Analysis of The Quality Recycled Aluminum Mix of Soft Drink Cans And Engine Block With Sand Casting Method Volcanic Ash

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Abstract

The use of aluminum for construction materials continues to rise, this led to use of aluminum raw materials continue to increase, and led to scarcity of raw material for aluminum. Recycles aluminum waste can reduce the use of aluminum raw materials. Recycled aluminum material like the soft drink cans have low mechanical properties, so that the necessary a mixture of aluminum with characteristics better mechanical properties to improve mechanical properties, one of which is waste engine block. Scrap mix soft drink 70% and 30% scrap engine block melted together. After melting do foundry in the mold of volcanic ash with water binding 10% in difference of pour temperature 660^{o}C, 690^{o}C and 720^{o}C. Shaped silicon microstructure visible polygons or nearly unanimous well as large size and shape of the lines very little between the Al matrixes. Hardness increased at pouring temperature of 660^{o}C is 32.2 HVN, and decreasing at pouring temperature of 720^{o}C is 26.6 HVN. Tensile strength increased by 59.09 kg/mm^2, at temperature 660^{o}C pouring, and decreasing at pouring temperature of 720^{o}C is 32.91 kg/mm^2. Increased porosity in pouring temperature 660°C is 5.3%, and decreased in pouring temperature 720^{o}C, is 3.9%.

Keywords: Recycling, soft drink cans, engine blocks, volcanic ash, molding sand, mechanical properties, porosity.

I. Introduction

The use of aluminum for construction materials continues to rise, this led to use of aluminum raw materials continue to increase, and led to scarcity of raw material for aluminum [2]. Need a study of the process recycling aluminum material have become waste. One way to recycle of aluminum material is by means metal casting. Some recyclable materials like aluminum soft drink can have low mechanical properties, so that necessary mixture of aluminum with the characteristics good of mechanical properties to improve the mechanical properties of scrap cans of soft drink. Waste engine block is one of the materials that is often found, with good mechanical properties, engine block can be used to improve mechanical properties of scrap cans of soft drink, because the price of waste is more expensive engine blocks it can be used as additive in castings soft drink can. This done only to suppress the price production of castings.

Al-Si microstructure is dominated by the Al matrix and silicon at the grain boundary, silicon is colored gray that consistently long shaped [1]. Increasing pouring temperature decreases the percentage of porosity [2]. Porosity occurred between dendrite Al-Si because nitrogen trapped after the liquid freezes. In the pouring temperature is high, hydrogen gas formed in molten metal and cause the formation of gas porosity and porosity shrinkage [7]. Increasing aluminum content decreases the tensile strength and the higher the aluminum content increases the hardness [6]. By adding a scrap of the engine block fluid scrap cans thus diminishing the content of pure aluminum, this may affect the mechanical properties. Pure aluminum has a very low strength, therefore aluminum requires alloy to improve its mechanical properties [3]. Volcanic ash of the volcano has a sintering temperature 1200^{o}C and 1300^{o}C melting temperature, so it can be used as molding sand in metal casting [5]. Moulds of volcanic ash have permeability is good, good compressive strength and shear strength with water as the binder [9].

Soft drink can is an aluminum alloy material containing fe0,8%, Mn1.4%, Mg0,8% and the rest is aluminum, is material with the market name of AA3105 type material wrought [10]. Cans typically used as food or beverage packaging because it is resistant to corrosion and very light, aluminum in this case is very suitable for use in food packaging. In the use of other construction needs in-depth study to process the cans in order to satisfy the requirements a mechanical construction. Making blind flens by means of casting techniques and the use of raw materials soft drink can be expected to meet the mechanical requirements in their use, the mechanical properties of tensile strength, hardness and microstructure of casting results. This study aims to determine the effect of pour temperature to mechanical properties of castings recycling of cans soft dringk with the sand casting method volcanic ash mold.

II. Research Methods

The study began by making scrap Al-cans soft drinks Fig. 1.a, and scrap Al-block engine Fig. 1.b, which is melted in a furnace crucible. Scrap cans soft drinks and 70% engine block 30% scrap is melted together. After pouring melted done on the mold of volcanic ash with the water binding 10%.

The sand used is volcanic ash eruption mount of Gamalama obtained around Ternate Island. Pattern mold made of wood shaped like blind flange with dimensions of 85 mm diameter and height 15 mm, Fig. 2. Casting in pouring temperatures of 660^{o}C, 690^{o}C and 720^{o}C.

After pouring castings allowed standing for 10 minutes then unloaded from the mold and cleaned. For testing purposes castings formed according to standard tensile test specimens No. 7 JIS Z2201 (Fig. 3), microstructure test, hardness test and porosity test.

(a) (b)

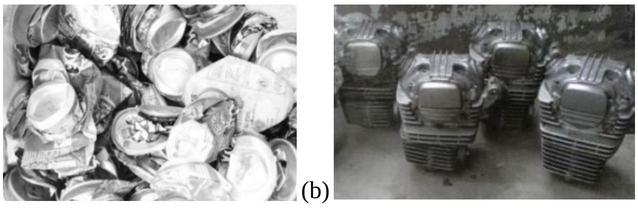



Fig. 1. (a). Soft drink cans. (b). Waste engine block

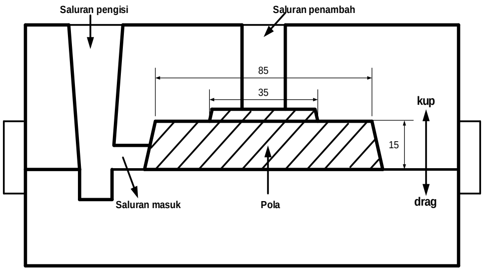


Fig. 2. Sand molds and patterns

Porosity testing conducted by measuring the density, through weight measurement specimen in the air and pure water, densities of actual specimen determined the equation (1)[7].

$$\rho_b = \frac{W_d \rho_w}{W_s - W_b} \quad (1)$$

Where: ρ_b = Actual density
ρ_w = Density of water
W_d = Dry weight specimen
W_b = Weight of specimen in water

Percentage porosity of each specimen was calculated using equation (2).

$$\%\,porositas = \left[1 - \frac{\rho_b}{\rho_{th}}\right] x100 \quad (2)$$

Where: ρth = Theoretical density alloy (2.658 g/cm^3)

Tensile test conducted to complete the basic design information strength of a material and as supporting data for material specifications. On the tensile test specimen is loaded tensile axis that grows continuously, along with observations about the extension experienced by the test specimen.

$$\sigma = \frac{P}{Ao} \quad (3)$$

Tensile stress (can be calculated to divide load (P) with initial area (Ao) cross section the specimen (3).

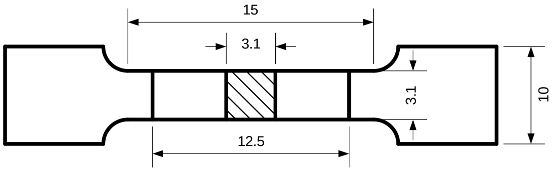


Fig. 3. Dimension of standard tensile specimen No.7 JIS Z2201

Vickers hardness number is defined as load divided by surface area of the curve, in practice calculated based on the long diagonal measurement of microscopic trace. Vickers hardness number is calculated by equation (4).

$$VHN = \frac{2\,P \sin(\theta/2)}{L^2} = \frac{1{,}854\,P}{L^2} \quad (4)$$

Where: P = Working load, kg
L = Average diagonal length, mm
θ = Angle between surface diamond opposite(136°)

Vickers testing do not depend on load because the trail created with pyramids geometrically pounder. Load which usually used on Vickers testing ranging from 1 to 120 kg, depending on the hardness metal to be tested.

Table 1. Chemical composition of soft drink scrap

Unsure	Si	Fe	Cu	Mn	Mg	Cr	Al
Wight%	0.6	3.01	0.27	0.92	1.22	0.02	93.76

Table 2. Chemical composition engine block scrap

Unsure	Si	Fe	Cu	Mn	Mg	Cr	Al
Wight%	10.1	0.8	1.95	0.17	0.06	0.02	85.61

Table 3. Chemical composition mixture soft drink scrap 70% and engine block scrap 30%

Unsure	Si	Fe	Cu	Mn	Mg	Cr	Al
Wight%	4.12	1.87	0.93	0.48	1.005	0.01	91.1

The chemical composition is changing after scrap soft drink (Table.1) and scrap engine block (Table.2) combined. The composition becomes 4:12% Si, 1.78% Fe, Cu0.93%, Mg 1.005%, a 0.01% Cr and Al 91.1%. (Table.3).

III. RESULTS AND DISCUSSION

Optical microscopy shows the microstructure at a pouring temperature 660^{o}C (Fig. 4a) looks silicon hypoeutectic shaped polygon or nearly unanimous as well as having a large size between the Al matrix. Silicon continues to decompose into short lines and long lines between Al matrixes at a pouring temperature of 720^{o}C (Fig. 4c).

The pouring temperature difference gives clotting time difference. Long freezing time provides opportunity silicon to decompose into smaller or forming small lines between the Al matrixes. Al-Si microstructure is dominated by the Al matrix and the grain boundaries, which is colored gray is consistently shaped silicone length [4].

The higher pouring temperature decreases hardness Fig. 5. microstructure at a temperature of 660^{o}C in the form of silicon that dominates the surface in the form of a square field or nearly spherical, give higher strength than hardness value at a temperature of 720^{o}C pouring silicon in the form of a short thin line between Al matrix. Silicon has high hardness compared with Aluminum [3].

The higher of pouring temperature decreases the tensile strength (Fig. 7). This happens because the microstructure at a pour temperature 660°C silicon dominates the surface in the form of a rectangular area provide higher power compared with hardness values at a pouring temperature 720°C silicon thin stripe short form on the surface of the Al matrix.

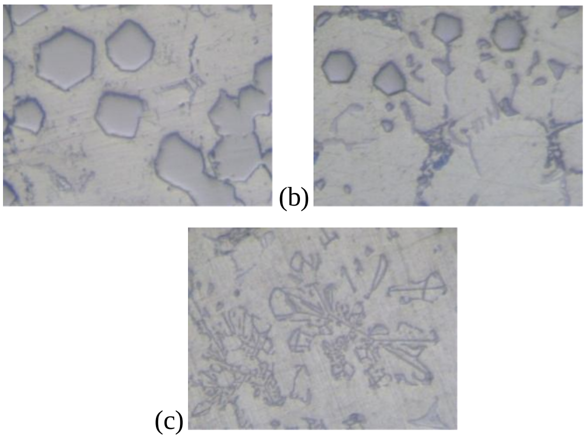
(a) (b) (c)


Fig. 4. Microstructure of castings at pouring temperature a. 660°C. b. 690°C. c. 720°C (magnification 100x)

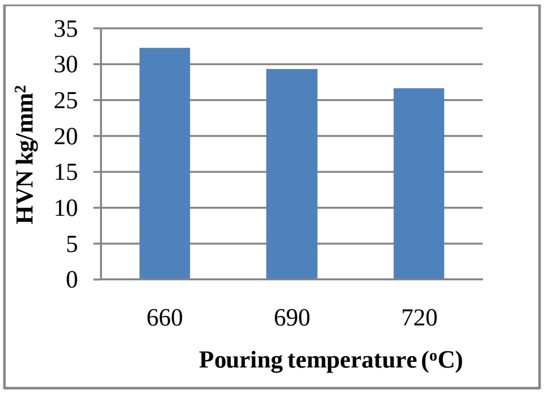


Figure 5: Graph effect of pouring temperature Vs. hardness

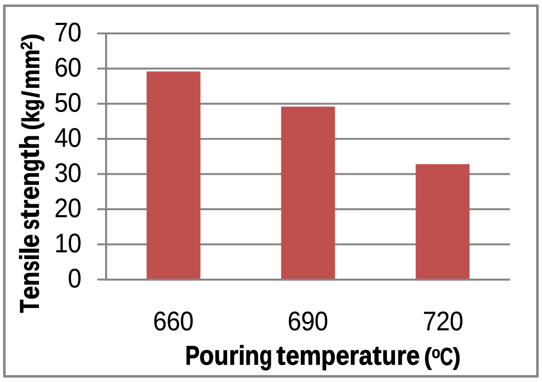


Figure 6: Graph effect of pouring temperature Vs. tensile strength

Increased porosity in pouring temperature of 660°C is 5.3%, while at pouring temperature 690°C porosity becomes 4.8%, and at pouring temperature 720°C porosity decreased to 3.9%. Increasing the pouring temperature decreases the percentage of porosity (Fig. 8).

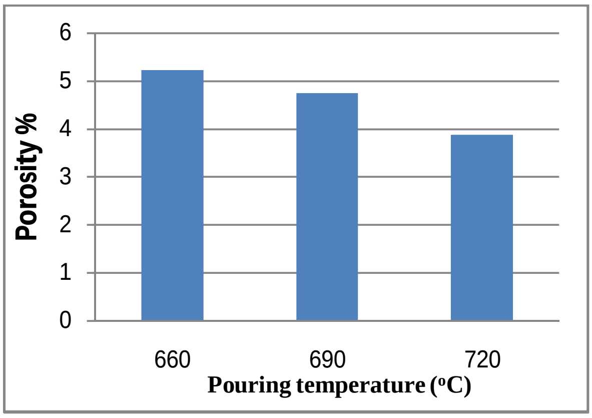


Fig. 7. Graph effect of pouring temperature Vs. porosity

This happens because in pouring temperature 660°C, high-speed freezing castings cause gas trapped and did not get out of liquid metal. In contrast to the pouring temperature 720°C slow freezing time provide opportunities trapped gas in liquid metal to get away. Porosity occurred between dendrite Al-Si; this is because the nitrogen trapped after the liquid freezes. In the pouring temperature is high, such as hydrogen gases formed in the liquid metal and cause the formation gas porosity and shrinkage porosity.

IV. Conclusion

The difference of pour temperature give difference freezing time, slow freezing time provide opportunities microstructure silicon (Si) in the form of a square field at low temperatures decompose into smaller or forming small lines between the matrix Al in high pouring temperatures. Silicon pouring decomposes at high temperatures shaped thin stripes lowering mechanical properties such as hardness and tensile stress. Porosity decreases with increasing temperature pouring, at temperature lower pouring castings freezing high speed causing a gas formed did not get out of the castings. High pouring temperature making long freezing time thus providing an opportunity trapped gas can out of metal liquid.

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