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Total Production Management of Non-Ferrous Casting

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***Abstract*:- As we know that the foundry industries are suffering from the poor quality and productivity due to some of the parameters. Even in the fully controlled process, defects are found in the final product hence the casting process is known as a process of uncertainty which challenges the remedies of the defects generate in casting. 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. Mould shifting, Crushing, Lower Surface finish, Shrinkage, Porosity, Cold shut and Extra material are common casting defects due to these manual operations. These defects directly affect on productivity, profitability and quality level of organization. Our main aim in this research is to increase the productivity by atomization of the industry and by using the Kanban system. This research paper includes the modified vertical design of the crucible tong lifting device which reduce the extra worker at single point, new and modified barcode system which helps to remember the data for long time and to analyze the quality of work done by the workers. In this research paper an attempt has been made to increase the quality and quantity of the final product.**
In this paper design, design analysis and new barcode system explained with calculations.

Keywords: - Sand Casting, Crucible, Furnace, Tong, Mold Boxes.

1. INTRODUCTION

Metal casting industries are mainly divided into two parts ferrous material casting, non-ferrous material casting. In non-ferrous casting iron material is not present. So, the moisture content in the sand will not affect the final product. That is why the sand casting is widely used in the casting of non-ferrous material casting like aluminum, bronze, gunmetal etc. Sand casting can produce a number of various and difficult size and shape of the parts very easily. In the aluminum or bronze casting a crucible is used in which the scrap of the metal is put and then it placed in the furnace for melting down. Generally crucible are made from the high heat resistance material graphite.

There are so many variables in the production of a metal casting that the cause is often a combination of several factors rather than a single one. All pertinent data related to the production of the casting defect is identified an attempt to eliminate the defect by taking appropriate corrective action is necessary for quality enhancement. The defects need to diagnose correctly hence Kanban System and Total production management system are used to identify and classify the reasons that are responsible for defective casting production and lower productivity of the industry[3]. This diagnosis is done with help of some techniques which are mainly classified into conventional and advanced techniques. For intricate designs, conventional method does not give correct solution; hence some advanced tools are used [4].

1.1 OBJECTIVES OF PAPER

Main intension of our study is to provide a quantitative result that will increase the productivity of the non-ferrous casting and to decrease the wastage of the material with help of barcode system. But due to lack of timing or sometimes in order to get more wages by producing more and more batch of product workers do "truancy" which means they skip any of the required process from the sequence like degassing, scrap removal process, improper lubrication, etc. in result of that final product will be poor quality, or sometimes we get 100% defective piece.

2. GENERAL PROCEDURE FOR ANALYSIS CASTING DEFECTS

The general procedure for analysis of the casting defects is taking place with help of the Defect Diagnostic Approach, as shown in the figure below,

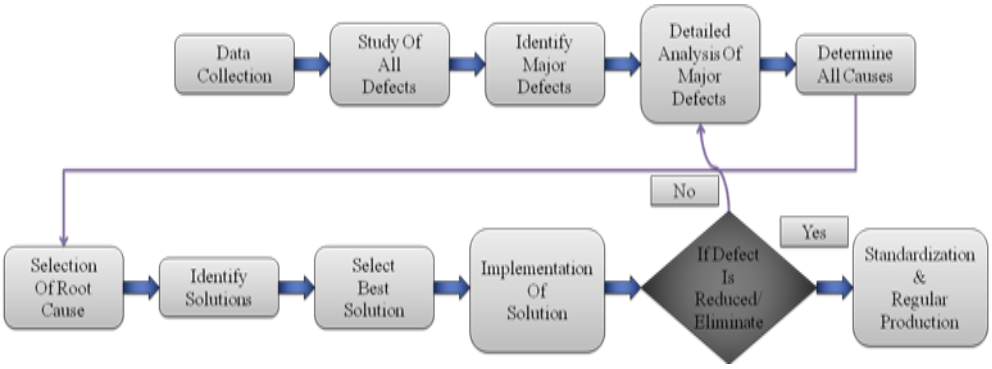

Fig. 1 Defect Diagnostic Process [4]

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Vol. 6 Issue 05, May - 2017

The study was made in a small scale foundry producing a varieties of non-ferrous casting. The rejection in the casting due to breaking of core or mold is a major problem among the many castings produced in the industry.

2.1 Data Collection

For casting industries 5% of rejection rate is considered as a normal rejection rate[2]. But after analyze the industry we came to know that it is approx 8-9% in the reality. After analysis of 2 months finally we get following graph of rejection rate Vs. date of production.

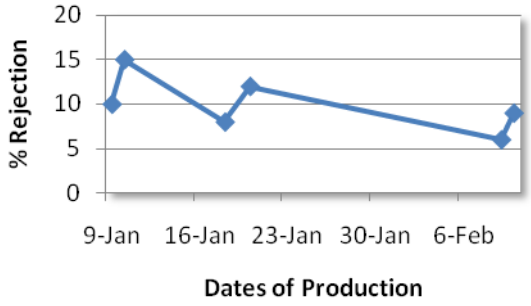

Fig. 2 Analysis report of 2 months production rejection

2.2 Study About Defects Occurring Reasons

After realizing the major difference between theoretical and real numbers it is our next step is to study about the causes due to which defects occur either it maybe technical reason or manual reason. For that lets analyze on the 20 parts and we get following result.

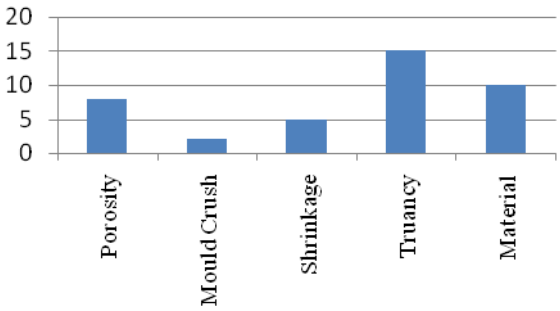

Fig. 3 Main Casting Defects Reasons

2.3Analysis Of Defects

A detailed examination of the rejected casting is required to identify the root cause of the defects. We know that porosity is one of the major problem occur in the casting process. So we analyze that weather the porosity was occurring in particular days or in particular atmosphere or it was distributed all over the days regularly. But after analysis we came on result that porosity problem is normal for casting problem and it occurs normally in everyday in every atmosphere. But like as we talked earlier that casting process is process of uncertainty anything is possible. There is not a single cause/reason which involve behind the casting defects. Material and atmosphere are equally responsible as the workers.

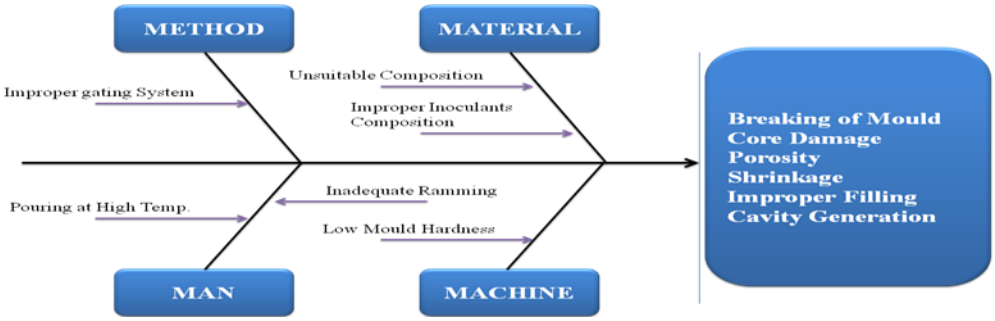

Fig. 4 Cause- Effect Diagram For Casting Defects[5]

For more detailed study of the defects generated in the sand casting be took following equations which are based on the Total Production Management(TPM) System.

Productivity = productivity of the any industry can be given by the following formula,

$$productivity = \frac{Output}{input}$$

According to the above equation if industry wants to increase their productivity then either they can increase the output at same input or they can decrease the input.

Quality = quality of the production is calculated on the final output of the company. For example if the company is producing 100pieces of casting in a single day from which 15 pieces are defective then quality rate of the industry for that particular day will be calculated as follows

$$Quality = \frac{Good\ Count}{Total\ Count} \times 100$$

$$= \frac{85}{100} \times 100$$

$$= 85\%$$

To increase the quality of the final product it is necessary to reduce the number of defective pieces produce. In this research to increase the quality of final product new modified barcode design made.

Efficiency = efficiency of any industry is called how effectively a industry can generate maximum output in short period of time.

$$efficiency = \frac{Actual\ Output}{Expected\ output\ in\ running\ time}$$

A good example of an effective set of plant floor metrics is TAED:

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Vol. 6 Issue 05, May - 2017

T :- Target (A real-time production target driven by the planned rate of production)
A :- Actual(The actual production count)
E :- Efficiency(the ratio of target to actual; how far ahead or behind production is running in terms of a percentage)
D :- Down Time (accumulated unplanned stop time for the shift updated in real-time; this keeps a strong focus on a key actionable improvement area) [11]

By analyze the current scenario we observe that in the small scaled industries due to lack of proper planning, laziness of the engineer or the workers, old technology, inventory issues time waste rate is very high.

During the process analysis we found that sometimes workers finished their work on the time but due to some problem metal in the furnace not melt completely so they have to wait for it and production of the company stop.

To increase the productivity if the industry we use the **Total Production Management(TPM)** system and along with that to reduce the truancy effect we use **Kanban System**. It is easy to say that by keeping eye on the each worker or by keeping an engineer material wastage and truancy effect can be reduced but, It looks quite impossible to keep an eye on each and every worker of the industry. So, instead of keeping eye on each and every worker we invent a new barcode system. A new modified barcode which can give the information about the casting part like, date of manufacturing, Name of Worker , Batch Number, Furnace type, etc.

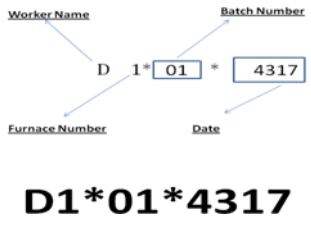

Fig. 4 Modified Barcode Design

With use of the new barcode system owner of the industry can easily identify which worker is skipping the work flow.

We observed that In the small scaled industries there are majority of the workers are uneducated. So there is no meaning of showing them and giving them a instruction manual about the safety and process. Just because they cannot read or write it does not mean that they are not talented to reduce this education gape we made a pictorial posters and stickers to make them understand that place where they work is how much safe.

Fig.5 Systematic Arrangement for reducing time wastage in industry

In order to increase the productivity of the casting industry we analyze the whole procedure done to produce a single piece of casting. We check that there is too many time losses generated during the process due to that work stopped or process stopped. We found that the tong using by the small scaled casting industries is too heavy approx **11.27Kg.** and after melting the aluminum inside the tong it becomes more heavy according to data received from the workers it becomes **80-90 times** more in weight than it's empty. It means every time during the process of pouring the workers pickup **100-120 kgs.** During the process of pouring there are **3 workers** are required to pickup and to displace the tong from one place to another. Due to that during the process of the pouring molten metal spread outside the mold and to hide their theft workers add sand above it so that waste metal hide from the owner.

In the vertical tong 3 persons are required during the process of the pouring and that makes it more difficult because if any of the person move then the motion of the molten metal become uneven which will lead it to the material wastage. To overcome this problem we design a new tong which is vertical and which can lift over **150 Kg.** easily with help of only two workers.

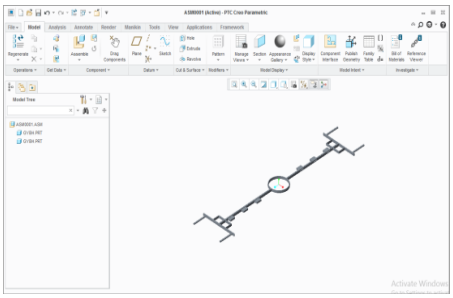

Fig. 5 Vertical Tong

In the modification of the design we consider all the safety factors for the workers. We used **Fe-20** Material for designing this tong. Total weight of the tong will around 13.57 Kg. but the main important thing of this tong is that it can easily handle by two workers.

Table No. 1 Configuration Of The Tong Design

Material Of Tong	Fe-26
Diameter At Center	250 mm
Thickness Of Rod	8mm
Width Of Rod	30 mm
Total Length Of Tong	600 mm
Length Of Handle	250 mm
Total Weight of unit	13.57 Kg.

The reason behind using Fe-26 material is it's melting point and overall life of the material. During the casting of non-ferrous material maximum temperature of the furnace is 1200-1300ºC and the melting point of the fe-26 material is 1538ºC. There are few advantages and disadvantages of the tong are as written below:-

Advantages

1. Light in weight.
2. Easy in process of pouring.
3. Self locking system for quick connection and for safety purpose.
4. Due to incline shape at the center it is impossible for crucible to slip.
5. Compact in size so it is easy to store in small place.

Disadvantages

1. Fully manual.
2. Can carry limited 100 Kg. weight.

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By using the some conventional methods wages and time require for production can be reduced. But in the developing countries Still strongly believes that "**An experienced worker can do far better than a mindless machine**". That is why still old hand mold making system is used widely in it. Keeping both the points in the mind we made a new design of the tong which is semi automatic. In other words you can say that we combine both conventional method as well as old method and create a new design of the tong which works on either way.

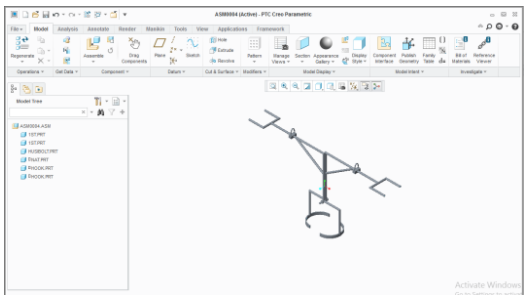

Fig. 6 Semi Automatic Tong

When the two workers pickup the tong the diameter at the end of the tong decrease. Again we used Fe-26 material for making this tong.

Table No. 2 Configuration Of Semi-Automatic Tong

Material Of Tong	Fe-26
Diameter At Center	250 mm(can vary)
Diameter Of Rod	ϕ 12 mm
Total Length Of Tong	600 mm
Length Of Handle	250 mm
Total Weight Unit	8.42 Kg.

Few advantages and disadvantages of the Semi automatic tong are as written below:-

Advantages

1. Very light weight.
2. Operated dual way either manually or automatically.
3. Can carry Maximum 100 Kg. with it.
4. Its incline round shape make it more hard on the surface of crucible.

By using the above modified and upgraded techniques time required for production will definitely decrease. But besides of this all techniques there are some concept and system with help of them also the productivity of the industry can be increased.
One of the concept is very widely used by the heavy and big industries at a very wide range but there are still some of the points of that which might be used for the small scaled foundry industry. **Just In Time(JIT)** is very wide and very used concept at a high level companies.

3 JUST IN TIME (JIT) CONCEPT

As a definition, JIT is a manufacturing philosophy that aims to eliminate wastage, generating from the different sources in industries. The basic concept of JIT is that the industries should produce what is needed, when it is needed and in how much quantity is needed. JIT is more than just a production and inventory planning and control system analogous to the well-known material requirements planning (MRP) systems. JIT covers all aspects of the production and inventory flow process, covering not only the work-in-process (WIP) inventories, but also the flow of finished goods from manufacturing to distribution centers in the forward direction and, in the backward direction, the flow from suppliers. [7] The cost that saved by implementing the JIT technique can be used to employ the other methods to reduce the rejection caused by casting defects.
The concept of JIT is majority used for the mass production company or some medium scaled industries. But still there are some points and concept of the JIT concept that can be used by small scaled industries which can help industries to grow and increase the productivity. In the JIT concept there are some facts which can be used by the small scaled industries are as written below: -

According to JIT concept

1. **Over production should be avoid**, in the case of foundry industries the over production of molten metal should be avoided.
2. **Waiting of raw material should be avoid**, in the case of the foundry industries raw material like sand, coal, scrap to be melt, binder etc. should be kept in enough that waiting of it can be eliminate.
3. **Excess Inventory should avoid**, the raw material should be only stored only enough that production not stopped.
4. **Non-Value-Added-Processing should avoid**, non value added process like excess machining of final product should be minimized.
5. **Excess Motion should avoid**, here it means that industry should be planned such that the flow of the material process should be linear and minimum.

4. CONCLUSIONS

We have implemented above techniques in the small scaled non-ferrous casting industry to detect and further to reduce the rejection caused due to different casting defects. All the techniques as discussed above can be implemented in the small scaled industries to increase the productivity. JIT is the technique which can also be used in casting industries for reduce the time wastage and to get better productivity.
From the all research and analysis of the all details following conclusions can be given shortly as follows,

After implementing the new designed tong the requirement of the worker will reduce to previous one. Due to this extra worker can start other work in that time, at the end by implementing this productivity of the industry increased.
After using the new modified "barcode" system workers work with more accurately and the rate of truancy will decrease also the quality of the final product will increase.
Due to automization of the industry the quality of the final product increase.
Working efficiency of the workers will increase. Safety of the workers will also increase.

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