion and shrinkage. Practices for exerting quality control need to be considered in early stage of planning.

Senthilkumar *et al*.,(2009), studied the pull down defect. The reasons for pull down effect are pouring temperature, carbon equivalent and gating system. Each factor was analysis for three signal levels. The estimated robust design factors values were analyzed using ANOVA technique. Using Taguchi method with L18 orthogonal array they used different combinations to form optimum levels of them to reduce rejection due to pull down effect. They found the acceptance raise to 96% from 86%.

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.

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. Eventually rejection is observed to be improved to 3.59% from 10%.

Chokkalingam and Nazirudeen,(2009), present a systematic approach to find the root cause of a major defect (mold crush) in an automobile casting produced in a medium scale foundry. The origin of the mold crush defect was identified by means of analyzing tools and processes using defect diagnostic approach as well as cause and effect diagram. Finally, it was found that the core was the root cause for this major defect. The necessary remedial action was made in the core box to take the core as a single piece. The major mold crush defect was totally eliminated after using single core in regular production. The total rejection was reduced to 4% from 21%.

Bhattacharya *et al*., (2012), have carried out analysis of casting defects and identification of remedial measures. Diagnostic study carried out on Trunion Support Bracket (TSB) Castings revealed that the contribution of the four major common defects in casting rejections are sand drop, blow hole, mismatch, and oversize. It was noticed that these defects are frequently occurring at particular locations. Systematic analyses were carried out to understand the reasons for defects occurrence and suitable remedial measures were identified. Outcome of the validation trials showed substantial reduction in rejection of castings. They suggest standard operating procedure and sponsors accepted it. 77 % reduction in rejection was reported.

A study by Nerle (2013), deals with the procedure to analyze and minimize sand drop casting defect in automobile Cylinder block of grey cast iron in foundry. The primary tools used in this investigation process were the check sheet, cause-and-effect diagram, cause-and-effect matrix, and why-why analysis. Causes are classified into two types, measurable causes which are deeply investigated and non-measurable such as mixing of dry sand with prepared sand, Sand in runner bar. The work showed that the quality tools are an effective way of investing and minimizing rejections due to non-measurable causes. Rejection reduced from 37.17% to 16.3%.

A.G.Thakare, Dr.D.J.Tidke (2016), studied various defects occurred in the duplex molding process. They focused on the systematic way on finding the root cause for every defect rather than old trial and error method. Bar chart is used to show the rejection percentage of different defects. They explained various defects and their probable or common root causes with remedies. Showed reduction in rejection percentage of duplex molding process with the systematic approach to find root causes for each defect.

Abolarin *et al*., (2010), studied effect of moisture content in molding properties using Tudun-Wada clay of River Niger sand, as a binder. All the result obtained show that the sand properties were affected by the quantity of moisture content and other factor such as clay. The moisture content has the effect on the sand properties at varying quantity of moisture, sand and fixed amount of clay. Focus on determination of green and dry compression strength, determination of green and dry shear strength, permeability too. River Niger sand is found to be suitable for use as foundry molding sand. Tudun-Wada clay could serve as a satisfactory alternative to bentonite for use as binding clay in foundry and mold. The molding mixture of Tudun-Wada clay and River Niger sand with appropriate water content is suitable for ferrous and non-ferrous alloy casting of components.

Kermanpur *et al*.,(2008), studied flow of metal within mold cavity, by three dimensional analysis with the help of software FLOW-3D. The commercial code use to track the front flow of molten metal by volume to fluid method. Break disc and flywheel are the two automobile parts under study. Number of mold cavities is another area under study. The turbulent flow approach is used to study the filling of molds for three or four mold cavities. 3D model was developed for three and four

cavities. They found four cavity model is suitable for mold filling in getting more uniform casting quality. The simulation model is also able to study the pouring time, melt super heat, gating design and mold surface roughness.

Prasan Kinagi, Dr. R.G. Mench (2014), emphasis on the use of quality tools. They used Pareto chart to sort the defects, FMEA method to find the potential failure mode and cause of potential failure of defects, studied the process parameters using DOE approach though L9 orthogonal array based on Taguchi method and Minitab software used to get the final results for each process parameter. Process parameters such as pouring temperature, inoculants, and moisture content and sand binder ratio is studied. Rejection percentage reduced by finding the optimum levels for each process parameter. The percentage contribution of error is within 10%, which indicates that, no important factors are left out from analysis.

Siddalingswami. S. Hiremath and Dr. S. R. Dulange (2015) have studied the different literatures for the reduction in rejection percentage (40%) of a 4R cylinder block. They have collected different technique used by others to control the rejection. Accordingly they have classified defects occurred in following categories as Filling related defect, Shape related defect, Thermal defect, Defect by appearance. After studying all the techniques and categorizing defect; formed the conclusion that, the casting defects can be minimized by an intelligent methoding and simulation using casting software.

Avinash Juriani (2015) emphases on sound knowledge about the casting defects and the techniques used apart from trial and error method. It is an industrial case study. Author studied different defects in different cast components. Used Ishikawa's diagram for rejection analysis. The author analysed different defects and provide their probable causes with remedies. This study will be highly usefulin reducing casting defects in industries and improving the quality of casting with minimized rejection. Foundry professionals will find it highly useful in increasing the yield of casting.

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 is used to collect the data, Pareto is used to sort major defects, Ishikawa is used to find possible causes, and Brain storming is used 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%.

Udhaya Chandran. R.M (2013) optimized the process parameters which are green compression strength, mold hardness, moisture content and sand particle size. Sand drop, blow holes, pin holes and scab are the defects studied. Taguchi approach is used to capture the effect of signal to noise ratio of the experiments based on the orthogonal array (L9) used due to optimum conditions are found. Quality of casting can be improved by aesthetic look, dimensional accuracy, better understanding of noise factor and interaction between variables, quality cost system based on individual product, scrap reduction, reworking of casting and process control. The rejection is reduced to 47% through systematic approach.

DISUCISSIONS

Here a systematic Literature review is carried out to analyze the depth of work in the field of casting rejection control using various techniques. Various casting defects such as cold shut, mould shifting and dimensional errors etc. are reported along with the methodology to overcome the defect. Thus research can be carried out to in this field to achieve quality improvement by using QC tools to obtain better control.

CONCLUSION

It is difficult to achieve zero percent rejection or defect free casting. The final quality of casting depends on each and every department which helps to complete molding process. There are different process factors which can reduced or increase the rejection percentage. Different approaches were used to control the rejection. Traditional trial and error approach is most commonly used in small scale industries. This approach is time consuming and may become costly. The new systematic approach i.e use of statistical quality tools and simulation software are more versatile and neat approach to collect and analysis the data. It is time saving and economical.

References

Aniruddha Joshi, L.M. Jugulkar (2014), Investigation and analysis of metal casting defects and defect reduction by using quality control tools, *International Journal of Mechanical and Production Engineering*, ISSN: 2320-2092.

K. Siekański and S. Borkowski (2003), Analysis of foundry defects and preventive activities for quality improvement of castings, ISSN 0543-5846.

T.R.Vijayaram, S. Sulaiman, A.M.S. Homouda, M.H.M. Ahmad (2005), Foundry quality control aspects and prospects to reduce scrap rework and rejection in metal casting manufacturing industries, *Journal of materials processing technology* 178, 39-43.

B. Borowiecki, O. Borowiecka and E. Szkodzińka (2011), Casting defects analysis by the Pareto method , Archives of Foundry Engineering, ISSN (1897-3310), Volume 11, 33 – 36.

B. Senthilkumar, S.G. Ponnambalam and N. Jawahar (2009), Process factor optimization for controlling pull-down defects in iron casting, *Journal of materials processing technology*, pp 554-560.

Rajesh Rajkolhe, J. G. Khan (2014), Process Factor Optimization to Enhance Productivity of Green Sand Casting Process by Using Taguchi Methodology, *International Journal of Research in Advent Technology,* E-ISSN: 2321-9637.

Uday A. Dabade and Rahul C. Bhedasgaonkar (2013),Casting Defect Analysis using Design of Experiments (DoE) and Computer Aided Casting Simulation Technique, CIRP Conference on Manufacturing Systems-7, 616 - 621.

B Chokkalingam, SS Mohamed Nazirudeen (2009), Analysis of casting defect through defect diagnostic study approach, 1. *Journal of Engineering Annals of Faculty of Engineering Hunedoara*,Volume 2,pages209-212

Dr. D. N. Shivappa, Mr Rohit, Mr. Abhijit Bhattacharya (2012), Analysis of Casting Defects and Identification of Remedial Measures – A Diagnostic Study, *International Journal of Engineering Inventions* ISSN: 2278-7461, Volume 1, Issue 6, PP: 01-05

Vaibhav Nerle, Sachin Shinde (2013), Analysis of the Sand Drop Defect to Reduce the Rejection level of Cylinder Block Casting-A Case Study, *International Journal of Engineering Research & Technology* (IJERT) ISSN: 2278-0181,Vol. 2 Issue 9

A.G.Thakare, Dr.D.J.Tidke (2016), Casting Defect Analysis Using DMAIC, *International Journal of Innovations in Engineering and Science*, Vol. 1, No.3.

M S Abolarin, S A Lawal and Abdul Rahman Asipita Salawu (2010), Effect of Moisture Content on the Moulding Properties of River Niger Sand Using Tudun-Wada Clay as a Binder, AU J.T. 13(3),PP: 170-174

Kermanpur, A, Mahmoudi, S, Hajipour (2008), A Numerical simulation of metal flow and solidification in the multi-cavity casting moulds of automotive components. *J Mater Process Tech;* 206: 62-68.

Prasan Kinagi, Dr. R. G. Mench (2014), A development of quality in casting by minimizing defects, *International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME)* Vol.1, Issue 1, pp: 31-36

Mr. Siddalingswami. S. Hiremath, Dr. S.R.Dulange (2015), Advance Techniques in casting Defects and rejection analysis: A Study in an industry, *International Journal of Innovations in Engineering research and Technology*, ISSN: 2394-3696 Vol.2 Issue 9.

Avinash Juriani (2015), Casting Defects Analysis in Foundry and Their Remedial Measures with Industrial Case Studies, *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)* Volume 12, Issue 6 Ver. I , PP 43-54

B. R. Jadhav, Santosh J. Jadhav (2013), Investigation and analysis of cold shut casting defect and defect reduction by using 7 quality control tools, *International Journal of Advanced Engineering Research and Studies*, (2249-8974) ,PP:28-30, 2013.

Udhaya Chandran. R. M (2013), Optimization of process parameters to minimize the casting defects *International Journal of Advances in Engineering Science and Technology* (2013), ISSN: 2319-1120.

How to cite this article:

Sidhant Arvind Karnik *et al.*2017, Casting Quality Improvement And Rejection Control Methodology Using Statistical Tools: A Literature Review. *Int J Recent Sci Res.* 8(12), pp. 22470-22473. DOI: http://dx.doi.org/10.24327/ijrsr.2017.0812.1271

****