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Reducing casting rejection rate in foundry to improve productivity

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ABSTRACT

Production of casting involves various processes like pattern making, molding and assembly, core making and melting, etc. A casting defect may be a result of a single cause or a combination of causes. The single castings have one or more defects. These can be minimized by taking corrective actions in the tools like pattern, mold making, core making, and melting process. This paper presents a systematic procedure to identify as well as to analyze major casting defects. Keeping rejection to a bare minimum is essential to improve the yield and increase the effective capacity of the foundry unit and also improve productivity. This paper identifies the major cold defect. There are many reasons to generate these defects. So it preferably necessary to reduce it as much as possible by appropriate analysis of the defects which includes the root cause analysis so that actual reasons behind occurring the defects can find out to make the corrective action. In this paper use six sigma technique and Shainin tool for identity and analysis casting defect. Shainin tool works on the elimination principle. The final result of this work has to be a cold defect by taking corrective action. The tool should be identifying the sources of variation clearly.

Keywords— *Six sigma, Shainin Tool, Casting defect*

1. INTRODUCTION

The principle 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. The size of the components is varied from very large to small, with intricate designs. Out of the several steps involved in the casting process, molding and melting processes are the most important stages. Improper control at these stages results in defective castings, which reduces the productivity of the foundry industry. All foundry processes generate a certain level of rejection that is closely related to the type of casting, the processes used and equipment available. However, in most foundries, a substantial proportion of rejection results from lack of shop floor supervision and technical control and the use of poorly maintained and inadequate equipment. The rejected casting can only be re-melted and the value addition made during various processes such as melting, molding, fettling and heat treatment etc. is a lost irrecoverably. The casting process is also known as the process of uncertainty [4]. Even in a completely controlled process, defects in casting are found out which challenges explanation about the causes of casting defects. The complexity of the process is due to the involvement of the various disciplines of science and engineering with casting. The cause is often a combination of several factors rather than a single one [4]. When these various factors are combined, the root cause of a casting defect can actually become a mystery. The objective of the paper to reduce defects of casting (cold defect) by using the Shainin tool. For defect analysis and elimination use Shainin tool.

2. LITERATURE REVIEW

Mayank Dev et al. [2] have been focused on the flow of material movement for better utilization of plant area for improves productivity. Objectives towards accomplished this study is to identify problems in the casting and fastening process and improved it in terms of reduction in production time. Prof. Ketki Kaskhedikar et al. [3] have studied the quality Management is an integrated management approach that aims to continuously improve the performance of products, processes, and services to achieve and surpass customer's expectations. B. Chokkalingam et al. [4] have been an analysis of casting defect through defect diagnostic study approach. They are presents a systematic procedure to identify as well as to analyze a major casting defect. T.R. Vijayaram, S. Sulaiman et al. [5] have been studied Foundry quality control aspects and prospects to reduce scrap rework and rejection in metal casting manufacturing industries.

3. METHODOLOGY

Advanced Six Sigma method is Shainin tool. Depending on the type of the problem and the SSV's, the tool has to be selected for troubleshooting, most of the problems will require the sequential application of many tools to reach the root cause(s). In the Shainin tool, there are five steps to find out the suspected cause. In Shainin tool first has to take screening experiment according to their slandered value of all causes. From trial find the batch contains 8 good parts and 8 bad parts. The combination of 8 good parts and 8 bad parts called WORST of WORST (WOW) and BEST of BEST batch (BOB). Make counting of all batches. If the Total count is greater than or equal to 6, then that SSV is the "reason for the problem". If the Total count is less than 6, then that SSV is not the reason for the problem. From a lot of causes, the tool should be a focus on the particular cause has an exact reason for the problem and again conduct experiment according to new standard values [1]. In figure 1 show that step wise procedures of methodology from problem define to result. In this flow chart first to define the problem by previous data. Generate clues related to the problem and list the causes. According to causes conduct designed experiment and observe the process parameter, which has affected the process and finally monitor the result from analysis.

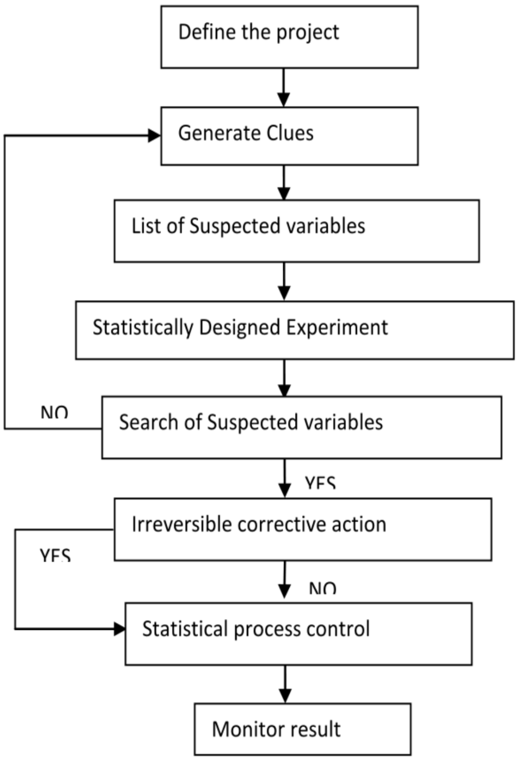

Fig. 1: flow chart

4. IMPLEMENTATION

4.1 Cold defect

Cold is observed on fins after shot blasting operation in Hero Honda CNC block component. The problem generated at the furnace and inspected after shot blasting stage.

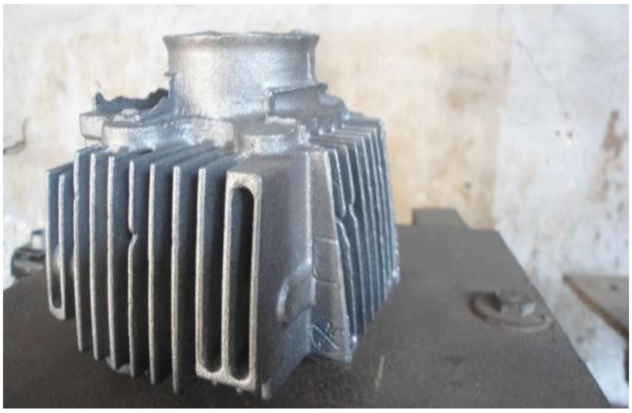

Fig. 2: Cold defect in HH block

There are eight number of Suspected Sources of Variation (SSV's) to create this problem. This SSV's are characterized by design and variation SSV's. During the trial, all SSV's are analyzed to control the problem. These eight causes are observed from initial trials.

Table 1: Suspected Sources of Variation (SSV's)

S no.	SSV's	Design or Variation SSV
1	Low Temp.	Variation
2	Excess pouring of mould	Variation
3	Mold at a long distance from F/C	Variation
4	Excess time for pouring	Variation
5	Laddle frequency	Variation
6	The thickness of fin in mould/pattern	Design
7	Less metal quantity in pouring laddle	Variation
8	Unskilled Pourer	Variation

The cold defect is generated due to eight major causes. Generally pouring temperature mostly effect on the cold defect. Other suspected causes also impact on the problem. Arrangement and distance of mould from the furnace are also proper, because if the distance of mould from the furnace is long, then it is the reason for the low temperature. Furnace temperature and mould distance from the furnace is related to each other. If the time for pouring is increased, then the temperature of the metal in laddle is continuous decreases, so low-temperature metal reason for the problem. Pourer has knowledge about pouring time, how to pour metal and pouring height from the mould. Laddle is changing after some use otherwise dirty laddle reason for the problem. If less metal quantity in pouring Laddle, then the temperature of the metal is fast decreases and another effect is mould is not properly pour. If excess pouring mould, then it is also the reason for the cold defect and also for extra material on the side fins and on the crank case. There is no. of reasons for the cold defect generation; solidification rate is also the reason for the problem. From the above trials find the worst of worst and best of the best batch should be analyzed. As per the Shainin tool obtained the 8 bad parts and 8 good parts (WOW / BOB batch). As per Shainin rule make counting of all WOW and BOB batches. Here two causes are analyzing, pouring temperature and pouring time.

Table 2: WOW and BOB temp. Of pouring

S no.	Pouring Temp.	WOW / BOB
2	1473	B
14	1450	B
15	1450	B
16	1450	B
17	1435	B
19	1435	W
57	1442	W
61	1434	B
77	1411	B
78	1411	W
80	1411	W
81	1416	W
86	1401	W
118	1390	W
135	1446	B
137	1444	W

It contains 8 good parts and 8 bad parts, are selected from the above Nos. of castings. At the time of trials, both parameters are simultaneously analyzing. As per rule draw the transition line from the top and from the bottom where the transition is happening.

Table 3: WOW and BOB for time

S no.	Pouring Temp.	WOW / BOB
1	3	W
3	4	W
7	3	W
13	4	W
15	3	B
16	3	B
19	2	W
35	3	B
36	3	B
59	3	B
63	2	B
64	2	B
107	4	W
108	4	W
109	4	W
138	3	B

Table 4: WOW / BOB batch for pouring temp.

S no.	Pouring Temp.	WOW / BOB
118	1390	W
86	1401	W
78	1411	W
80	1411	W
77	1411	B
81	1416	W
61	1434	B
17	1435	B
19	1435	W
57	1442	W
137	1444	W
135	1446	B
14	1450	B
15	1450	B
16	1450	B
2	1473	B
	Count	9

In counting method according to Shainin tool rules, counting of temperature of pouring Addition of top and bottom count i.e. total count is 9 and it is greater than 6, hence according to the Shainin rule pouring temperature is the reason for the problem.

4.2 fin cores

There are three fin cores on one core box pattern. HH CNC block has fins on at three sides (two side core and one fin core), so we carried location wise ABC analysis.

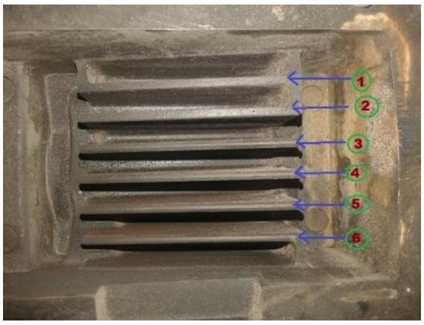

Fig. 3: Thickness of Fins

5. ANALYSIS OF RESULT

5.1 For Cold Defect

(a) Die temperature is the not reason for the cold problem.
(b) Pouring temperature is the reason for the cold problem.

Temperature as per standard in company 1440^{0}c +/-10 but from the analysis data, it should clear that temperature between 1411 -1420^{0}c has no defected part. But these range difficult to maintain, so range for temperature is taken as 1400–1430^{0}c. Between 1400 to 1410^{0}c has minimum rejection percentage as compared to 1390 to 1400^{0}c and 1431 to 1440^{0}c. So from above, WOW and BOB batch contain 1400c to 1430^{0}c between this rang has minimum rejection. Mould arrangement from the furnace and laddle temperature is related to each other. If Mould arrangement from the furnace is at long distance, then the temperature of the metal in laddle is decreased at high speed.

5.2 For fin thickness

From location wise ABC analysis percentage of rejection at a side is 3.46%, B side 89.60% and at C side 6.93%. So from observation at B fin core side thickness is small as compared to side A and side C. In fin core side it observes that particular fin no. 1, 2 and 6 has minimum thickness compare to other fin thickness.

Laddle Frequency: Change laddle after 6 heats instead of 8 heats.
Mould form F/C: Mould arrangement from the furnace is kept at 8ft.

Table 5: Trial description and result

Trial Description	Inspected Qty	Rejected Qty	Rejection %
Trial 1 Temp. 1411 – 1420^{0}c	240	2	0.83
Trial 2 Temp. 1411 – 1420^{0}c	240	1	0.42

6. CONCLUSION

Foundry process involves a number of stages. At each stage no. of and different type of defect generated due to some operation related or due to incorrect process related. The defect needs to be diagnosed correctly for appropriate remedial measures, otherwise, a new defect may get introduced. Shainin tool works on the elimination process. This tool useful for quality improvement and this tool eliminates the defect. In this work, reduces the cold defect, and has shared a higher percentage in the total rejection of the foundry. Shainin tool keeping rejection to a bare minimum is essential to improve the yield and increase the effective capacity of the unit. From the result of trials, it can reduce rejection level and also improve productivity.

7. REFERENCES

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