Casting Defect Reduction by using Seven Quality Control Tools

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Abstract— An experimental investigation into cold shut formation in, castings has been carried out. Results indicate that cold shuts are formed when liquid metal. Overflowing solid metal, does not completely remelt the solid. As the occurrence of the defect depends upon the thermal energy of the liquid, effective superheat -superheat at which the liquid meets the solid metal is the most important variable affecting the co Id shut formation. This superheat is controlled by both the pouring rate and the superheat at pouring. This paper represents the defect reduction by controlling alloy composition and pouring temperature. The seven quality control methodology is used to analyze and reduce defects which includes check sheet, pare to analysis, cause effect diagram, flow chart, scatter diagram, histogram and control chart.

Key words: Casting Defect, Cold Shut, Seven Quality Control Tool

I. Introduction

The art of metal casting is one of the oldest and most durable examples of the production of metal objects and will probably continue to be the best way to produce comp1icated shapes. The casting process, involving the flow of molten metal and the flow of heat, is the central part of the foundry industry.

Basically, for a Sound metal casting, the liquid metal should both fill the mold cavity as quickly. As possible and solidify, by losing heat, from the remotest regions inward toward the source of molten metal. Only if the metal and heat flow sequence is properly coordinated, can the final product be expected to be free from defects. Otherwise, there will be a high probability of the occurrence of imperfections.

Metal casting is a process in which molten metal or more commonly an alloys is poured into a mould or die that contains a cavity which represents the shape of the component or casting to be produced. Here main focus focus is on improving the pouring practices and alloy composition for improving the flowability of the molten metal and to control the casting defects by using quality control tools.

COLD SHUT is caused by following parameter

1) Low pouring temperature of molten metal
2) Improper metal chemistry
3) Variation in wall thickness of the casting
4) Improper core dimension

II. 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.

The basic optimization tools are

1) Check sheets
2) Pareto Analysis
3) Fishbone Diagram
4) Scatter Diagram
5) Flowchart
6) Control charts
7) Histograms

A. Check Sheet

Check sheets are simple forms with certain formats that can aid the user to record data in a firm systematically. Data are “collected and tabulated” on the check sheet to record the frequency of specific events during a data collection period.

B. Pareto Analysis

It introduced by an Italian economist, named Vilfredo Pareto. A Pareto chart is a special type of histogram that can easily be apply to find and prioritize quality problems. Pareto chart can generate a mean for investigating concerning quality improvement, and improving efficiency, material waste, energy conservation, safety issues, cost reductions,etc.

C. Fishbone Diagram

This diagram can provide the problem-solving efforts by gathering and organizing the possible causes, reaching a common understanding of the problem, exposing gaps in existing knowledge, ranking the most probable causes, and studying each cause.

D. Scatter Diagram

Scatter diagram is a powerful tool to draw the distribution of information in two dimensions, which helps to detect and analyze a pattern relationships between two quality and compliance variables as an independent variable and a dependent variable, and understanding if there is a relationship between them, so what kind of the relationship is Weak or strong and positive or negative.

E. Flowchart

Flowchart presents a diagrammatic picture that indicates a series of symbols to describe the sequence of steps exist in an operation or process. On the other hand, a flowchart visualize a picture including the inputs, activities, decision points, and outputs for using and understanding easily concerning the overall objective through process.

F. Control Chart

Control charts is a special form of “run chart that it illustrates the amount and nature of variation in the process over time”. Also, it can draw and describe what has been happening in the process. Therefore, it is very important to apply control chart, because it can observe and monitor process to study process that is in statistical control accordant to the samplings or samplings are between UCL and LCL.

G. Histogram

Histogram is very useful tool to describe a sense of the frequency distribution of observed values of a variable. It is a type of bar chart that visualizes both attribute and variable data of a product or process, also assists users to show the distribution of data and the amount of variation within a process.

1) Check sheet:

Month	Pouring	Total reject-tion	Cold shut	Sand	Porosity	Shrink-age	Other
October	88560	10227	2412	1853	1235	1059	2668
November	89800	10506	2373	1885	987	1116	4145
December	72530	7776	1887	1595	942	870	3794

Table 1: Check sheet

2) Pareto chart:

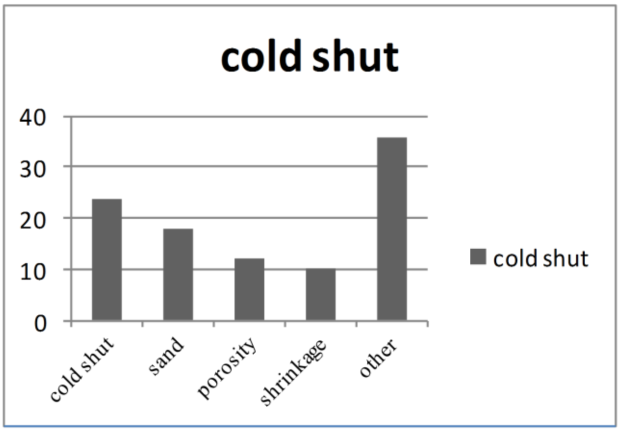


Fig. 1: Pareto chart

3) Fishbone Diagram for cold shut:

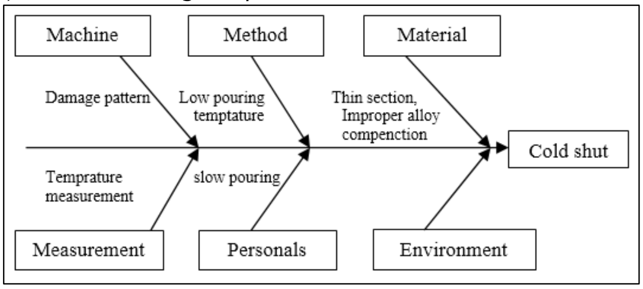


Fig. 2: Fishbone Diagram

4) Brain storming:

Sr. no	Causes	Lab incharge	Quality manager	Furnace supervisor	Worker at furnace	Mould supervisor
1	Low pouring temperature	Yes	Yes	No	No	Yes
2	Low % of si and p	Yes	Yes	Yes	Yes	Yes
3	Slow or intermittent pouring	Yes	Yes	No	No	No
4	Slow ladder carrying	Yes	Yes	No	No	No
5	Damaged patterns	No	No	Yes	No	No

Table 2: Brain storming

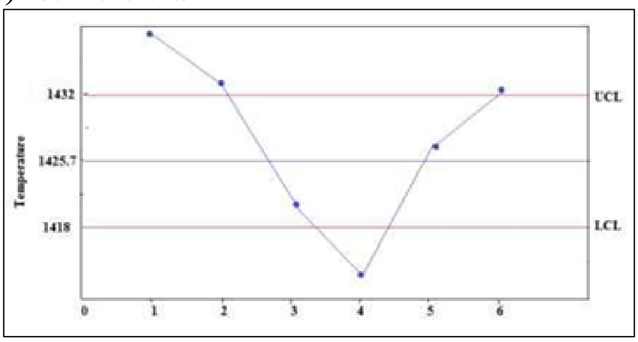
5) Trials table:

Readi-ng	Temp.	%phos-phorus	%sili-con	Sample size	Good	Bad	Cold shut
1.	i)1434 ii)1436	i)0.12 ii)0.11	i)1.80 ii)1.81	150	103	17	4
2.	i)1432 ii)1429	i)0.15 ii)0.13	i)1.83 ii)1.85	150	106	14	5
3. Tiral 1	i)1421 ii)1423	i)0.10 ii)0.12	i)1.84 ii)1.84	150	110	11	4
4. Tiral 2	i)1413 ii)1406	i)0.12 ii)0.14	i)1.82 ii)1.86	150	111	12	5
5. Tiral 3	i)1429 ii)1424	i)0.22 ii)0.18	i)2.10 ii)1.95	150	114	7	2
6. Tiral 4	i)1435 ii)1431	i)0.22 ii)0.23	i)2.00 ii)1.98	150	113	3	1

Table 3: Trials table

6) Control chart:

Fig. 3: Control chart X-bar for Temperature



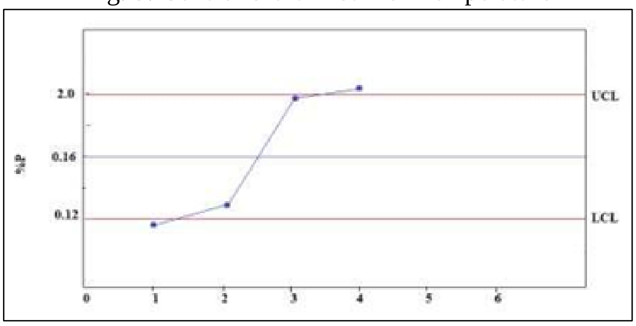


Fig. 4: Control chart X-bar for %Phosphorus

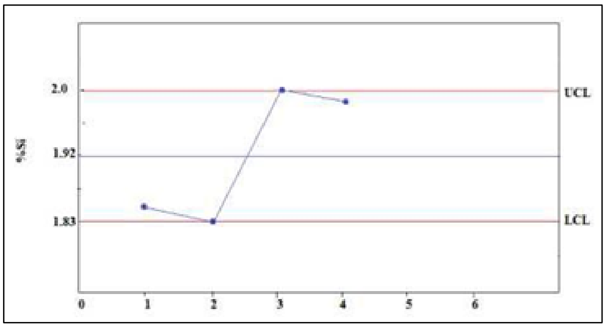


Fig. 5: Control chart X-bar for %Silica

7) Histograme:

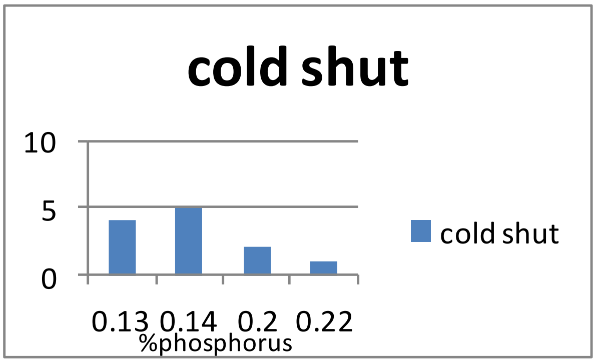


Fig. 6: Histograme for defect vs %phosphorus

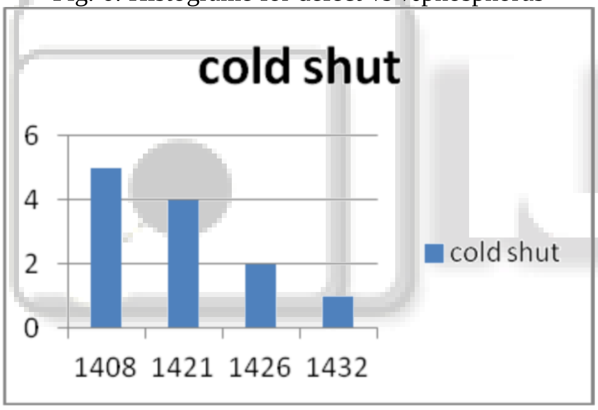


Fig. 7: Histograme for defect vs Temperature

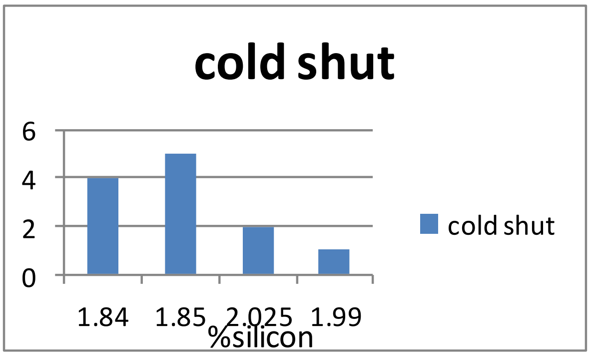


Fig. 8: Histograme for defect vs %silicon

III. RESULT

By performing the methods using different Control tools we find out the ranges for Temperature, Phosphorous and Silicon.

As the defect sand, porosity and shrinkage requires lower pouring temperature in the recommended range and cold shut requires higher pouring temperature so temperature range observed which can be useful to reduce cold shut considering the other defects is 1420 to 1435^{0}C

Phosphorous percentage is recommended to be 0.11 to 0.2%. Silicon percentage is recommend ended to be 1.82 to 2.0 %.

IV. CONCLUSIONS

Initially we identify 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.

The major Cold shut defect was reduced by up to 40%. The total rejection from cold shut was reduced to 8.2% from 12.3%.

A. Nomenclature

%p - percentage phosphorous
%si - percentage silicon
Temp. - Temperature
UCL - Upper Control Limit
LCL - Lower Control Limit

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