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Manufacturing of Al-20%Si with Electric Arc Furnace

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--***ABSTRACT***--
Furnaces are equipment used to process metal or non-metallic minerals in the process of reduction or fusion. One of the mineral processing stoves is a single phase electric arc furnace. In this study Si Al-20% alloy will be made using an electric arc furnace, this arc furnace uses an electric arc with a power of 5.6 kW consisting of the main material of the furnace using brass and quartz cylinder glass Ø 120 mm. the furnace was designed with a cylindrical size of Ø 150 mm with a height of 190 mm the diameter of the electrode used was 3 mm and a length of 150 mm. Testing of electric arc furnaces by making Al-20% Si alloys in Ar gas conditions using 100 A electric current, Al and Si melting in the furnace at temperatures of 800-900ºC 40 seconds operating time with a composition of 4 gr aluminum and 1.25 gr silicon ore. then the microstructure was tested using optical microscopy from the fusion consisting of the main Al-α phase with Si in the form of needles, plates, and eutectic Al-Si structures evenly as the micro-structure of Al-Si hypereutectic alloys.

KEYWORDS: *Al-20% Alloy Si, Micro Structure, Hypereutectic and Silicon*

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I. BACKGROUND

In the metallurgical process one way to obtain liquid metal is through the pyometallurgical process. This method is done by using a furnace that can be used to repair and melt metal and non-metallic minerals. The choice of the melting furnace to be used to melt the metal must be in accordance with the raw material to be melted. Aluminum alloys, copper alloys, lead alloys, and other light alloys are usually melted using a crucible type melting furnace, while for cast iron using a low frequency induction furnace or kupola. High frequency induction furnaces are usually used to melt steel and high temperature resistant materials. The stoves are broadly divided into two types based on the heat generation method, which is a furnace that uses fuel and a furnace that uses electricity. Electric furnaces in general can be classified into two types, namely direct heat arc furnace and indirect heat arc furnace. In the direct heat arc furnace the positive pole and negative pole of the furnace are contacted so that heat arises. Whereas in the indirect heat arc furnace, the contact between the two poles is not direct but the relationship between the two poles is through the charge (charge). One type of electric arc furnace is a single phase electric arc furnace. Generally a one-phase electric arc furnace with one electrode has a tubular combustion chamber and the electrodes are placed in the middle of the combustion chamber. Metal melting using this furnace is done by using energy derived from electricity in the form of arcs or arcs which can melt metals. The efficiency of the furnace can be seen from the ability of the furnace to melt or reduce and fuse metal minerals.

With this condition, a new breakthrough is needed to get the new material that needs to be tested with a laboratory using a smelting material that is resistant to heat during smelting, with these testers trying to make electric arc furnaces with small capacity using brass material and quartz glass with conductivity good and absorbs heat, the current strength used is 100 A argon gas as a fusion process and prevents air from entering the furnace to produce a cleaner alloy.

II. METHODOLOGY

The method used in this study is descriptive and experimental methods so that data can be obtained regarding the manufacture of Al-20% Si alloys using electric arc furnaces.

The Process of Manufacturing Electric Arc Furnaces

Preparation

Creating an image design pattern using Auto Cad with the size specifications of the top and bottom with a diameter of 150 mm, a 42 mm gun drive ball holder, 150 mm height, 60 mm glass height, upper and lower glass holder with a diameter of 100 mm. the bottom there is a hole for cooling fusion.

Brass Material

The material used for Dais is turmeric, Brass is a metal that is a mixture of copper and zinc. Copper is the main component of brass, and brass is usually classified as a copper alloy. The brass color varies from dark reddish brown to silvery yellow depending on the amount of zinc. Zinc affects more the color of the brass. Brass is stronger and harder than copper, but not as strong or hard as steel. Brass is very easy to form into various forms, a good heat conductor, and generally resistant to corrosion from salt water. Because of these properties, brass is mostly used to make pipes, tubes, screws, radiators, musical instruments, ship applications, and cartridge casings for firearms.

Figure 1. Mold making brass material

Machining Process

The process of smoothing brass workpieces using a machining machine while making a 42 mm diameter firing stove and heat-resistant pyrec glass holder and gun drive ball holder.

Figure 2. Molded brass furnace after machining

Drilling Process
This process is drilling the screw baud as a cooling water into the bottom which can then drain the cooling water so that the cooling temperature of the electric arc furnace remains stable.

Figure 3. Drilling of cooling holes

Figure 4. Tapping process making screw threads from cooling valves

The Process of Cutting Glass

Glass measuring 1000 ml is measured by using Vernier Caliber with size 6 em up and down after making a line against the glass that has been measured then to limit the cutting process and prevent cracking on the glass. black after that the glass is cut by using a glass cutting machine speed 0-9900 rpm and the engine can be adjusted so that it does not cause the glass to crack.

The glass used is pyrex glass that is resistant to heat up to 100 C which can withstand heat when casting Al-Si is done while waiting for combustion.

Figure 5. Glass cutting machines speed 0-9900 rpm

The Process of Drilling Gun Drive Balls

This process uses a milling machine (Drilling) is to enlarge an 18 mm diameter gun mount hole that has been drilled or given a core. In principle, it is an operation of fitting a hole that has been previously excavated with a tool of a single eye lathe.

Figure 6. Drilling ball drive TIG welding gun

Process of Assembling Electric Arc Furnaces

The connection process of several component parts to form an electric arc furnace includes:

1. Installing the top and bottom glass holder seals using grease aims to glue the seal so that the argon in the furnace does not come out.

2. Install bolts with a diameter of 18 mm to connect the hose in and out of the cooler to the cooling tank.
3. Install the four bolts that are 100 mm long and as the upper and lower furnace connectors.
4. Positioning pyrex glass on a glass stand that has been given grease.
5. Put the arc furnace on the top of the four bolts then glued.
6. Lock the four bolts with nuts crosswise.

Figure 7. The process of assembling an electric arc furnace

III. RESULTS AND DISCUSSION

Al-20%Si Melting Results

The smelting consists of the main Al-α phase with Si in the form of a needle, plate and eutectic Al-Si structure evenly as the micro-structure of the Al-Si hypereutectic alloy. The microstructure of the Al-Si smelter uses an electric arc with a power of 5.6 kW (1000 X).

Discussion of Al-20%Si

With the same magnification, the microstructure of the results of remelting 1 still shows the presence of the primer even though the amount is not as much as the former microstructure of the piston. While the change from remelting 2 to remelting 3 shows a change in the form of a longer and larger eutectic (flake) Si. Enlargement of the size of the eutectic as described above is due to the presence of a grain refiner whose ability is reduced and it is even possible to lose it when carried out remelting. The more repetitions (remelting) that are carried out, the ability and levels of these elements also diminish. When casting and cooling there is a fading effect on the grain refiner and it is known from experience that the effect of grain refining on the agent has decreased due to the holding time during the casting process, which states that potential refiner is lost during the hold time, but to reduce the effect this can be done by stirring.

That there are similarities in the form of images of needle-shaped Si, the plates have eutectic Al-Si structure evenly as the micro-structure of Al-Si hypereutectic alloys so that in this study electric arc furnaces with small power can be used in the manufacture of new alloys and suitable and developed compositions this research in the laboratory.

Microstructure Testing Results

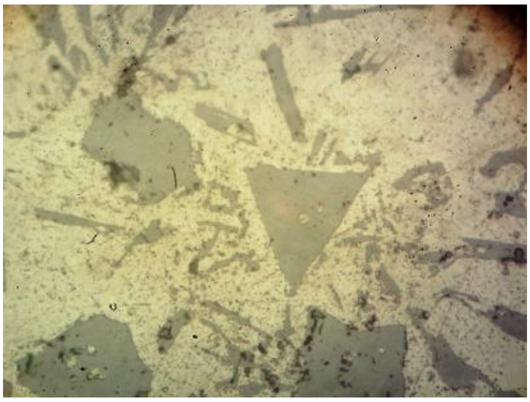

Figure 8. Microstructure on Al-20% fusion Si uses an electric arc (1000 X)

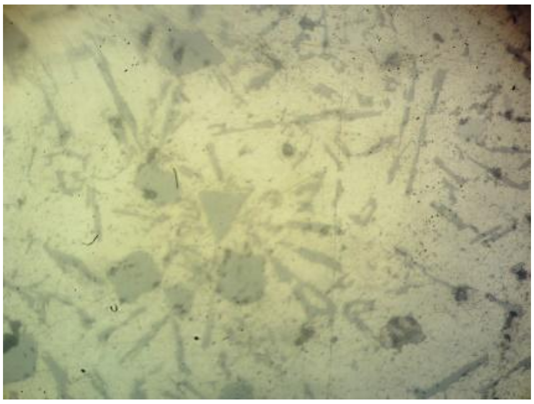

Figure 9. Microstructure of Al-20% fusion Si uses an electric arc (600 X)

The microstructure of the smelting consists of the main Al-α phase with Si in the form of a needle, plate and eutectic Al-20% Si structure evenly as the micro-structure of Al-20% Si hypereutectic alloy. The microstructure of the Al-Si fusion uses an electric arc (1000 X).

IV. CONCLUSION

From the results of making Al-20% Si alloys with electric arc furnaces and testing the microstructure of Al-20% Si aluminum silicon alloy it can be concluded that:

1. Based on the making of electric arc furnace the good material is brass and quartz glass so that the resulting microstructure of the smelting consists of the main Al-α phase with Si in the form of a needle, plate and eutectic Al-20% Si structure evenly as the micro-structure of Al-Si hypereutectic alloy.
2. The melting process using Ar gas makes the Al-20% Si alloy cleaner

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