INFLUENCE OF POURING TEMPERATURES TO FLUIDITY OF ALUMINUM SCRAP CANS WITH INVESTMENT CASTING USING NATURAL CLAYS AS MOULD MATERIALS

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Abstract

Pekanbaru area produced scrap of beverage cans; an average of 4.5 tons per month by a scrap collector and it will increase every time. The Pekanbaru area also has natural clays, which can be used as mold material for investment casting. Processing of aluminum cans into a product using the natural clays as a mold in investment casting method will add the economic value of aluminum scrap cans. Study of fluidity is necessary to obtain usable information before creating of cast part design. This research aims to investigate the influence of pour temperatures to fluidity for the aluminum scrap cans casting, in natural clays. In this research used the pouring temperature variables: 650ºC, 700ºC and 750ºC. Results showed the fluidity at pour temperatures of 650ºC, 700ºC, and 750ºC approximately of 213.88 mm, 292 mm, and 360.97 mm, respectively. Results also showed that the fluidity was increased as well as increasing the pour temperatures. The fluidity increased 78.12 mm or 36.52% at pour temperatures of 650ºC to 700ºC, and it increased 68.97mm or 23.62% at pour temperatures of 700ºC to 750ºC.

Keywords: fluidity, temperature, cast aluminum cans

1. Introduction

Based on the results of a survey on the scrap collectors in Pekanbaru area, the numbers of scrap cans were 4.5 tons per month in each collector [1]. Recycling activities of scrap aluminum cans in the Pekanbaru area limited to collecting, reselling, and process them into semi-finished materials (ingots), none of them lead into final products thus the economic value would not rebe optimum. Hence the need for the utilization of aluminum cans to be recycled into a product is a must.

Foundry is one of the ways that can be used in recycling aluminum cans into raw materials (ingots) or into a product. Investment casting is a casting method using wax as a pattern, it is not only offers a precision but also minimize the stages work as for machining process [2]. Pekanbaru has natural clay which could be use as a mold in investment casting. Utilization of natural clay as a mold would be an advantage to lower the cost of investment casting.

Fluidity is defined as the ability to keep the molten metal to flow when the temperature decreases to eventually freeze inside the mold cavity in metal casting process [3]. The value of the fluidity of a material is very important notes in the designing of mold casting of a product. Bad fluidity will produce defects in casting product, the molten metal solidifies before it fills the entire cavity mold. Fluidity is influenced by many factors such as pour temperature, mould temperature, cavity thickness, melt cleanlyness, alloy compotitions, and mould materials. Knowing the influnce of each parameter obviously would reduce the chances to produce fail parts.

The influence of pour temperature has also been studied. Sabatino [4] varied of pour temperature (700ºC, 715ºC, and 730ºC) for Al-Mg-Si Alloys, Fischer [5] varied of pour temperature 690ºC and 740ºC. Moreover, the effect of mould materials was investigated Amira [6] used Zircon Sand A (70 - 200 mesh) as primary slurries.

This research investigated the influence of pour temperatures to fluidity, aluminum scrap cans were cast in natural clays as base material mold and pour temperature were varied from 650ºC, 700ºC, and 750ºC.

2. Methodology

2.1. Tools and materials

Scrap of beverage cans were from a particular manufacturer. Natural clays as mould materials were taken from the Riverside villages of Siak, Palas, Rumbai, subdistrict of Pekanbaru [7], and gypsum as a binder. Paraffin Wax as the mold pattern.

The main equipments were mold candles pattern, 200 mesh sieve, crucible furnace, tempering furnace, thermocouple, and vernier caliper.

2.2. The making of wax patterns

Wax patterns made in this research is seen in Figure 1.

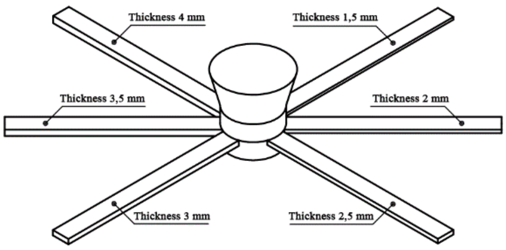

Figure 1. The wax pattern design

Wax patterns have 2 main sections namely strips (Figure 2-a) with 6 different thicknesses and a sprue and pouring cup (Figure 2-b). They were casted separately then assembled into a single tree (Figure 2-c). The temperature of wax cast was 55^{o}C.

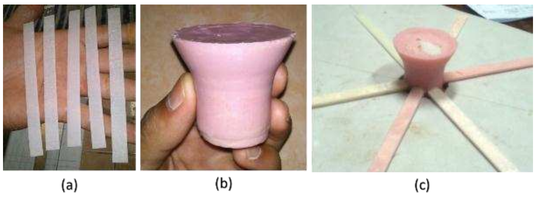

Figure 2. (a) The strip wax patterns, (b) Pouring cup, (c) Tree

2.3. Mold Making

Broke the clays into small pieces then dried them under the sun for approximately 3 days. Dried clays were sifted using a 200 mesh sieve.

Making of ceramic slurry for primary coating, a mixture of clays 200 mesh, gypsum, and comparison with water 1:1:3 was used, and the secondary coating using a mixture of flour sika (cement based grout) and water 1:2 by comparison.

The process of coating for primary coating was done by casting ceramic slurry into mould fixture with ± 10 mm thickness (Figure 3-a), a secondary coating was done by overlaying of primary layer that has already hardened for 3 times, the interval of each process was 1 hour and ± 3 mm coating thickness (Figure 3-b).

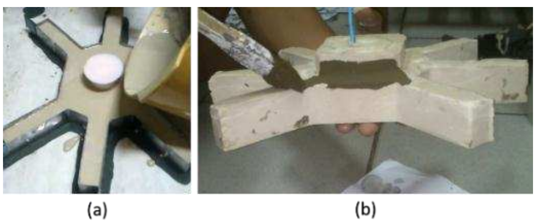

Figure 3. (a) Primary coating, (b) Secondary coating

Next process was dewaxing in tempering furnace at 120°C for 60 minutes [8]. Then it was sintered in tempering furnace at 350^{o}C with 60 minutes holding time [8].

2.4. The process of melting and molding

Aluminium casted process done by as much as 3 times the pouring temperature variations at each pour 650^{o}C, 700^{o}C, and 750^{o}C in the mold temperature 200^{o}C.

2.5. Measurement of fluidity

Fluidity of specimens (Lf) were measured with a 0.05mm precision vernier caliper. The length is the distance between each incoming cavities to the tip (Figure 4).

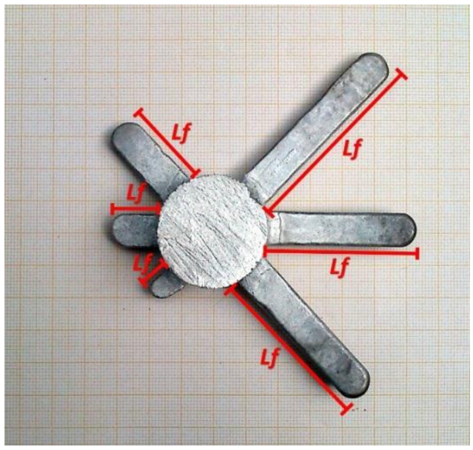

Figure 4. Area measurement of fluidity

3. Results

Fluidity tests were performed on three variations of pour temperature 650^{o}C, 700^{o}C, and 750^{o}C with mold temperature 200^{o}C and three specimens were made on each pour temperature (Tp).

3.1. The influence of pour temperature to fluidity

Figure 5 shows the relationship between the variation of pour temperatures with the average fluidity at 200^{o}C mold temperature. Each point is derived from the average total fluidity of all cavities on each pour temperature.

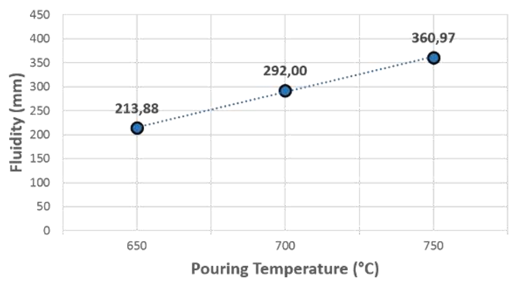

Figure 5. The graph of the relationship of pour temperature to average fluidity (mm)

Fluidity were increase as the pour temperature increase, minimum fluidity was 213,88mm at 650ºC, fluidity was 292mm at 700ºC, and maximum fluidity was 360.97mm at 750ºC. The increased of fluidity 78.12mm from 213.88mm to 292mm at 650ºC to 700ºC with percentage increse 36.52%, and increased of fluidity at 700ºC to 750ºC lower than 650ºC to 700ºC i.e. 68.97mm from 292mm to 360.97mm with percentage increase 23.62% so its graph is a little more ramps.

4. Discussions

4.1. Influence of pouring temperature on fluidity

Fluidity of molten metal is the ability of the molten metal to continue to flow while it continues to lose temperature and even while it is starting to solidify is a valuable feature of the casting process [3]. Fluidity is expressed as the time of filling speed and freezing time. Molten metal has the viscosity and surface tension, with increasing pour temperature the viscosity and surface tension is reduce so as to increase of filling speed. Figure 5 shows an increase fluidity as the pour temperature increase.

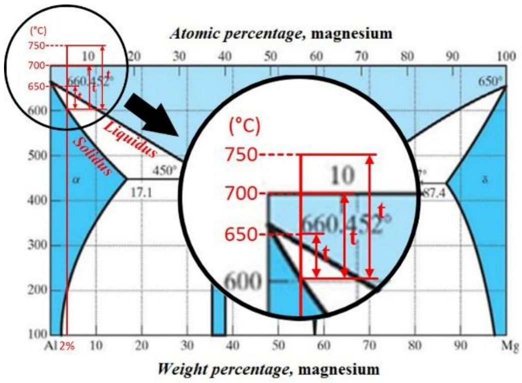

Figure 6. The phase diagram of Al-Mg

The molten Al-2%Mg flows from it pour temperature and slot at solidus line (figure 6). High pour temperature will increase freezing time (t), the longer freezing time will increase molten metal's ability to flow in the mold, at low pour temperature the freezing time become faster so that molten metal's ability to flow is getting smaller. The increased of fluidity as the pour temperature increase also stated by Andri [1], Campbell [3], Qudong [9], Sabatino [10].

The influence of fluidity against pour temperature with intervals 50ºC has different enhancement, this is because the relation between fluidity and pour temperature is not linear. The relation between filled length and pour temperature is almost linear, these results are explained by an increase in the enthalpy of the metal with pouring temperature [11]. Molten metal at high pour temperature remains liquid for a longer period of time and consequently a better filling of the mould cavity is obtained.

5. Summary

Fluidity was increase as the pour temperatures increase. Fluidity at pour temperature 650ºC, 700ºC, and 750ºC approximately of 213.88 mm, 292 mm, and 360.97 mm respectively. Fluidity increased 78.12mm or 36,52% at pour temperature 650ºC to 700ºC and increased 68.97mm or 23.62% at pour temperature 700ºC to 750ºC.

6. Acknowledgements

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