# REVIEW ON PRODUCTIVITY IMPROVEMENT IN CASTING INDUSTRY

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### Abstract
The purpose of this study is how we can enhance the productivity for small and medium scale casting industry. This study is focus on casting processes in various casting industries. It is required that a industry should have defect free operations to lower the manufacturing cost and higher the productivity with high quality to survive in present cut-throat competitive environment of market. During the casting there are a number of casting defects occurs due to material nature ,sand properties and manual operations. In an organization  productivity, profitability, quality  can be directly affected by casting defects .As we know casting process is a state of art with experienced people, but these experience needs to be transformed in engineering knowledge for the better growth of the casting industries. In this study we discuss the various defects of casting and suggest remedies for the defects in a day to day activity.

**Keywords:-**Productivity, Casting, Casting Defects, Process Mapping, Quality tools

## 1. Introduction:-
Today a number of casting industries are suffering from poor quality and productivity due to involvement of a number of process parameters in casting process even in a completely controlled process. Defects in casting are due to process of uncertainty. The diagnosis is done with the help of some techniques which are mainly classified into conventional and advanced techniques. For complex designs, conventional method does not give correct solution, hence some advanced tools are used. There are a lot of variables in the production of a metal casting that the cause is often a combination of several factors rather than a single one. When these various factors are combined, the root cause of a casting defect can actually become a mystery. It is necessary for quality and productivity enhancement that all the data relevant to casting defects should be identified and eliminated by taking a appropriate remedial action. Hence various tools and techniques have been used to identify  the reasons that are responsible for defect in  casting which is the one of the reason for lower productivity of an organization. our study focused on how quality control tools are used to improve the productivity in a casting  industry.

## 1.1 Objective of the study:-
The main objective of this study is how to use the quality control tools to enhance the productivity in small and medium scale casting industry for the growth of companies in future. This study is based on the work of various researchers on small and medium scale casting industry, where production of metallic parts is done  by using casting process. Here we review the research work made by several researchers and try to get technical solution for minimizing various casting defects to improve productivity.

## 2. Literature Review:-
Different-different  Paper give different-different idea about which tools and technique used in casting industry and also give information about implementation of end solution. Now in these day's casting industry produce a variety of product of ferrous and non ferrous.. We will also discussed about various casting defects occur in casting industry like shrinkage , blow hole , porosity , pinhole , sand inclusion , cold shut , miss run , surface discontinuity , mould break , flash etc . This study gives the  idea about how the defects occur and which types of precaution should be taken in future to minimize the defects. T.R.Vijayaram et al. (2006) explainedquality control aspects in a simplified manner to eliminate the

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unawareness of the foundry industrial with how to use quality tools & their effect on end result. VivekPatil and Mahesh Sutar (2015) illustrated Pareto chart and cause effect diagram can be used as defect diagnostic process for collected data to improve productivity and reduce the rejection in casting. Suyash et al. (2017) stated that the use of quality tool is major in identifying different type of defect and accordingly suggests them the remedies so that these tools widely help to identify the root cause and try to control those root cause. This study helps us to understand implementation of these technique in casting industry to achieve maximum productivity in a organization.

## 2.1 Productivity:-

As per ILO productivity is the ratio of aggregate output to aggregate input. Simply the productivity is defined as :

P= O/I (output / input)

P= Productivity,O= Output from the system,I = Effective Utilization of the input resources.

## 3. Casting Process:-

It involves a number of define processes that convert raw material in to final required Casting .Based on various researches we try to find best casting process in which it incorporated all the activity.
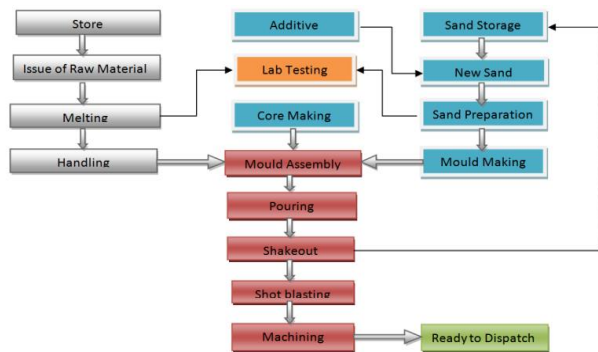


*Fig.1 Casting Process*

In manufacturing industries casting process is the most widely used . The activities concerned in castingprocess are as:-

1.Pattern making                    2.Core making

3.Sand for mold preparation

    4.Fitting of pattern

5.Filling and ramming of sand.

    6.MakingGating system

7. Remove prepared mold              8. Placed for pouring

9. Fill the mold cavity with molten metal

    10.Allow to solidify

11.Remove the cooled desired casting.

Above activities are usually usedin manufacturing because of its simplicity in process, cost-effective to operate and easy to produce castings.Casting process involves a number of interactions amongvarious parameters and operations related tometal composition, methods design, moulding, melting, pouring, shake-out, fettling, machining andinspection etc.

## 4.Commonpractice for reducing casting defects:-

A defect diagnostic approach is used for analyzing the casting for defects that is shown in the figure below.
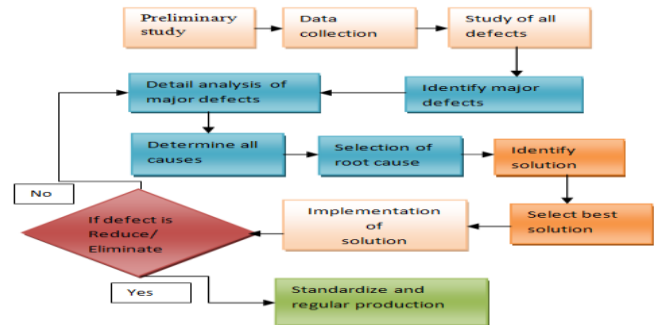


*Fig.2 Flow diagram(For Reducing Casting Defects)*

It shows the defects analysis process to find the root cause of occurrence of defects and helps to take necessary action to reduce defects for improve the casting yield hence improved the productivity.

### 4.1Different activityinvolved are as:-

1. Preliminary study

    2. Data collection

3. Study of all the defects

    4. Identify major defect

5. Detailed analysis of the major defect

    6. Determine all causes

7. Selection of Root cause

    8.Identify solution

9. Selection of the best solution

    10. Implement that solution in company

11. Standardize and regular production

## 4.2 Main Types of Casting Defects and

**Their Remedies**:-In molding process causes for defects in castings which may be eliminated with best molding practices or repaired using method such as welding and other metal working processes. Some of the major defects in sand casting production with possible causes and proposed remedies are listed in Table.

*Table 1. Casting defects their cause and remedies*

| S.No. | Types of Defect | Nature of Defects | Possible Cause of Defects | Proposed Remedies |
|---|---|---|---|---|
| 1. | Gas Defect | Blow holes, Open blows, Air inclusion, Pin hole porosity | Gas pass through mold, Improper design of gating | Evacuation of air and gas from the cavity and increase the permeability of mold core |
| 2. | Shrinkage Cavity Defect | Solidification problem | Proper flow of liquid and solid state, Poor casting design | Proper casting design and feeding of molten metal. |
| 3. | Mold Material Defect | Cuts, Washes, Metal penetration, Fusion, Run out, Buckles, Swell and drop | Molding sand erosion , Not having enough strength, Higher pouring temperature and faulty molding practices | Proper selection of molding sand and molding method, Correct pouring temperature and suitable molding practices. |
| 4. | Pour Metal Defect | Miss run, Cold shuts, Slug inclusion | Molten metal not filling the cavity completely, Improper pouring | Having sufficient molten metal in the ladle to fill the cavity, Proper gating system, Proper use of pouring crew and practice. |
| 5. | Metallurgical Defect | Hot tears, Hot spot | Poor casting design, Damage at shake out | Casting design Improvement, Proper Metallurgical control. |
| 6. | Shifting Defect | Mismatch | Shifting of molding flashes. | Use of proper molding box and closing pins. |

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**4.3 Methodologies :-**The Seven Basic Tools of Quality is a designation given to set graphical techniques and most helpful for troubleshooting issues related to quality and productivity.



*Fig.3 Quality Tools Flow Chart*he tools are suitable for people with little knowledge on statistics and can be used to solve majority of quality related issues shown in Figure .

**4.3.1Check Sheet:-**
The rejection data was obtained from the casting and placed in a tabulated form for the convenience to use and understand. Rejection data sheet are large data sheet showing all the information about the rejected items. So we can say that the different defect are considered while analysis  with the help of the check list it help to identify the major defect and help towards root cause of the element coming in the particular .

**4.3.2Brain Storming :-**
It consists of a group of members from different departments which includes pattern shop manager, quality manager, melting supervisor, molding supervisor, fettling supervisor, core shop supervisor and high level management members and also shop floor members. They sit together and find out the cause behind the defects and their remedies.

**4.3.3Fish Bone Diagram:-**
The major defect are selected and there cause and effect diagram are developed it gives us the deep idea of what are thereason and how can they be overcome to reduce rework .The Root - Cause analysis is carried out for one of the repeated defect of Sand Inclusion which is elaborately given in figure below.
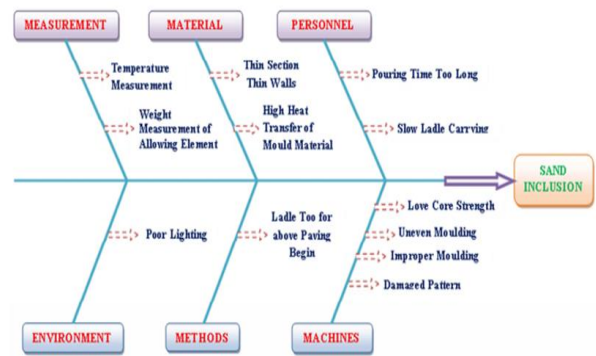


*Fig.4  Root-Cause Analysis for sand Inclusion*

**4.3.4Control Charts:-**
A control chart as a tool of the Statistical Process Control (SPC) is a graph used to display how a process changes over time.The control chart always has a central line for the averagevalue(CL –Central Line), an upper line for the upper control limit and a lower line for the lower control limit.The control chart provides users with on-line view to the process behavior and its advantage is simplicity of its construction and ease of its application. The control
chart can be also used for controlling ongoing processes and correcting problems as they occur.

**4.3.5Histogram:-**
Histograms are used to define the product produced and the defective product in that particular month. Then effect ofremedies causing decrease in the rework. It defines number of defect in the month on one axis and the month in which onthe other .It represents a visual display of data observed frequencies versus the number of defects. The height of each bar is equal to the frequency occurrence of the defects. The shape of histogram showsthe nature of the distribution of the data.
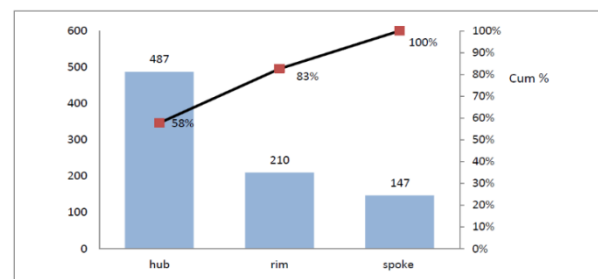


*Fig.5Histogram for shrinkage defects in aautomotive  component casting*

**4.3.6  Scatter Diagram:-**
It is basically used to know that the product is under the proportional limit and gives broad idea of the proportional limit.For identifying a potential

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relationship between two variables Scatter Plot is used. By using this plot, a positive, negative or no relationship between variables can be detected. A scatter diagram for the number of pin holes and casting machine parameter is given below figure.
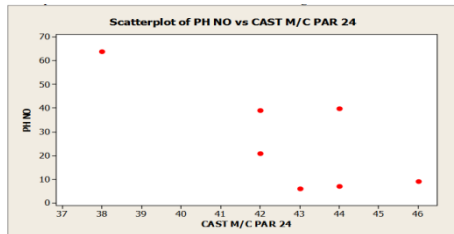


*Fig.6 Scatter diagram*

### 4.3.7Pareto chart:-

The chart use to define the cumulative frequency of the defect in overall defect of the casting. It directly defines the major defect in the casting and with their percentage of involvement .
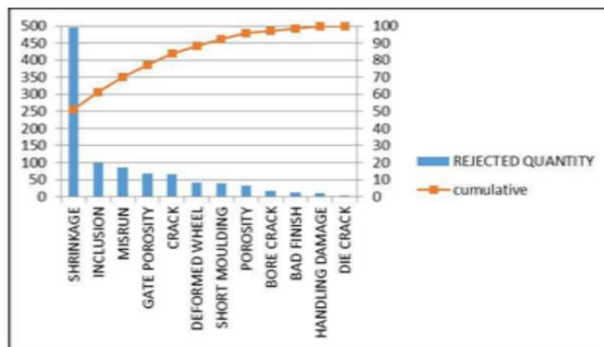


*Fig.7Pareto chart*

## 5. Conclusion:-

To get high quality and productivity using of advanced mechanical engineering software and simulation techniques is boon for manufacturing industries. To stand and compete world wide, an organization should focus on customer delight instead of customer satisfying. Above discussed tool scan be useful to reduce the rejection and enhance the quality and productivity. For better quality of casting we should utilized a number of optimized parameters regarding man, material ,machine, process etc. In India there are number of small scale casting industries which can implement such techniques to improve the their productivity .

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