Casting Weight Optimization

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Abstract- The work in the present paper is based on the study conducted in a foundry industry. The industry manufactures the castings and fittings for CI and DI pipes as per Indian standards (IS). The current production of the firm is around 200 tons per month. Most of the castings manufactured are sold on the unit basis. The firm faces the problem of non provision of standard weights for any type of fittings made as per IS in IS. This leads to uncontrolled extra weight addition in castings which still conforms IS, causing increase in cost of production. Based on the literature study and plant study the paper suggests a methodology to overcome the problem, the implementation of Kaizen philosophy in the firm for continuous improvement of manufacturing processes in firm. Here the aim is to reduce the weights of the castings as low as possible while still conforming IS to gain competitive advantage.

Keywords—Kaizen, Castings, Fittings, Weights, IS 9523-2000

I. INTRODUCTION

The Indian Metal casting (Foundry Industry) is well established. According to the recent World Census of Castings by Modern Castings, USA India Ranks as 2nd largest casting producer producing estimated 7.44 Million MT of various grades of Castings as per International standards. The various types of castings which are produced are ferrous ,non ferrous, Aluminum Alloy, graded cast iron, ductile iron, Steel etc for application in Automobiles, Railways, Pumps Compressors & Valves, Diesel Engines, Cement/Electrical/Textile Machinery, Aero & Sanitary pipes & Fittings etc & Castings for special applications. However, Grey iron castings have the major share that is approx 70 % of total castings produced.

The study was carried out at leading foundry firm in Nagpur, India. The firm is a prominent manufacturer of Cast and Ductile Iron and all types of alloy casting like Brake coupling, Brake Body, Pulleys, Brackets, pig mould, gratins, Hubs, Cranks, Gear Boxes etc. The installed capacity of plant is about 10000 MT per annum.

II. PROBLEM IDENTIFICATION

A. Existing scenario

The present issues regarding the manufacturing process and the inspection of castings are outlined as below

- Quality control processes are governed by the IS 9523-2000 in terms of tolerance and the specifications for manufacturing fittings but it do not specifies the weights for the castings.
- Castings are not being made to the minimum weight to which they can be made
- Most of the castings made as per IS are sold on the unit basis.
- Each time the casting is made its weight is to be calculated which is very laborious job and unproductive in nature.
- There are no standard operating procedures (SOP) and checklists in manufacturing department.

B. Effects of existing scenario

The results of the existing scenario has various effects as specified,

- No standardization of weights.
- Problem in identifying the total expense required in manufacturing the order of casting.
- As standard weight for any particular casting is not known, even there are no SOP followed in manufacturing the addition of extra weight in casting or in batch of casting due to the pitfall in the process cannot be identified.
- Overweight in castings.

C. *Objectives*

Considering the problems and their effects in the existing scenario the following are the objectives for the study.

- To calculate the weights of castings for standard, maximum and minimum dimensions conforming IS.
- To reduce the overall cost of casting by reducing the excess weight in castings.
- Continuous improvement in manufacturing process using Kaizen.

III. LITERATURE REVIEW

Purshottam k. Godhia [2], In his research work explains an approach to reduce cost of components by reducing input / final weight of components. Here, Grey & Nodular Iron casting components are considered. The specific methodology and steps are developed by the author to control the weights of the casting within the specified limits. I. Wojtynek [4] explains the importance of the process management in foundry is highlighted and suggested the process management improvement tools like TQM, Kaizen, Just In Time etc. based on his research author concluded that the process management allow foundry to organize the staff and to function better, thus to confirm its competitive position. They also fulfill basic requirements such as: customer orientation, skill to react quickly and to adapt for new requirements, introducing changes to the organization. J. Jezierski, k. Janerka [5] the lack of knowledge about the lean manufacturing is shown in a study conducted in Poland. In this study the author based on his knowledge and research work developed a set of 20 questions. He asked these questions in 300 foundries and concluded that, Although lean tools seem to be well known and widely used, the foundries generally are not much aware of the long-term benefits of such an approach, and the largest problem with lean thinking is that foundry personnel (including engineering staff) are not well educated in this field and have only general knowledge in this area, which is not enough to drive changes inside the plant. Ross Banerjee [7] explains the importance of the Kaizen and the effectiveness of it if implemented carefully in any foundry industry. He also explains how the implementation of kaizen helps in improvement of the processes achieving the best result from the manufacturing of castings. Article review [6] the article defines the concept of Kaizen and the terms included in it. The other basic principles of kaizen like Kaizen philosophy, Kaizen Umbrella, and the three pillars of the Kaizen are defined and briefly explained in the article. Further it also describes the importance of each and every level of employee involvement in the process of continuous improvement of the process they are working in.

A. *Concluding remarks*

With reference to the literature review could be concluded that the existing scenario in the company could be improved by the systematic planning and study of existing quality aspects in the company. By making the analysis of the defects occurring in the products and by compiling the data regarding the products manufactured we can prioritize the castings based on their volume and cost of production and the analysis on high priority products can be done. Further it could also be concluded that if lean manufacturing techniques for waste reduction are applied in the company it can save a lot of material in manufacturing process, hence implementing Kaizen for the continuous improvement of the processes in manufacturing could also lead to lowering the weights of casting. As improved processes can manufacture the castings closer to lower specification limit

IV. METHODOLOGY

Based on the literature review the following methodology is developed to overcome the problem identified

1. Study of existing quality aspects/practices.
2. Defect analysis
3. Compilation of production Data.
4. Analysis of production data.
5. Preparing casting 3D models.
6. Kaizen implementation.
7. Audit

A. *Study of existing quality aspects/practices*

In this stage the current quality aspects and practices which are being followed in the company are to be studied thoroughly. The necessity to study the existing quality practices is to know the tools and techniques currently being used in the firm for maintaining the quality of the products being manufactured.

B. Defect analysis

The study and analysis of various types of defects occurring in the castings manufactured is to be done. This analysis will show which type of defect is occurring on regular interval causing rejections of casting.

C. Compilation of production data

The compilation of the different production records of the firm regarding the manufacturing of different products is necessary if the firm s manufacturing the different types of products by the same method of manufacturing. The following parameters about the casting are to be collected for the brief idea about the trend of manufacturing and rejections occurring.

- Casting Manufacturing process
- Casting Rejection
- Casting Layout
- Machining Process
- Cost of Individual Casting
- Volume/Number of Individual Casting made

D. Analysis of production data

This is the most important step in the plan of action since based on the data being analyzed it will be decided that what are the most manufactured and high value products in the company. The further process improvement and study will be done on the same products. The data is to be prioritized on the parameters like frequently manufactured weight.

E. Preparing casting 3D models

3D model of prioritized castings in suitable designing software for standard, minimum and maximum dimensions is to be made. Providing us actual theorotical weight of the castings based on the density of the metal being used in casting. It will be the reference for the target weight to be acheived, and to know the difference while manufacturing the casting to lower specification limits and to higher specification limits.

F. Kaizen implementation

Kaizen means improvement, continuous improvement involving everyone in the organization from top management, to managers then to supervisors, and to workers. Improvements through Kaizen have a process focus. Kaizen generates process-oriented thinking, it is people-oriented, and is directed at people's efforts. Rather than identifying employees as the problem, Kaizen emphasizes that the process is the target and employees can provide improvements by understanding how their jobs fit into the process and changing it. Thus by implementing the Kaizen the every process involved in the manufacturing of the casting will be in continuous process of improvement. Improved processes will ultimately lead to manufacturing of castings closest to the required dimension in this case it is lower specification limits.

G. Audit

In this stage the comparison of weights and dimensions of fittings of pre implementation of the methodology and post implementation of methodology is to be done. Based on the results of audit, if there is any further necessary action required that shall be taken.

V. RESULTS

From the total production data analyzed of nine months period, Products having 5oo plus units manufactured in that period were selected. Models of these selected castings were prepared in Solidworks 2016 based on the standard, maximum and minimum dimensions specified and conforming IS. The weights calculated using analysis tool in Solidworks 2016 are shown in Table-I.

The density of ductile iron is selected as 7100 kg per metric cube.

The minimum weight of the castings can be obtained if the castings are made with the minimum dimension or with lower limit of specified dimensions. But on the basis of following points, weight comparison of castings made with standard dimensions to maximum weights is done to find the potential saving in weights.

- If the castings are manufactured with the lower limit of dimension then there is more chance that the slight deviation of procedure to manufacture castings may lead to rejection of more castings due to underweight or a casting not conforming IS than usual.

- Considering practical situations if the casting are made with lower limit dimension then there is more chance that the socket or other critical parts in the large casting may fail while in use.
- These above points will lead to loss of profit by increase in rejection than usual.
- Hence for manufacturing castings with optimum weights with lower rejection the castings should be made with standard dimensions conforming IS.

Table -I Weight calculations

Sr. No.	Product	Weight as per standard dimensions	Weight as per maximum dimensions	Weight as per minimum dimensions
1	Standard flange drilling for flange fitting DN 150	4.7	5.8	3.7
2	Standard flange drilling for flange fitting DN 200	6.4	7.8	5.3
3	Double socket 90 bend DN 100	9.3	9.8	7.8
4	Double socket 45 bend DN 100	8.1	8.5	7
5	Double socket 22.5 bend DN 100	7.3	7.7	6.5
6	Double socket 11.25 bend DN 100	7	7.4	6.9
7	Double socket concentric taper 150X100	11.2	12.3	10.1
8	All socket Tee 100X100	12.7	13.5	12.2
9	Flanged socket DN 100	8.6	9.8	6.5
10	Flanged spigot DN100	9.3	10.5	6.3
11	Double flanged 90 bend DN 200	29.1	33.4	21
12	Double flanged 45 bend DN 100	10.5	12.4	7.3

Table –II Weight comparison

Sr. No.	Product	Weight as per maximum dimensions	Weight as per standard dimensions	Potential savings in weight
1	Standard flange drilling for flange fitting DN 150	5.8	4.7	1.1
2	Standard flange drilling for flange fitting DN 200	7.8	6.4	1.4
3	Double socket 90 bend DN 100	9.8	9.3	0.5
4	Double socket 45 bend DN 100	8.5	8.1	0.4
5	Double socket 22.5 bend DN 100	7.7	7.3	0.4
6	Double socket 11.25 bend DN 100	7.4	7	0.4
7	Double socket concentric taper 150X100	12.3	11.2	1.1
8	All socket Tee 100X100	13.5	12.7	0.8
9	Flanged socket DN 100	9.8	8.6	1.2
10	Flanged spigot DN100	10.5	9.3	1.2
11	Double flanged 90 bend DN 200	33.4	29.1	4.3
12	Double flanged 45 bend DN 100	12.4	10.5	1.9

VI. CONCLUSION

In the Table -I the standard, maximum and minimum weights of castings are calculated based on the standard, maximum and minimum dimensions specified and conforming IS. From the Table -II it is clear that there is a marginal difference in the weights of castings manufactured at maximum and standard dimensions conforming IS. Hence if proposed methodology applied successfully on all castings manufactured in the company it would result in manufacturing castings with minimum dimensions conforming IS. Hence castings will be manufactured at optimum weights subsequently reducing the manufacturing cost of per unit of casting and with less chance of rejection after production.

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