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The Effect of Adding Wood Charcoal Powder and Coconut Shell Charcoal on Recycle Aluminum Alloy 6061 Against Hardness

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Abstract:
Background*: The purpose of this study was to determine the smelting mixture of aluminum alloy (6061) with coconut batak charcoal powder and a mixture of aluminum alloy smelting (6061) with wood charcoal powder on hardness. Aluminum Alloy (AA) 6061 is an aluminum alloy that is generally applied to automotive and construction equipment, aluminum alloy has beneficial properties such as corrosion resistance, good handling and durability.*
Materials and Methods*: Wood charcoal powder is charcoal made from burned powder, this powder is easily obtained at sawmills, while coconut shell charcoal powder is charcoal made from coconut shells which is easily obtained in coconut shells where people rarely use coconut shells. The smelting is done with materials such as pieces of aluminum that have been inserted into a cylindrical tube so that it melts first, where the melting temperature is measured with a minimum temperature range of 650^{o}C and to achieve even melting has been burned for 5 to 15 minutes before being poured into the mold. The samples tested were obtained from the pouring of wood charcoal powder and aluminum alloy coconut shell charcoal. Aluminum castings in the form of cylinders are cut 1 cm for hardness test, the sample is formed in a circle with a diameter of 5 cm and a thickness of 1 cm and then the hardness test is carried out using the Brinell method..*
Results*: the addition of charcoal powder into the mold just before pouring the aluminum liquid, the result has decreased the value of the hardness of the material. The addition of 12.5 grams of charcoal powder has reduced the hardness value from 31.66 BHN to 29.90 BHN. However, with the addition of 25 coconut shell charcoal, the hardness value decreased to 30.04 BHN. Likewise, adding 37.5 grams of charcoal powder has reduced the hardness value to 30.08 BHN. The addition of 12.5, 25 and 37.5 grams of charcoal powder affected the Brinell hardness.*
Conclusion: *The more coconut shell charcoal powder and wood charcoal added, the lower the Brinell hardness value.*
Key Word*: Aluminum Alloy 6061;Coconut Shell; Charcoal;Wood Charcoal;. hardness test*

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I. Introduction

Aluminum is the most widely used commercial metal in construction, machinery, household, and aircraft. The use of aluminum in large quantities in everyday life produces a large amount of metal waste. Aluminum waste from various activities, including beverage cans, cooking utensils, scrap, cable waste, can be recycled. Recycling work is carried out by almost all countries of the world. Commercial aluminum is classified according to the type of load, type of treatment, and workmanship of the manufacturer. The properties of aluminum that make the metal and its alloys most economical and attractive for a variety of applications are appearance, light weight, ease of work, physical properties, mechanical properties, and corrosion resistance. It is generally known that the strength-to-weight ratio of aluminum is higher than that of iron or steel. In addition, the corrosion-resistant properties of aluminum have been established when cooling aluminum castings. A thin layer of aluminum oxide is found on the outside of the aluminum alloy that adheres tightly to the surface, the properties of this layer are stable and can protect the inside. Some of the commonly known physical properties of materials are tensile strength, hardness, impact, and wear. The ability of the material to accept dynamic loads is included in the fatigue test or material fatigue. Meanwhile research on the amount of material activation energy due to alloy decomposition has also been carried out by several researchers. Several researchers have carried out physical testing of aluminum materials, fatigue tests, and measurements of the activation energy of aluminum alloys. This research uses 6061 aluminum alloy which is included in the category of aluminum that can be heated and forged. Aluminum alloy is a type of aluminum containing the pre-dominant elements Magnesium and Silicon, which has excellent fatigue properties and is corrosion resistant and is used in heavy duty. This type of material is widely used for various purposes in life. Aluminum alloy 6061 is smelted and then added new elements obtained from combustion.

II. Material And Methods

The material that will be used for this research is aluminum alloy 6061 which is a commercial aluminum alloy that uses the most of other types of alloys. The aluminum cylindrical bars are cut to size and this is a simulation of recycling of machined 6061 aluminum alloy chips. Coconut Shell Charcoal is taken from PT MUTIARA AGUNG in Kramat Jati, East Jakarta. The coal was finely ground and then sieved with fine sieves of 20, 40, 60, and 100 mesh. When Coconut Shell Charcoal is heated and until it burns, it can be observed by proximate analysis. This proximate analysis includes the percentage values of moisture, volatile matter and ash, while the total difference of 100% is the fixed carbon content [1].

Coconut Shell Charcoal and Wood Charcoal are burned at high temperatures, leaving ashes. The coal used has a water vapor content of 3.58%, volatile matter 43.65%, ash 6/5% and fixed carbon 46.27%. The number of coconut shell charcoal and fine wood charcoal added to the cylinder tube mold is 12.5; 25; and 37.5 grams. As a comparison, aluminum smelted is also poured without the addition of fine coal.

The smelting is carried out with materials in the form of pieces of aluminum which are inserted into the crucible until it melts, but before inserting the aluminum feeder in the form of scrap so that it can be melted first. The melting temperature is measured with a Hand Held Infra Red Thermometer, the minimum temperature range is 700^{o}C, in order to obtain an even melting, it is necessary to hold the temperature for about 5 to 15 minutes before pouring into the mold, while removing the dross that has arisen on the surface. A tube mold measuring 5 cm and 30 cm high is prepared, held with a long clamp, where this tube was previously heated on a crucible. The pouring of this high-temperature aluminum into the tube mold causes a fairly high burst of flame, indicating the presence of coal burning in the tube. This combustion provides continued heating of the aluminum material in the tube. However, it is also estimated that not all coconut shell charcoal and fine wood charcoal burned, and this coconut shell charcoal and fine wood charcoal were trapped in the castings. So it is estimated that there are 3 (three) components of coconut shell charcoal and fine wood charcoal remaining due to this heating, namely unburned fine charcoal, volatile matter, fixed carbon and ash.

The test sample was obtained from the results of molding aluminum coal mixture. For the hardness test, the sample is made in the form of a circle with a diameter of 5 cm and a thickness of 1 cm. Researchers conducted a hardness test using the Brinell method. In the Brinell hardness test, a steel ball indenter with a diameter of 5 mm, given a load of 500 kg was pressed against the surface of the sample so that it formed a hollow. The relationship between the magnitude of the load, the diameter of the steel ball indenter and the diameter of the basin on the surface of the test sample is the basis for calculating the Brinell hardness value.

III. Result and Discussion

From the research process, a number of samples have been obtained for hardness testing. The samples were codified such as w/o (without wood charcoal and coconut shell charcoal), twf (12.5 grams), ttf (25 grams) and tsf (37.5 grams)

Table no 1: Hardness/Brinell results.

	Sample	BHN
E	w/o	58.58975649
F	ak12.5	48.18757559
G	ak25	49.12302554
H	ak37.5	52.50434786
I	ab12.5	50.49700632
J	ab25	53.57065468
K	ab37.5	49.12302554

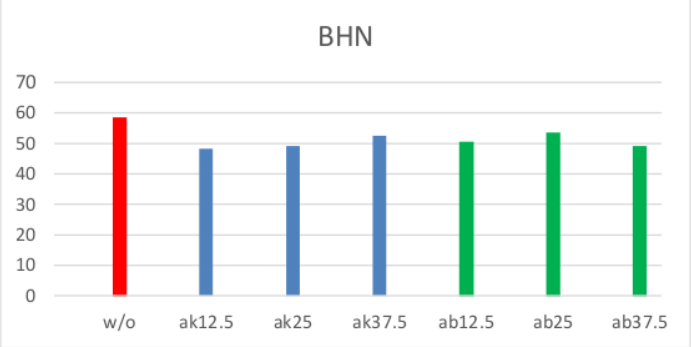
Description :

w/o = No charcoal
ak = wood charcoal
ab = shell charcoal

E = 0 gram, w/o

Wood Charcoal:
F = 12.5 gram
G = 25 gram
H = 37.5 gram

Shell Charcoal
I = 12.5 gram
J = 25 gram
K = 37.5 gram



Gambar 1: Brinell Hardness Chart

From Figure 1 it can be seen that by adding charcoal powder into the mold just before pouring the aluminum liquid, the result has been a decrease in the hardness value of the material. The addition of 12.5 grams of charcoal powder has reduced the hardness value from 31.66 BHN to 29.90 BHN. However, with the addition of 25 coconut shell charcoal, the hardness value decreased to 30.04 BHN. Likewise, adding 37.5 grams of charcoal powder has reduced the hardness value to 30.08 BHN. The addition of 12.5, 25 and 37.5 grams of charcoal powder affected the Brinell hardness. This decrease in value is appropriate [2], where in this case the presence of other elements other than the main material has reduced the hardness value of the aluminum material. The addition of other elements to the main material has also changed the value of hardness and other mechanical properties. [3][4][5][6][7]. Likewise, the addition of fly ash resulting from coal combustion in the manufacture of composite materials has changed the value of the mechanical properties of the material [8][9]. However, if we look at the sample given charcoal powder, it can be seen that the more charcoal powder added, the greater the Brinell hardness. There is a discrepancy in this case, the addition of charcoal powder generally decreases the hardness, but with the addition of more charcoal powder, the hardness increases. So it can be estimated that the presence of unburned charcoal powder in the aluminum sample cannot be said to increase the hardness. However, it can be said that there is an effect of burning charcoal powder on the hardness value. Charcoal powder which is inserted into the cylindrical tube just before pouring, has burned (figure 2) which leaves a mark in the form of carbon or ash and a moment later extinguished by leaving white smoke, which thus has a further heating effect on the aluminum sample.

In the pouring of aluminum into a cylindrical tube that already contains charcoal powder, the measured pouring temperature is around 650^{o}C. In this case, the molten aluminum has heated the charcoal powder directly, in this case the moisture content has evaporated completely. The decrease in temperature due to this temperature difference has lowered the temperature of the molten aluminum, but rapidly, the gas in the volatile matter burns, and by itself raises the temperature of the molten aluminum again. It is estimated that the formation of fixed carbon at this temperature, in accordance with what is said by Speight [1]. However, in the tube, the formation of ash is estimated to almost not occur, because the temperature inside the cylinder tube does not reach 900^{o}C

Figure 2: Pouring into the Cylinder

IV. Conclusion

From the discussion, it can be concluded that research by adding coconut shell charcoal and wood charcoal into the cylinder tube has an effect on the hardness of the aluminum casting material. Coconut shell charcoal powder and wood charcoal that have been burned can be seen from the fire and white smoke that comes out when the aluminum liquid is poured into the cylindrical tube. The formation of a new shape on the surface of the sample indicates that a certain amount of charcoal powder has formed a porous hole containing unburned charcoal powder, fixed carbon or ash. The presence of pores, which is indicated as not burning charcoal powder or burning charcoal powder and trapped into carbon, it can be said that the pores formed are a new form for aluminum alloys. So it can be concluded that a new material has been made, namely porous aluminum metal filled with charcoal powder/carbon/ash from burning coconut shell charcoal and wood charcoal. This addition has reduced the hardness of the sample. However, if you look at the sample that has been given charcoal powder, it can be seen that the more coconut shell charcoal powder and wood charcoal added will increase the Brinell hardness value.

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