A REVIEW ON PROBLEM OF SHRINKAGE IN ALUMINUMALLOY LOW PRESSURE DIE WHEEL CASTING AND ITS CONTROL

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ABSTRACT
Presently with the increasing use of Aluminium alloy wheels in automotive industry the Aluminium foundry industry had to focus on the quality of the products. The quality of a foundry industry can be increased by minimizing the casting defects during production.Casting defect analysis is carried out using techniques like historical data analysis, cause-effect diagrams, design of experiments and root cause analysis. The major defects for the rejections during production were identified as shrinkages, inclusions, porosity/gas holes and cracks.

I INTRODUCTION

As the shrinkages mainly occur due to lack of feedability 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 [1].

II METHOD OF ALUMINUM CASTING

2.1 Low Pressure Die Casting

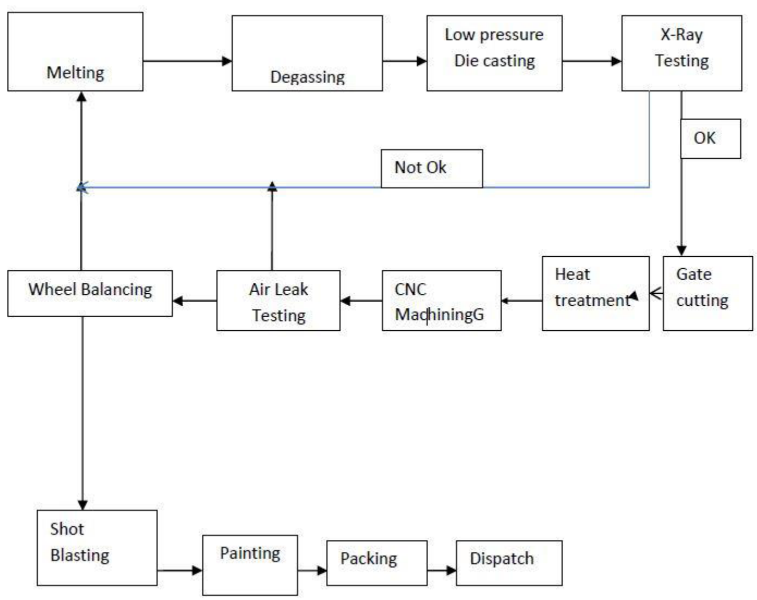
The mould which is made in the metal (usually cast iron/ die steel) is filled by upward displacement of molten metal from a sealed melting pot or bath. This displacement is effected by applying relatively low pressure of dry air (0.5 – 1.0 kg/mm^2) on the surface of molten metal in the bath. The pressure causes the metal to rise through a central Ceramic riser tube into the die cavity [2]. The dies are provided ample venting to allow escape of air, the pressure is maintained till the metal is solidified ; then it is released enabling the excess liquid metal to drain down the connecting tube back in to the bath. Since this system of upward filling requires no runners and risers, there is rarely any wastage of metal [3]. Low pressure on the metal is completely eliminates turbulence and air aspiration.

III AL ALLOY WHEEL PRODUCTION PROCESS [3]:

It consists of the following steps:

1. Melting of Al Alloy
2. Degassing Process
3. Low Pressure Die Casting
4. Solidification of Al Alloy
5. X-Ray Inspection

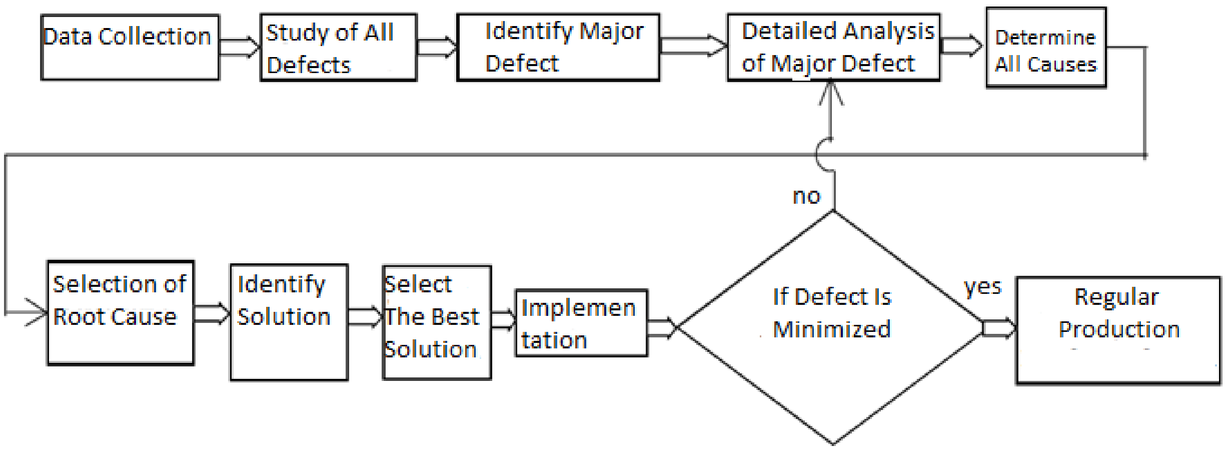
3.1 PROCESS CHART



IV DEFECT DIAGNOSTIC APPROACHES

Defect analysis in casting defects is carried out using techniques like [5]

1. Historical data analysis
2. Cause-effect diagrams
3. Design of experiments and
4. Root cause analysis



V SHRINKAGES

The following points describe how shrinkages occur in castings

- Shrinkage occurs during solidification as a result of volumetric differences between liquid and solid state. For most aluminum alloys, shrinkage during solidification is about 6% by volume.
- Lack of adequate feeding during casting process is the main reason for shrinkage defects.
- Shrinkage is a form of discontinuity that appears as dark spots on the radiograph.
- It assumes various forms, but in all cases it occurs because the metal in molten state shrinks as it solidifies, in all portions of the final casting.
- By making sure that the volume of the casting is adequately fed by risers, Shrinkage defects can be avoided.
- By a number of characteristics on radiograph, various forms of shrinkages can be recognized.

5.1 Types of Shrinkages

(1) Shrinkage Cavity

(2) Shrinkage Dendritic

(3) Shrinkage Filamentary

(4) Shrinkage Sponge types

5.1.1 Shrinkage Cavity

The following points explain how shrinkage cavity occurs in castings [5]

1. It appears in areas with distinct jagged boundaries.

2. When metal solidifies between two original streams of melt coming from opposite directions to join a common front, cavity shrinkage occurs as shown in Figure-1.

3. It usually occurs at a time when the melt has almost reached solidification temperature and there is no source of supplementary liquid to feed possible cavities.

5.1.2 Dendritic Shrinkage

This type of shrinkage can be identified by seeing distribution of very fine lines or small elongated cavities that may differ in density and are usually unconnected as shown in Figure

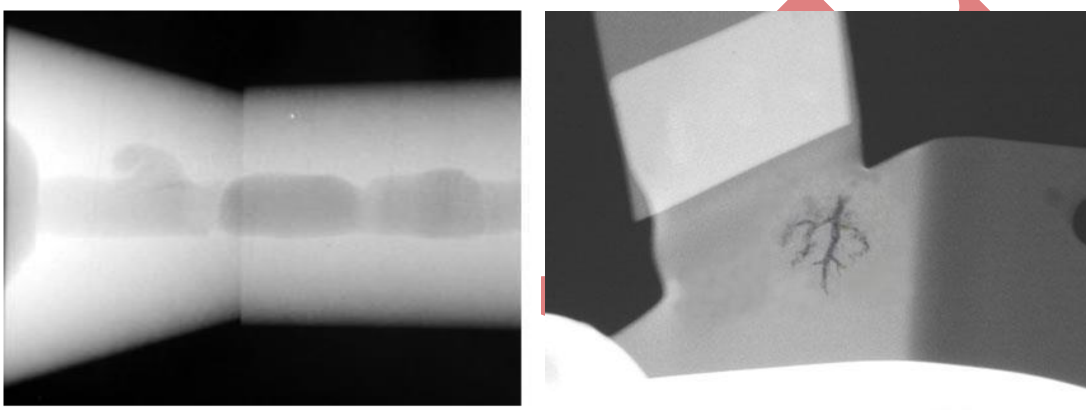


Figure-1

5.1.3 Filamentary Shrinkage

This type of shrinkage usually occurs as a continuous structure of connected lines of variable length, width, density.

5.1.4 Sponge Shrinkage [5]

1. Sponge shrinkage can be identified from areas of lacy texture with diffuse outlines as shown in Figure 2.

2. It may be dendritic or filamentary shrinkage.

Filamentary sponge shrinkage appears more blurred as it is projected through the relatively thick coating between the discontinuities and the film surface.

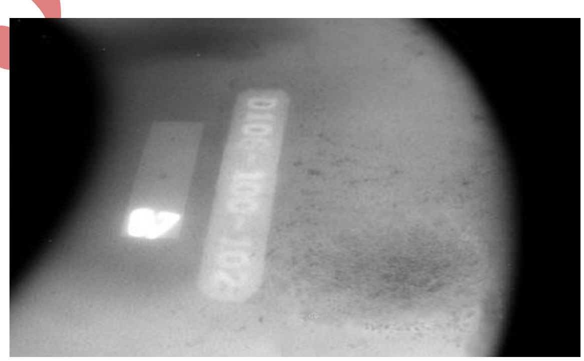


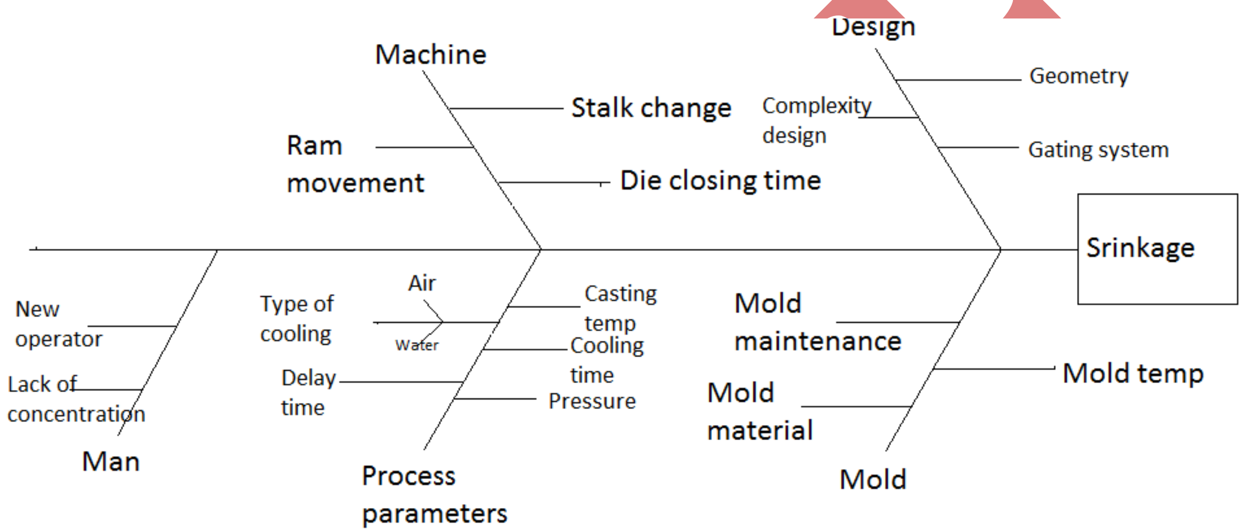
Figure-2

VI ANALYSIS OF SHRINKAGE BY USING FISH BONE DIAGRAM

Fish bone diagram helps in following ways [6]

- Once a defect has been identified, potential causes of this undesirable effect has to be analyzed [7].
- Fishbone Diagram (Cause Effect Diagram) is a useful tool in finding potential causes. By using this fishbone diagram, all contributing factors of defects and their relationship are displayed in a place [7].
- It identifies areas of problem where data can be collected and analyzed.

The fish bone diagram for shrinkages is shown in figure.



VII CONCLUSION

The factors that influence the formation of shrinkagecavities are as follows:-

7.1 Metal Quality

Solidification range: -If the solidification is large,the shrinkage cavity tends to take the form of aconcavity in the upper surface of the casting.If the solidification is short,the pockets ofliquid can soon become isolated from the exterior uppersurface and these will give rise to major internal shrinkage cavities [9].

Shrinkage during solidification:-Thecrystallization is generally accompanied by a volumecontraction, which is a phenomenon in alloy which is inthe liquid form and allowed to cool in a die. This effects mainly responsible for the formation of shrinkagecavities**.**

7.2 Pouring Condition

Pouring temperature: -Alloys are normallypoured at a temperature above the liquid temp. The degree of super heating affects the formation of shrinkage cavities [10].

Rate of pouring: -The rate of pouring must be always higher than the rate of solidification. In general for most of the casting, weighing from 1 to 3 kgs, filling time of 8 to 15 sec is practically found ok. When the filling time goes beyond 20 seconds, the molten metal temp inthe pouring ladle begins to drop down and starts freezing in the ladle itself. For thick section castings, it is found beneficial that ifthe castings are poured at slower rate [11].

Feeding systems:-The way in which the metal is introduced inthe die is of fundamental importance with respect tothe formation of shrinkage cavities. Throughoutsolidification, it is essential that the liquid phaseshould be in contact with a reservoir of liquid metal(Riser) whose temperature is higher than that of themetal in the die cavity.

7.3 Die Condition

Initial temperature of the die:-The die temperature at the start of pouring is equally important as regards to the formation of shrinkage cavities. The die must pre- heatednearer to this temperature as far as possible usingspecial gas burners. Then only the pouring mustbe started.

Conductivity of the die:-This also affects thesolidification rate of the casting and consequentlythe formation of shrinkage cavities. Increasing the conductivity of the die cavity locally causes chilling [13].

7.4 Casting Parameter [14]

Thickness: - With thinsection castings little shrinkage only occurs.

Shape: -Shrinkage cavities occur in the heavy portions, particularlywhen they are isolated from the main riser atsome stage of solidification.

7.5 Shell Sand Cores Parameter

Metal entry in to the die after impingingagainst shell sand core.The incoming metal over heats that impinging portionof the sand core.

This can cause

1) Resin gas blowholes and

2) Shrinkage cavities.

To avoid over heatingof the sand and for better heat dissipation, Iron chillscan be embedded in that portions of the shell cores orsand cores.

7.6 Factors Depending On the Molten Metal Quality [15]

Inclusion content:-When the moltenmetal contains more of inclusionsit helps tonucleate shrinkage cavities.Pour metal in the gas sample conand watch carefully. If the gas evolution takes placeimmediatelyafter filling the cone, it means the metalcontains excess inclusions & Hydrogen gas.

7.8 Calcium Content in the Alloy

If the alloy contains calcium more than 0.0008%, microshrinkagescavities may occur.

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