Study on effect of temperature smelting and pouring to mechanical properties Aluminum 7075

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Abstract. Aluminum alloy is one of the most non-ferrous metals used in the field of engineering and construction due to its mild nature and resistance to corrosion, while specifically for the A7075 has been widely used in the industrial world and aircraft construction. Cast temperature is one of the many variables found in the casting process. This variable is important because if the pouring temperature is too low then the cavity in the mold will not be fully filled where the inlet of the mold will freeze first, and if the pouring temperature is too high, this will cause shrinkage and loss of accuracy in the dimensions of the castings. The purpose of this research was to compare the aluminum smelting process and the aluminum pouring process in molds made of sand. From this research, the results obtained by increasing the temperature of casting on 7075 aluminum alloy casting. In this study increase the hardness of castings at a pour temperature of 7500 C in sample 1 of 78.4 HB, sample 2 is 79 HB and sample 3 is 76 HB then hardness decreases at 7700 C pouring temperature which is in sample 1 equal to 55.6 HB, sample 2 was 62 HB and sample 3 was 60.6 HB. Tensile strength tends to decrease with the highest increase in pouring temperature of 198 N / mm² at pour temperature of 7150 C and at the lowest 150 N / mm² at 7700 C.

1. Introduction

Aluminum is one of the most non-ferrous metals used in engineering and construction due to its mild nature and resistance to corrosion. There are many alloys found in the aluminum such as Al-Si, Al-Cu, Al-Mg and Al-Zn and many other aluminum alloys. Each of these alloys has different characteristics with different intended uses. Additions of elements such as Zn, Mg, Mn, and chromium with relatively small amounts will improve strength and resistance to corrosion [1]. Al-Zn-Mg alloy alloys have a moderate tensile strength in the casting process. By performing an annealing process, stability from dimensions can be developed. Good engine and corrosion-resistant, even though it is easily exposed to stress corrosion. Al-Zn-Mg alloy is generally combined with other elements such as Cu, Mn and so on.

One Aluminum alloy with a relatively high Zn content of 5.1 to 6.1% is A7075 which is widely used for parts or components with high enough stress and good corrosion resistance. Cast temperature is one of the many variables found in the casting process. This variable is important because if the pouring temperature is too low then the cavity in the mold will not be fully filled where the inlet of the mold will freeze first, and if the pouring temperature is too high, this will cause shrinkage and loss of accuracy in the dimensions of the castings. Cast temperatures in aluminum alloys are usually found in
the range 675 – 790° C and must be maintained at pouring, the pouring temperature must be kept between ± 80° C [2]. The results show that it is important that the speed of entry of molten metal fills the mold, very little oxide will be trapped in the mold. The gating system geometry is a very important factor that influences the pattern of filling the mold [3]. This element also provides a little solid solution strengthening or work-hardening effect on aluminum, but the formation of the Al-Zn-Mg precipitate forms the basis of alloys from 7xxx and 7xx.x casting alloys. The optimum gating system design can reduce turbulent flow of molten metal, reduce gas and trapped dirt [4].

2. Methods
This research uses Aluminum 7075 material with composition Si 0.4%, Fe 0.5%, Cu 1.2 - 2.0%, Mn 0.5%, Mg 2.1 - 2.9%, Cr 0.18 - 0.28%, Zn 5.1 - 6.1% and Ti 0.2%. Casting is done using a furnace with a crucible from graphite. The melting temperature to be used is 770° C and for pour temperatures 715, 730, 740, 750 and 770° C.

The smelting and pouring process was carried out by lifting the 7075 aluminum smelter and pouring it into the sand mold. Casting usually begins with making patterns and prints with sand. Sand molds can be made manually or by machine. Manually making molds is done if the number of components to be made is limited, and many variations. Making hand dimensions with large dimensions can use a mixture of clay as a binder. Cast temperature is one of the many variables found in the casting process. This variable is important because if the pouring temperature is too low then the mold cavity will not be filled where the inlet will freeze first, and if the pouring temperature is too high then this will result in shrinkage and loss of accuracy in the dimensions of the castings. To form the castings as desired, the metal must flow throughout the mold area before the metal freezes. Some factors that influence this include pouring temperature, pouring speed, and turbulence [5].

![Image](image1.png)  
(a) 7075 aluminum smelting process  
(b) Pouring process in the sand mold

**Figure 1.** (a) 7075 aluminum smelting process and (b) pouring process in the sand mold

The metal liquid is then poured into a mold made of silica sand. Samples of castings made of plates and plates will be cut into hardness test samples for tensile test samples according to the 2008 ASTM E-8 standard. Also, other test methods that can be used are provided [6–8].
3. Results

Melting and pouring temperature is one of the important elements that must be considered in producing casting products because these factors greatly influence the quality of the results of castings. The best temperature of aluminum 7075 melting is used to melt at a temperature of 770°C and poured at pour temperatures 715, 730, 740, 750 and 770°C. In order to form the castings as desired, the metal must flow throughout the mold area before the metal freezes. Some factors that influence this include pouring temperature, pouring speed, and turbulence [5].

3.1. Violence test results

Hardness testing was carried out using the Brinell method to determine the effect of pouring temperature on the hardness of the Affi Hardnes Tester system (load 1226 N, steel ball ø 5). From the results of testing the data is entered into the table as shown in table 1.

| Sample            | Brinell (HB) |
|-------------------|--------------|
| Cast temperature 715°C | 55.6 55 54.7 |
| Cast temperature 730°C | 73.6 72 72.2 |
| Cast temperature 740°C | 74.2 74.7 74 |
| Cast temperature 750°C | 78.4 79 76 |
| Cast temperature 770°C | 60.4 62 60.6 |
In Figure 3 the graph of the results of the hardness test can be seen that the increase in the pouring temperature of aluminum 7075 casting has increased to a pour temperature of 750°C in sample 1 of 78.4 HB, sample 2 of 79 HB and sample 3 of 76 HB then hardness has decreased at temperature pour 770°C, this is influenced by a high pour temperature so that it can affect the low hardness value that is in sample 1 of 55.6 HB, sample 2 of 62 HB and sample 3 of 60.6 HB. The increase in pour temperature will further increase the hydrogen content in the metal liquid followed by taking steam from the mold this will affect the formation of porosity and mechanical properties [3]. This is because the last freezing rate is located on the center axis of a cast. So the longer the freezing rate the lower the hardness. The hardness value is still in accordance with the hardness limit on aluminum which is equal to 30 – 100 BHN [9].

3.2. Tensile strength test results

Tensile testing is done to determine the strength of the material used. Tensile testing uses the standard ASTM E-8 2008 and to determine the effect of pouring temperature on the value of tensile strength. From the test results, the data is entered into the table as shown in table 2.

Table 2. Tensile test results (N/mm²)

| Cast temperature | Tensile test results (N/mm²) |
|------------------|-----------------------------|
| 1 Cast temperature 715°C | 198 |
| 2 Cast temperature 730°C | 188 |
| 3 Cast temperature 740°C | 169 |
| 4 Cast temperature 750°C | 170 |
| 5 Cast temperature 770°C | 150 |
Figure 4. Graph of the tensile test results (N/mm²)

In figure 4 we can see that the graph of the tensile test results can be seen that at a pouring temperature of 715° C the tensile strength value is increased by 198 N / mm². This is influenced by the pouring temperature carried out which is 715° C while at pour temperature 770° C has a tensile strength value of 150 N / mm², thus experiencing a slight decrease along with the increase in pouring temperature.

4. Conclusion
From the research conducted, several conclusions can be drawn, namely:

1) The increase in pouring temperature of the 7075 aluminum alloy casting in this study increases the hardness of the castings at a pour temperature of 750° C in sample 1 of 78.4 HB, sample 2 is 79 HB and sample 3 is 76 HB then hardness decreases at 770° C pouring temperature that is in sample 1 is 55.6 HB, sample 2 is 62 HB and sample 3 is 60.6 HB.

2) Tensile strength tends to decrease with the highest increase in pouring temperature 198 N / mm² at pour temperature 715° C and at the lowest 150 N / mm² at 770° C.

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