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Optimization of Casting Components by Minimizing Cold Shut Defect

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Abstract- In Today's world, Foundry is emerging as the most profitable and Dynamic industry. Foundry shop comprises of various process which involve pattern making, molding, core making, melting. Rejection is also one part of the Foundry shop. Lots of industries are facing the problems regarding to casting rejection i.e. Shrinkage, Cold shut, Depression, Blow hole. In this paper Optimization tools and Statistical analysis is aim to optimize process parameters in case study at TRU FORM TECHNO PRODUCTS khasara, Nagpur to minimize the defects. The objective of this work is to analyze the COLD SHUT defect in DI Casting. In this Industry we observed that 80% of rejection due to Cold is because of Temperature issue, improper Metal Chemistry and Wall thickness. By focusing on COLD SHUT we carried out different techniques to minimize Cold Shut.

Keywords - Foundry, Rejection, DI Casting, Cold Shut, Temperature, Wall thickness.

1. INTRODUCTION

A casting defect is an undesired irregularity in a metal casting process. Some defects can be tolerated while others can be repaired, otherwise they must be eliminated. They are broken down into five main categories: gas porosity, shrinkage defects, mould material defects, Pouring metal defect and metallurgical defects. As the 80% of rejection in industries is due to COLD SHUT therefore we select cold shut as major defects. Cold shut is one type of surface defects and lines on the surface of the casting can be seen. This flow marks indicate metal are solidified at different stage. A cold shut is caused when two metal teams while meeting in the mould cavity do not fuse together properly, thus causing a discontinuity or weak spot in the casting .sometimes a condition leading to cold shuts can be observed when no sharp corners are present in a casting. These defects are cause essentially by the lower fluidity of the molten metal or that the section thickness of the casting is too small. The latter can be rectified by proper casting design. The remedy available is to increase the fluidity of the metal by changing the composition or rising the pouring temperature. This defect can also be caused when the heat removal capacity is increase such as in case of green sand mould. The casting with large surface-area-to-volume ratio is more likely to be prone to these defects. This defect is also caused in moulds which are not properly vented because of the back pressure of the gases. The remedies are basically improving the mould design. [4] The inspection of cold shut is done visually.
Defects analysis in Casting is the method of finding root causes which leads rejection of Casting and taking corrective actions to reduce the Defects. The Techniques like Pareto analysis, Ishikawa diagram, Control charts, Histogram, expert tools are used for casting defects analysis. [2]

COLD SHUT is caused by following parameter
- Low pouring temperature of molten metal
- Improper metal chemistry
- Variation in wall thickness of the casting
- Improper core dimension

Fig. Cold Shut

1.1. Cold shut due to Temperature

- Solidification before completion of metal flow in the mould box.
- Low Poring temperature.
- Environmental conditions.
- Moisture contain in Green Sand.

1.2. Cold Shut due to wall thickness

- Excessive use of Chaplet.
- Ovality in Core box.
- Improper setting time of core.
- Improper C-clamping of core box.

2. METHODOLOGY

The basic optimization tools are used for trouble shooting issues related to defects. Basic optimization tools are used because they are easily understood by engineers.[1]

The basic optimization tools are

- Pareto analysis
- Ishikawa diagram
- Control charts
- Histogram

2.1. Pareto analysis

Pareto analysis is a statistical technique in decision making use for the selection of a limited number of tasks that produce significant overall effect. It is also called as 80/20 principle in which 80%of rejection is due to 20% of defects and here cold shut is the major defect.

Table. Overall rejection

Sr. no.	defects	Rejection %
1	Air trap	0.48
2	Metal joint	2.06
3	Core shift	1.23
4	Slag inclusion	0.16
5	shifting	7.39
6	depression	2.04
7	Shor pouring	0.14
8	cold	12.96
9	shrinkage	7.55
10	Blow hole	1.3

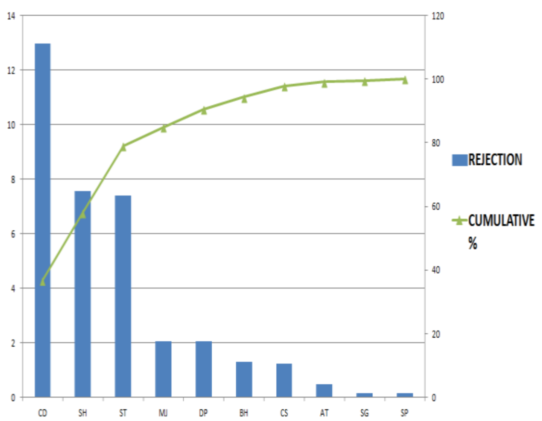

Fig. Pareto chart

2.2. Ishikawa Diagram

A fishbone diagram, also called a cause and effect diagram or Ishikawa diagram, is a visualization tool for categorizing the potential causes of a problem in order to identify its root causes.[2]

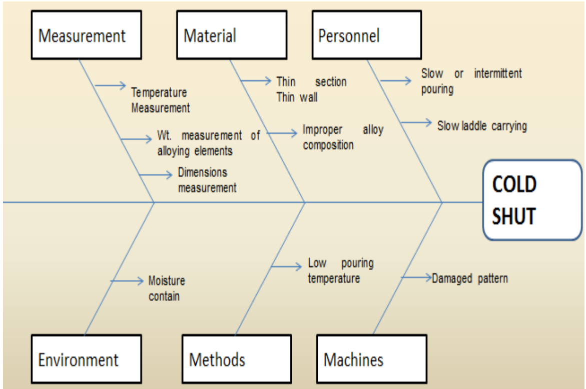

Fig. Ishikawa diagram

2.3. Control chart

The control chart is a graph used to study how a Process changes over time. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit and a lower line for the lower control limit. These lines are determined from historical data.

Table:-Temperature Data

Sr.No.	Temp. ^0C	silicon %	Ph. %	Sr. No.	Temp. ^0C	Silicon %	Ph. %	Cold defect
1	1373	2.51	0.051	11	1381	2.54	0.055	NO
2	1369	2.44	0.058	12	1376	2.50	0.061	NO
3	1375	2.50	0.056	13	1370	2.46	0.056	NO
4	1365	2.39	0.053	14	1366	2.47	0.060	NO
5	1377	2.43	0.042	15	1370	2.47	0.054	NO
6	1341	2.45	0.061	16	1352	2.47	0.049	YES
7	1343	2.36	0.059	17	1350	2.33	0.053	YES
8	1336	2.39	0.053	18	1339	2.36	0.055	YES
9	1348	2.44	0.054	19	1339	2.47	0.057	YES
10	1330	2.44	0.060	20	1354	2.50	0.059	YES

2.3.1 Control chart for Temperature

The recommended range of Temperature is 1367-1380^{0}C. The observed final range of Temperature is 1362-1382^{0}C.

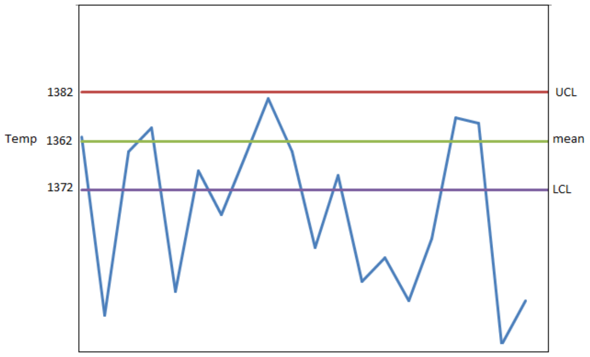

Fig. Control Chart for Temperature

2.3.2 Control chart for Phosphorous

The recommended range of Phosphorous is 0.06 maximum. The observed final range of Phosphorous is 0.04-0.06.

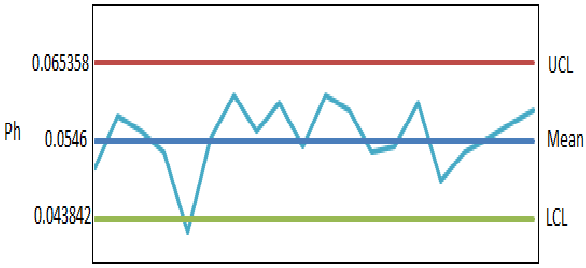

Fig. Control Chart For Phosphorous

2.3.3 Control chart for Silicon

The recommended range of Silicon is 2.4-2.6. The observed range of Silicon is 2.3-2.5.

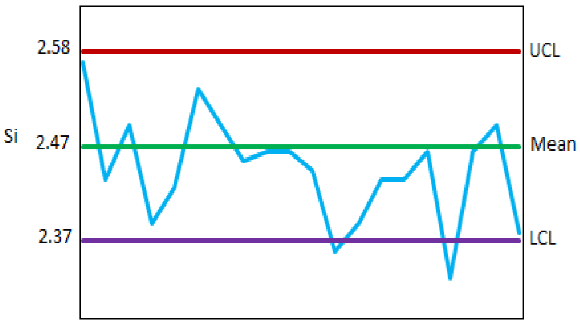

Fig. Control Chart For Silicon

RESULT

- By performing the methods using different Control tools we find out the ranges for Temperature, Phosphorous and Silicon.
- As the Cold Shut defect is the major problem for DI casting we need the proper range of pouring temperature. By performing practically in the industry we find out the temperature range of 1362-1382^{0}C. This range reduced the defect from 9% to 5%.
- Similarly for Phosphorous and Silicon ranges are 0.06% maximum and 2.4-2.6% respectively.

CONCLUSION

Initially we indentify the Casting defects with the help of charts and Control tools. This paper represents the proper sequence of finding Causes of defects and their remedial solution. By referring different research papers we find out the Methodology.

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