# MINIMIZATION OF DEFECT IN ALUMINIUM ALLOY WHEEL CASTING USING 7 QC TOOLS

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## ABSTRACT

The current study is to study defects of an aluminum alloy casting and to improve the quality of casting using quality control tools. This study shows the systematic approach to find the root cause of major defects in aluminum castings using defect diagnostic approach as well as cause and effect diagram. Casting defect analysis is carried out using techniques like historical data analysis, cause-effect diagrams, design of experiments and root cause analysis. Data from X-ray inspection (Radiographic Inspection) have been collected along with the production parameter data. Using Pareto chart major defects in the aluminum castings were noted. The major defects for the rejections during production were identified as shrinkages, inclusions, porosity/gas holes and cracks. Each defect is studied thoroughly and the possible causes for the defects are shown in Fishbone Diagrams (Cause Effect Diagrams). As the shrinkages mainly occur due to lack of feed ability during the fluid flow the stalk changing frequency is noted along with the shrinkages defects and a relation is drawn between them. As hydrogen forms gas holes and porosity in the aluminum castings the amount of hydrogen present in the molten metal is studied by finding specific gravity of the samples collected. The molten metal temperature effects the amount of the hydrogen absorbed by it. .So the effect of molten metal temperature on the specific gravity of the sample collected have been shown in a graph and the optimum value for molten metal temperature was found out.

## INTRODUCTION

The use of aluminum castings in the automotive industry has increased incredibly over the past two decades. The driving force for this increased use is vehicle weight reduction for improved performance, particularly fuel efficiency. In many cases, the mechanical properties of the cast aluminum parts are superior to those of the cast iron or wrought steel parts being replaced. For the production of aluminum alloy wheel, Al-Si casting alloys are mostly used as the raw material. Because of their good casting properties, this type of alloys provides the alloy wheel to have good corrosion resistance and strength so that the vehicle can adapt to the road and weather conditions

Aluminum casting alloy wheels are generally produced using low-pressure die-casting. For the application of this casting method, Al-Si casting alloys should be chosen owing to their high adaptation capability to the permanent metal molds. By the help of alloying elements, it is possible to achieve effective and efficient aluminum alloy wheel production. Aluminum alloy wheels have important advantages compared to the steel wheels. These advantages provide aluminum alloy wheel to be popular. However, in production of wheels, defects in the cast microstructure undermine performance characteristics

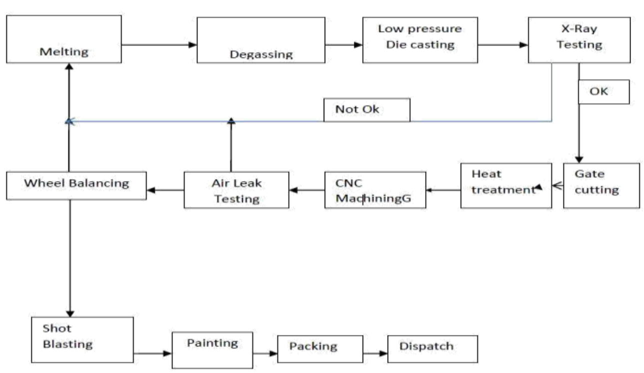



Fig-1Process flow diagram for manufacturing of Al alloy wheel

In the beginning of the production, the ingots are melted in the furnace. Then, molten metal is transferred to holding unit and as a second step, degassing process is applied to the molten metal. After degassing, the metal is ready for die-casting. At this step, under low pressure alloy wheel is shaped and then it solidified. Finally, wheels are inspected by real time radioscopic inspection unit for achieving quality control. If the defects on the wheel are within the standards, it is accepted. Otherwise, it is sent to the melting unit to be added to the molten metal as a scrap. Also, leakage, impact and fatigue tests can be applied for some produced wheels as other types of quality control step.

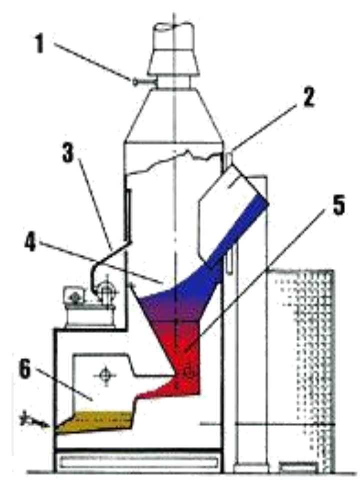



Fig.2Schematic diagram of shaft melting furnace

After melting process, molten metal generally has two transfer operations. Firstly, molten metal is transferred from melting furnace to holding furnace. And then, it is again transferred from holding furnace to the shot chamber of the die casting machine. Metal should be transferred at, or above, the holding temperature. When this is done, wide fluctuations in metal temperature are avoided

**Low Pressure Die Casting**

Forcing molten metal under pressure into permanent steel dies produces die-castings. Die-casting involves metal flow at high velocities induced by the application of pressure. Because of this high-velocity filling, die-casting can produce shapes that are more complex than shapes that can be produced by permanent mold castings

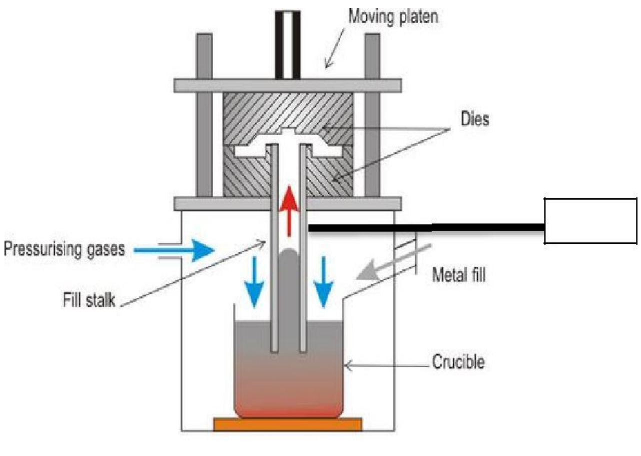



Fig-3 Low pressure die casting

Die casting dies are basically similar to heat exchangers and optimum die temperature for a specific casting is determined by section thickness and by the type of finish required. When optimum die temperature has been established, it should be maintained within ± 6°C. For casting Al alloys, such as AlSi, the usual range of die temperature is 220 to 315°C, with the average near 290°C

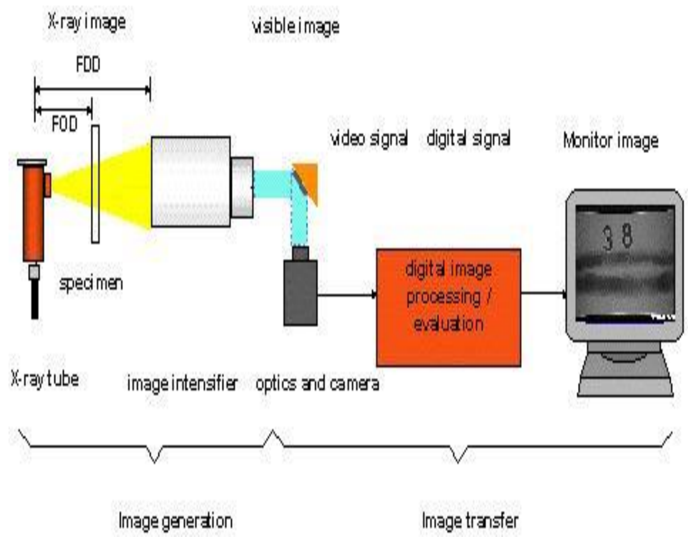



Fig-4Radioscopic inspection system

In the radioscopic system, the X-rays first pass through the specimen and reach to the image intensifier. The fluorescent screen takes place on the front surface of image intensifier and changes the X-rays to the electrons. Electrons are subjected to the exit as intensified by the lenses. The exit screen changes the electrons to the visible light by changing the wavelengths of them. A TV-camera, connected to the image intensifier, transfers the visible light to the monitor. The image on the monitor can be loaded into a video band or CD-Rom. The relation between the Focus-to-Detector distance (FDD) and the Focus-to-Object distance (FOD) determines the geometric magnification of the image.

**Defect Diagnostic Approach**

The graphics were constructed by using computer software, as Excel and Statistica. Pie charts, Pareto diagrams, Scatter plots were obtained by using Excel. Normality plot and box whisker plots were constructed with Statistica

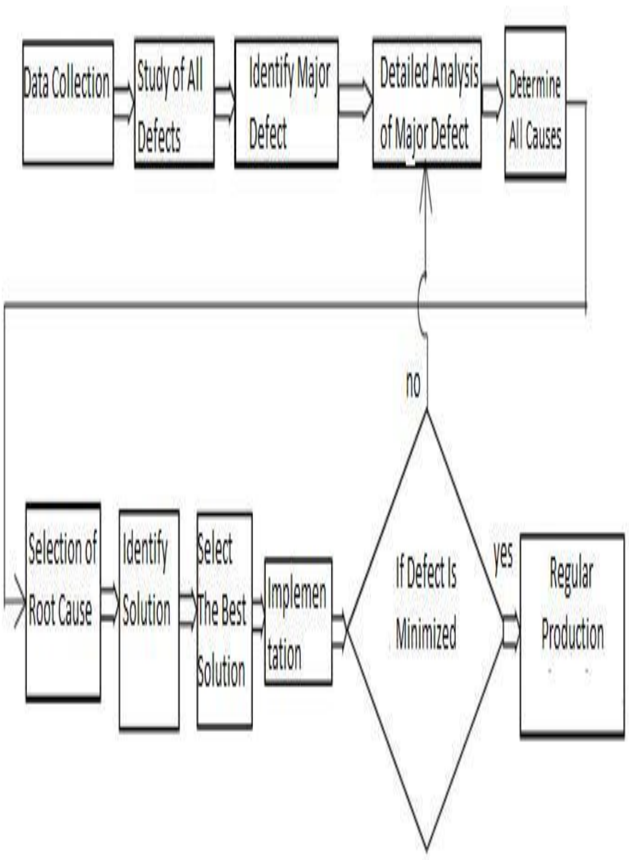



Fig-5 Defect diagnostic approach

**ANALYSIS**

**Pareto Diagram for Defects**

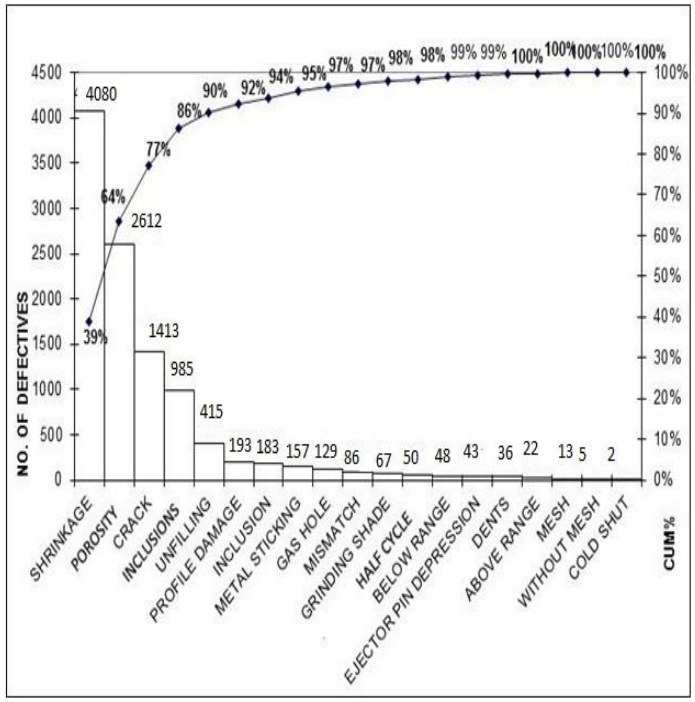
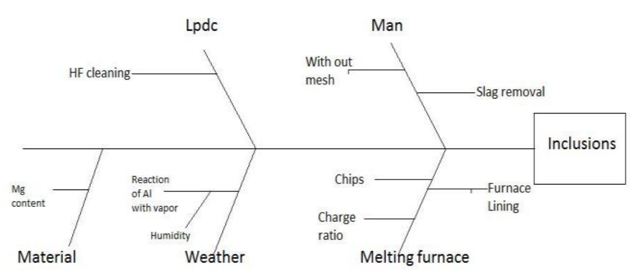



Fig-6Pareto chart of rejections of Al alloy wheels for one year




Fishbone diagram for inclusions

## CONCLUSIONS

In this study, casting of an Al alloy was investigated. Aim was to minimization of casting defects using 7QC tools. This study shows the systematic approach to find the root cause of a major defects in aluminium castings using defect diagnostic approach as well as cause and effect diagram. To obtain more detailed and effective feedback control during casting of Al-alloy wheel, a process model for the production line was constructed. By help of this diagram the causes of defects and remedies can be pointed

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