Analysis of Micro Structure of Result Casting on Drum Aluminium Music With Metal Molding

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Abstract. Metal casting is the production process in forming a cast by pouring hot liquid metal into a mold then allowed to cool and freeze. Metal molds are molds that are used once cast produces many castings so that the productivity is high and economically suitable and suitable for small objects. The diameter of granules of metal castings is strongly influenced by the material of castings and the hardness of the material. The smaller the diameter of the granules the hardness of the cast is higher and brittle, on the contrary the greater the diameter of the granules the harder the lower and soft. The microstructure test results that the diameter of Zn granules is larger than the Aluminum granules. The result of microstructure testing of lug foundry containing 99.9% Al indicates in this alloy that aluminum is very dominant even close to pure aluminum so that in picture of element of silicon is very small. The larger the diameter of the granules the material hardness is lower and soft. The smaller the grain diameter the higher the hardness of the material and the brittle. Hardness Al lug alloy castings are higher than the original lug Zn alloys. This is because the diameter of aluminum granules is smaller than the diameter of granules Zn.

1. Introduction

Various musical instruments have different sound levels of loudness. One of the musical instruments to be studied is a drum instrument, the drum can sound loud if made with quality materials. Lug is a drum fasteners, made of Zn alloys, so this research tries to manufacture lugs of aluminum alloys for lighter, corrosion-resistant, and easy to manufacture. How to manufacture this lug by metal casting, with casting materials are Al alloys and castings of castings derived from metal molds. Metal casting is the production process for forming a cast by pouring hot liquid metal into a mold then allowed to cool and freeze. Metal molds are molds that are used once cast produces many castings so that the productivity is high and economically suitable and suitable for small objects. The formulation of the problem in this research are: (1) What is the influence of diameter of castings on the hardness of castings? (2) What is the grain shape and the micro structure of the castings? Then, the purpose of this research is to know the effect of diameter of castings on the hardness of castings and to know the grain shape and micro structure of castings. Aluminum (Al) is a light metal that has good corrosion resistance and good electrical conductivity. Aluminum is commonly used for household appliances, aircraft materials, automotive, ships, construction and others. To obtain an increase in mechanical strength, usually aluminum metal is combined with elements Cu, Si, Mg, Zn, Mn, Ni, and other elements. [1]. The following is Table of physical properties of aluminium:
Table 1 Table Of Physical Properties Of Aluminium

| Sifat Fisis                | Kemurnian Aluminium (%) |
|---------------------------|-------------------------|
| Kemurnian Aluminium (%)   | >99                     |
| Density (20°C)            | 2.6989                  |
| Melting Point             | 660.2                   |
| Panas Jenis (cal/gr.C) (100gr) | 0.2226   |
| Conductivity (%)          | 64.94                   |
| Electrical resistance Temperature | 0.00429   |
| Coeffisien(°C)            | 0.0115                  |
| Expansion Coefificient (20-100°C) | 23.86x10^-6          |
| Type of crystal, contour lattice | FCC, a=4.013 A |
|                           | FCC, a= 4.04 A          |

(Source: Tata Surdia)

According to Raharjo et al [2] that testing of microstructure in this study aims to look at the morphology and characteristics of the foundry of ADC 12 material before and after the Remelting as follows:

![Figure 1. Al Casting before remelting](image1)
![Figure 2. Al casting after remelting](image2)

![Figure 3. Microstructure of hypoeutectic alloys (1.65-12.6% Si)](image3)

These organic substances will form gases when the sand is in contact with molten metal. While the metal mold is relatively cleaner than gas-forming substances. Metallic molds give good properties to cast aluminum metal because of defects due to less porosity than other types of molds and highest hardness. Sand molds will provide more ductile properties in cast aluminum metal, but slightly more porous defects than metal molds as shown in Figure 4 and Figure 5 are images of Al Cast microstructure with sand molds and metal molds. Casted metal is aluminum.

The data analysis showed that most cast defects were present in specimens using cement molds, and the least of which were on specimens using metal molds. By contrast the highest hardness is in the metal mold and the lowest is on the cement mold. While the quality of aluminum casting products using sand and ceramic molds are between sand molds and ceramic molds. [3].

One method of casting process is a centrifugal casting which is generally used to produce cylindrical objects or symmetrical workpieces in rotating molds. Therefore, it is necessary to study more about the effect of variation of rotation speed of mold on aluminum casting quality which include mechanical properties (hardness) and micro structure. Selected speed variations of 150 rpm, 180 rpm and 200 rpm. In the observation of microstructure, the grain shape produced by centrifugal casting is generally equiaxed and columnar in shape with slope orientation in accordance with the direction of engine rotation. From the Vickers hardness test results, it appears that 200 rpm rotation variations show greater hardness rates compared to other rotation variations. [4].
The brass casting procedure that has been carried out at partner IKMs is sand/soil molding. This process requires the stage of making molds from sand. This sand mold is used only once so that each product must be made in one mold. If the product is made in large quantities, this process becomes inefficient and requires a long time. Therefore, technology is needed that is more efficient and faster in the production process so that metal molds made of iron are needed as Figure 4.[5].

![Figure 4. Metal Molds For Pipe Connections](image)

Testing of hardness of specimen with well water well refrigerant medium is higher than the hardness of air cooling medium at room temperature and SAE oil 40.[6]. This research is to know hardness with variation of channel pattern, pattern A and C have no defect flaws but pattern B is cumulative. The lowest hardness on pattern I C and the highest hardness on channel A, this is due to the rate the freezing rate is finished at the point of casting. The longer the freezing rate, the lower the hardness value as Figure 5.[7].

![Figure 5. Pattern of Casting](image)

Figure 5. Pattern of Casting

The results achieved from this research are the realization of metal molds with motorcycle brake lever products and data on the effect of metal mold temperature on hardness as picture 5. The higher the metal mold temperature, the lower the hardness. At a pouring temperature of 100°C the average hardness that occurs is 41 HRB, while at 300°C the average hardness is 29.7 HRB.[6]

![Figure 6. Lever Products Include Motors With Metal Molds](image)

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The aluminium casting results have a smooth and shiny surface and its hardness and tensile strength can be optimal as Figure 7.[7]

![Figure 7. Aluminum Metal Casting Results](image)

Figure 7. Aluminum Metal Casting Results

The material used in this study is aluminum with Al chemical content = 71.2%, Cu = 11.7%, Si = 2.57%, Fe = 0.67%. The maximum tensile stress of the material is 7,1564 kg / mm² as Figure 8. (70,1758 MPa).[8].
Figure 8. Aluminum Metal Casting Results

The casting results by comparing the fluidity and quality of the casting, this research to determine the effect of the Lapindo mud to surface hardness and defective casting. The result of the study that the specimen casting Lapindo mud content of 7% has the highest fluidity value while the highest value of hardness at the Lapindo specimen 15%. Lowest casting defect analysis result is 15%, the result of this study that Lapindo mud is excellent for sand casting binder because it has a high density so good for binder.[9]. This research material is aluminium which melted with variation of temperature of 640°C, 700°C, and 740°C, the third variation has the highest toughness at temperature of 740°C and the micro structure is formed dendrites.[10]. The increasing temperature of pouring will result in different structure and mechanical properties. Because the higher the temperature of pouring causes more hydrogen gas to be trapped so that the value of violence decreases.[11]. The results show a significant difference in material microstructure and hardness between the surface and the core. The intense martensite tempering is observed on the die surface, while the core material microstructure remains unchanged. A considerable hardness drop is measured on the material surface and no change is observed in the depth of six millimetres from surface. [12] An attempt has been made to develop an investment powder which expands significantly in the setting period to meet the solidification shrinkage of most metals and alloys. Investment powders consisting of tricalcium aluminate, quartz, various sulphate bearing compounds and a small amounts of controlling agents (additives) were used in the preparation of the block investment molds. A413 Al-Si (Etiol 140) alloy was melted and poured in these molds to cast a test specimen of a special geometry. The preliminary results show that it is possible to produce dimensionally accurate castings by using expansive type investment powders. Samples cast into block investment molds prepared from ordinary non-expansive investment powder were smaller than the pattern size, while those poured into molds produced from expansive type powders were the same size or greater than the pattern size.[13].

2. Method

The research tool used in this research are metal mold, optical microscope test, and micro structure test instrument. The research material used is the original lug of Zn and Coran alloy from Al alloy. The workings of this research are: a) Al casting material included in foundry kitchen, b) Al metal casting material poured in metal mold, c) metal liquid waited until freeze, then removed and separated from the mold, d) casting result is examined using test equipment Optical microscopy, and microstructure. Flow chart of research can be seen in Figure 9. This research was at home industry owned by Mr. Bariman in Berbah, Sleman from January to March 2017.
3. Result and Discuss

The results of this study are as follows: Figure 10 is a dimension of Al 99.9% alloy castings, aluminum casting with metal molds. As for the figure of metal casting model on drum instrument fasteners like in Figure 11.
The result of microstructure testing using 500 times magnification using optical microscope such as picture 19 can be seen in picture 14 is the microstructure photo of Aluminum alloy lug and picture 15 is the original microstructure lug structure of Zn alloy that the Zn granular structure is bigger than that of Al. As per the Hull, D., and Bacon, D.J., formulas:

$$Ty = Tt + k \cdot D^{1/2}$$

With:
- $Ty$ = Voltage yield (kg / mm$^2$)
- $Tt$ = Friction voltage (kg / mm$^2$)
- $k$ = The fastening parameter
- $D$ = Grain diameter (mm)

The result of testing of microstructure of lug foundry containing 99.9% Al indicated at this alloy of aluminum is very dominant even close to pure aluminium so that in picture of element of silicon is very small as in Figure 12. The result of microstructure test that the diameter of Zn granule is bigger than Aluminum grain as in Figure 13.

The larger the diameter of the granules the material hardness is lower and soft. The smaller the grain diameter the higher the hardness of the material and the brittle. The hardness of Al lug alloy castings is higher than that of the original Zn alloys due to the diameter of the aluminum granules being smaller than the diameter of the Zn granules.

**Figure 11. Lug in drum music**

**Figure 12. Photos of the coran lug micro structure of Al alloy magnification 500 times**
4. Conclusion

a. The result of microstructure testing of lug foundry containing 99.9% Al indicates in this alloy that aluminum is very dominant even close to pure aluminum so that in picture of element of silicon is very small.

b. The result of microstructure test that the diameter of Zn granule is bigger than Aluminum grain.

c. The larger the diameter of the granules the material hardness is lower and soft. The smaller the grain diameter the higher the hardness of the material and the brittle. Hardness Al lug alloy castings are higher than the original lugs of Zn alloys. This is because the diameter of aluminum granules is smaller than the diameter of granules Zn.

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Figure 13. Photos of the original lug micro structure of Zn alloy magnification 500 times

Figure 14. Microscope Optic
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