P-ISSN : 2598-1277
E-ISSN : 2621-3966

JOURNAL OF GREEN SCIENCE AND TECHNOLOGY

ANODIZING CHARACTERIZATION OF ALUMINUM 1100 COMPOSITION OF SULFURIC ACID - OXALIC ACID 16% WITH AERATION AND NONAERATION AT DIFFERENT TIME INTERVALS

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ABSTRACT

Aluminum is a type of metal that is widely used in the industrial and household fields. This study aims to analyze the effect of variations in sulfuric acid and oxalic acid concentrations, as well as aeration systems, on the surface characteristics of aluminum 1100 through the anodizing process. The anodizing process is one of the surface treatment processes that is carried out with the aim of improving or improving the properties of a metal, including resistance to wear, increasing hardness, and aiming to beautify the appearance itself. This anodizing test is with sulfuric acid-oxalic acid electrolyte solution, electrolyte concentration 16%, at room temperature with a current density of 3/dm2 in time intervals of 20 minutes and 30 minutes. The data obtained from the test results showed that the oxide layer was formed maximally in the aeration system with a concentration of 13.5+2.5 and a time interval of 30 minutes of 0.0411 gr. This shows that the addition of oxalic acid and oxygen can accelerate the formation of the oxide layer. At electrolyte concentrations of 16+0, 15.5+0.5, 15+1, 14.5+1.5 and 14+2, there was an increase in the difference in oxide mass by 0.0337 gr, 0.0335 gr, 0.0366 gr, 0.0390 and 0.0411 gr.

Keyword: *Aluminium, Anodizing, Aeration, Oxide coating, Electrolyte concentration*

1. INTRODUCTION

Aluminum is a type of metal that is widely used in the industrial and household fields. Aluminum is widely used because it has advantages such as being lightweight and easy to process into the desired shape [1]. Aluminum also has several disadvantages, including easy deformation, low hardness. To improve these properties, it is necessary to treat aluminum, one of which is an anodizing process.

The anodizing process is one of the surface treatment processes that is carried out with the aim of improving or improving the properties of a metal, including resistance to wear, increasing hardness, and aiming to beautify the appearance itself [2]. The anodizing process provides changes to the microscopic texture of the surface and the crystal structure of the metal coated near the surface [3].

The electrolyte solution used in the Anodizing process is sulfuric acid (H_2SO_4) because it can produce a thicker layer of oxide. However, the use of sulfuric acid can result in large pores on the surface of the coated aluminum, which results in the hardness of the metal being reduced than it should be. This problem can be addressed by adding a weak electrolyte solution, such as oxalic acid, nitric acid, or phosphoric acid, which can reduce pore formation.

2. RESEARCH METHODS

2.1 Tools and Materials and Process Stages

The main tools and materials used in this study are shown in Table 1. and Table 2.

P-ISSN : 2598-1277
E-ISSN : 2621-3966

Table 1. Main Tools

No.	Tool	Specifications	Quantity	Function
1.	Aerator Aquarium	Roston	1	Oxygen supplier
2.	Jumper Cable	-	4	Electric Current Conductor
3.	Rectifier	Max 5A 30 V	1	AC to DC Electric Current Changer
4.	Chemical Beakers	Pyrex	1	Anodizing Process Reservoir Defender

Table 2. Main Ingredients

No.	Material	Quantity
1.	Aluminum 1100	2 Rolls
2.	Nitric Acid	300 grams
3.	Oxalic Acid	400 grams
4.	Sulfuric Acid	1.5 L
5.	*Aquadest*	25 L
6.	Grit Sandpaper	25 pieces
8.	NaOH	300 grams

2.1.1 Specimen Pre-Treatment

The workpiece, which is aluminum alloy 1100, is sanded and removes dirt or corrosion products on the surface of the workpiece, the sanding process with paper grip aims to smooth and level the workpiece so that the oxide layer sticks easily. Next, *a degreasing* process is carried out to remove oil, fat, and other organic substances from the metal surface using a 5% NaOH solution. Next, *an etching* process is carried out to remove the remaining alkaline solution in the *degreasing* process using an 8% HNO3 solution. Then the metal is removed and cleaned using *aquadest*. After that, initial weight measurements are carried out to determine the initial weight before the aluminum is anodized.

2.1.2 Anodizing Process

The anodizing process on aluminum metal that has been pre-treated is connected to the positive pole of the rectifier, namely aluminum which acts as the anode, while the negative pole of the rectifier is connected to another aluminum metal which acts as a cathode. Then this process uses an electrolyte solution, namely 16% sulfuric acid with the addition of variations in oxalic acid concentrations of 0%, 0.5%, 1%, 1.5%, 2%, and 2.5%. The operating conditions used in this anodizing process are $\leq$ temperature 25ºC (room temperature), current density of 3 A/dm², aluminum cathode and anodizing time of 30 minutes. After that, the coating thickness and surface hardness are tested against the coated aluminum alloy 1100. The oxide layer on the surface of the aluminum metal is absorbed in the base metal of the aluminum. The addition of aeration to the anodizing process is carried out using an aquarium aerator and a flow meter to regulate the discharge of air flow. The anodizing process on the workpiece is carried out using 2 methods, namely with aeration and without aeration. This process is carried out using a 16% sulfuric acid-oxalic electrolyte solution that is varied in concentration.

2.1.3 Testing of Oxide Masses Formed in the Anodizing Process

The oxidation period test is carried out by weighing before and after the anodizing process, then a comparison will be made on aluminum metal.

$$Oxide\ mass\ =\ final\ weight\ -\ initial\ weight$$

2.1.4 Coating Hardness Testing (Vickers)

Material hardness testing aims to determine the resistance of a material to plastic deformation when the material is subjected to external loads. This hardness test (vickers) aims to determine the hardness of aluminum after the anodizing process is carried out. Layer Thickness Testing The hardness value can be indicated with the help of the Vickers tool, performed by pressing by a certain compressive force by an indenter in the form of an inverted diamond pyramid with a peak angle of 136^o to the hardness metal surface. For hardness measurement refer to ASTM E384. The results of the calculation of the Vickers hardness value that have been obtained are then made a graph of the hardness value of the basic material and also the hardness value of the material that has undergone the anodizing process at the strong variation of current and dyeing time [4].

2.1.5 Micro Photo Testing

This microstructure testing aims to see the microstructure of the thickness of the aluminum oxide layer after the anodizing process [4]. Surface hardness testing of the thickness value shows the result of an oxide layer formed on the surface of the metal. The tool used is photomicro to show the morphological structure of the metal so that the layer becomes visible. Micro photographs aim to see the thickness of the oxide layer formed after anodizing using a magnification of 100 times each [5]. In testing, the specimen is treated including surface selection, measurement, cutting, cleaning, surface smoothing, coating (bakelite), grinding process, and polishing referring to ASTM E3. This photomicro testing method aims to find out how much thickness the aluminum oxide layer is after the anodizing process with a varied concentration of electrolyte solution.
As a scientific article, the systematics of writing articles can be arranged in two alternative arrangements as follows:

3. ANALYSIS AND RESULT

3. 1 Weight Increase of Oxidation Layer Formed by Anodizing

In this study, the calculation of the difference in the mass of aluminum metal was carried out which aimed to determine the mass of aluminum metal that has gone through the anodizing process. The mass of oxide is calculated by the initial end-weight formula. The result of the difference obtained indicates the speed of the aluminum oxide formation process.

3. 2 Effect of 20-Minute Interval Anodizing Results

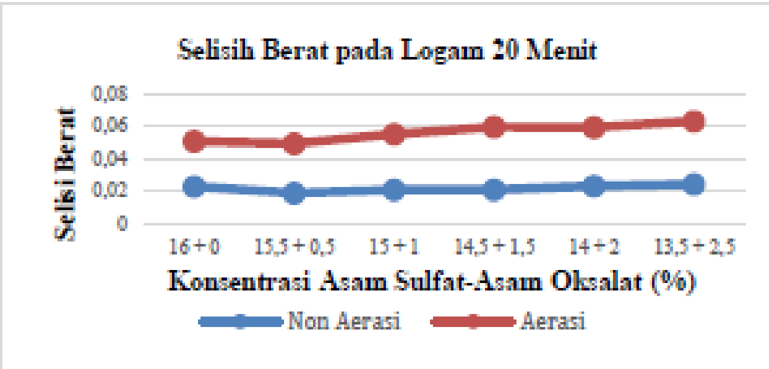

Figure 1. Relationship of Changes in Acid Concentration to Weight Difference at 20-Minute Time Intervals

Based on the observation of the difference in the mass of aluminum metal from the anodizing process as one-third in Figure 2. The maximum metal difference non-aeration system is at a concentration of 13.5+2.5 of 0.0247 grams. This shows that each addition of oxalic acid concentration increases the difference in the mass of oxides formed. The electrolyte concentrations of 16+0, 15.5+0.5, 15+1, 14.5+1.5 and 14+2 increased by 0.0232 gr, 0.0193 gr, 0.0212 gr, 0.0213 gr and 0.0237 gr. Then in the aeration system, the maximum metal difference is at an electrolyte concentration of 13.5+2.5 of 0.0386 gr. This shows that each addition of oxalic acid concentration increases the difference in the mass of oxides formed. The electrolyte concentrations of 16+0, 15.5+0.5, 15+1, 14.5+1.5 and 14+2 increased

P-ISSN : 2598-1277
E-ISSN : 2621-3966

by 0.0278 gr, 0.0303 gr, 0.0343 gr, 0.0384 gr and 0.0356 gr. From the test results, aeration and non-aeration systems have quite significant differences. The difference in oxide mass with aeration has a heavier mass, this shows that aeration can maximize the formation of oxide layers in aluminum.

The air flow (aeration) in this process is expected to supply a certain amount of oxygen to the electrolysis cell so that the electrolyte solution does not experience an oxygen deficit [6]. Anodizing aluminum with aeration produces a consistent oxide mass and a higher oxide mass formed compared to non-aeration. Meanwhile, in non-aeration, the oxide mass formed tends to be slow, but the oxide mass formed is stable with the addition of higher oxalic acid concentrations, the heavier the oxide layer formed.

3. 3 Effect of 30-minute interval anodizing results

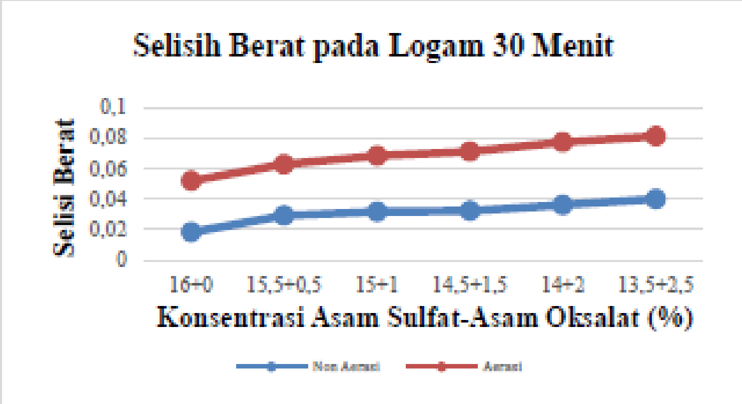

Figure 2. Relationship of Changes in Acid Concentration to Weight Difference at 30-Minute Time Intervals

Based on the testing of the difference in the mass of aluminum metal oxide from the anodizing process as shown in Figure 3. The non-aeration system of the oxide layer that is formed is maximally at a concentration of 13.5+2.5 of 0.0401 grams. This shows that each addition of oxalic acid concentration increases the difference in the mass of oxides formed. The electrolyte concentrations of 16+0, 15.5+0.5, 15+1, 14.5+1.5 and 14+2 increased by 0.0182 gr, 0.0293 gr, 0.0318 gr, 0.0322 and 0.0362 gr. Then in the aeration system, the maximum metal difference is at an electrolyte concentration of 13.5+2.5 of 0.0411 gr. This shows that each addition of oxalic acid concentration increases the difference in the mass of oxides formed. The electrolyte concentrations of 16+0, 15.5+0.5, 15+1, 14.5+1.5 and 14+2 increased by 0.0337 gr, 0.0335 gr, 0.0366 gr, 0.0390 and 0.0411 gr.

From the test results, aeration and non-aeration systems have quite significant differences. The difference in oxide mass with aeration has a heavier mass, this shows that aeration can maximize the formation of oxide layers and produce oxide masses that tend to be consistent and the mass of oxides formed is higher compared to non-aeration. Meanwhile, in non-aeration, the oxide mass formed tends to be slow, but the oxide mass formed is stable with the addition of higher oxalic acid concentrations, the heavier the oxide layer formed.

4. CONCLUSION

Electrolyte solution at a concentration of 13.5+2.5 is the most optimal solution in the formation of oxide layers, both aerated and non-aerated, with time intervals of 20 minutes and 30 minutes. The anodizing process with an aeration system is the best method because it can form a higher oxide layer compared to a non-aerated system. The anodizing process with a time interval of 30 minutes is the most optimal method compared to a time interval of 20 minutes with a smaller difference in oxide mass.

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