ISSN 2250-3153

Anodization of Aluminum

N. B. Ekwe, D. F. Aloko

Chemical Engineering Department, University of Abuja, Nigeria.

Abstract- The investigation into the effect of time and voltage on anodization of aluminum using 0.1M concentration and 2.5 pH of H_2SO_4 electrolyte, under 35^oC and 2.22amp/cm^2 current density was carried out. The result obtained showed that as the time and voltage increases the thickness of the coating on the surface of aluminum increases giving a much desired product for industrial and domestic use.
The optimum parameter for the coating was found to be 40minutes and 40volts for a thickness of 800µm.

Index Terms- Anodization, coating, electrolyte, thickness, time, and voltage.

I. INTRODUCTION

Anodization is the chemical change brought about by the passage of a direct current through and electrolyte via an aluminum anode and a suitable metal as cathode.
Basic Reaction
1. $2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$
2. $NaAlO_2 + 2NaOH \rightarrow Al(OH)_3 + NaOH$

Anodization of aluminum is formed by exothermic reaction on the external surface of aluminum or aluminum alloys with the nascent atomic oxygen produced by the electrolysis of an aqueous electrolyte. The electrolyte can be a solution of sulphuric acid, chromic acid, phosphoric acid and oxalic acid. The excellent corrosion resistance of pure aluminum is largely due to its affinity for oxygen. This results in the production of a very thin but tenacious oxide film which covers the surface as soon as a freshly cut piece of metal is exposed to the atmosphere.

Anodization can find its use in protection application against corrosion and abrasion; and since it is an extremely versatile process capable of giving coating of great thickness, durability and highly corrosion resistance, it is therefore used for naval equipment. It is also used in interior decoration, in the design work and more also in architectural design in making of sliding door, sliding window and cotton rail. It is also use in decorating motor vehicle.

II. MATERIALS AND METHOD

Apparatus: Thermometer, Voltammeter, Ammeter, Flexible wire, Anodizing bath made of high density polyethene materials, A.C. source (feedback generator), Beaker, 1 liter cylindrical flask, pH indicator, Oven.
Material: 0.1M H_2SO_4, 0.1M NaOH, 0.1M HNO_3, Ionized water, Aluminum anode, Lead cathode, Sand paper
Anodization Condition: temperature 35^oC**,** Current density 2.22 amp/cm^2**,** 0.1M H_2SO_4
Procedure:
Anodizing bath made of high density polyethene material was washed and rinsed with water and 0.1M H_2SO_4 (electrolyte) to remove dirt and greasy materials.

The anodizing solution was prepared to a concentration of 0.1M H_2SO_4 in a 500ml conical flask. The pH and the specific gravity of the baths were measured to be 2.5 and 1.251 using pH indicator and a specific bottle respectively.

The aluminum piece (anode) to be anodized was first washed thoroughly with soap to remove the dirt and later rinsed with water. The aluminum piece was then degreased using 0.1M NaOH, to allow for clean surface, and after rinsed in distilled water. The piece was introduced into a warm air circulation oven operating at 65^oC, from which they came out perfectly dry. The lead material (cathode) was clean with cloth and washed with distilled water to remove dirt.

The weighed aluminum piece (anode) and the lead (cathode) were inserted into the bath solution and connected to the positive and negative terminal of the D.C. generator respectively.

The current was switched on and the voltage was adjusted to 10volt, it was allowed to flow for 10 minutes and the current was switched off. The anodized aluminum was removed and rinsed with distilled water and dried in the oven. The anodized aluminum was then reweighed to ascertain the thickness of the coating. The experiment was then repeated severally. After the anodizing process, thorough observations were made on the nature and surface properties of the anodized aluminum, and these properties were noted. The anodized were rinsed thoroughly with distilled water and dried in the oven at the temperature of 60^0C for 30 minutes, to ensure complete drying of the anodized aluminum.

III. EXPERIMENTAL RESULTS AND DISCUSSION

Table I**:** Effect of corresponding increase in time and voltage on anodized aluminum.

Bath	Time (min)	Voltage (v)	Observation
Bath I	10	10	Not noticed
Bath II	20	20	Thin bright deposit
Bath III	30	30	Thin bright deposit
Bath IV	40	40	Bright smooth deposit
Bath V	50	50	Rough burnt deposit

Table II**:** Effect of voltage variation on anodized aluminum at constant time.

Bath	Time (min)	Voltage (v)	Observation
Bath I	40	10	Thin bright deposit
Bath II	40	20	Thin bright deposit
Bath III	40	30	Bright smooth deposit
Bath IV	40	40	Bright smooth deposit
Bath V	40	50	Bright smooth deposit

Table III**:** Effect of time variation on anodized aluminum at constant voltage.

Bath	Time (min)	Voltage (v)	Observation
Bath I	10	40	Not Noticed
Bath II	20	40	Not Noticed
Bath III	30	40	Thin bright deposit
Bath IV	40	40	Bright smooth deposit
Bath V	50	40	Rough burnt deposit

Table IV**:** Effect of Voltage on the thickness of the anodized aluminum.

Time (min)	10	20	30	40	50
Voltage (v)	10	20	30	40	50
Thickness (μm)	160	241	480	800	960

From the results obtained it was observed that there was no notice in the first 20 minutes until a thin bright deposit was observed after 30 minutes. But there was bright smooth deposit at 40 minutes, while in the fifth case where the time was increased to 50 minutes, rough burnt deposit was seen. This implies that 40 minutes is the optimum time for the anodization process.

IV. CONCLUSION

The optimum voltage and time for the anodization process has been determined after careful observation of the coat formed on the surface of the aluminum. It was found that at 40 volts and 40 minutes, the aluminum was effectively anodized and, the coating formed was very smooth and clear.

APPENDIX

$$\text{thickness} = {P2 - P1}/{S \times D}$$

Where: P_2 -weight after anodization
P_1 - weight before anodization
S - surface area of the aluminum
D - density of the aluminum

Sample 1		Sample 2
P_2	58g	57.5g
P_1	57g	56g
S	$22.5cm^2$	$22.5cm^2$
D	$2.771g/cm^3$	$2.771g/cm^3$
thickness	160µm	241µm

$$\text{Current density} = \frac{\text{Current}}{\text{Surface}}$$

S = Surface Area ($22.5cm^2$)
I = Current (50amp)

$$\text{Current density} = \frac{22.5}{50} = 2.22\ amp/cm^2$$

REFERENCES

[1] W.J. Bernard, Electroplating *and Metal Finishing*, 1980, Pg. 15-16
[2] F. Fusom, Electroplating and Metal Finishing, 1991, Pg. 33
[3] R.W. Harrington and H.R Nelson, *Metals Technology*, 1986, Pg. 10-15
[4] J.F. Murphy, *Anodization Technology*, 1976, Pg. 5-9
[5] L.E Samuel., *Finishing of Aluminum*, 1996, Pg. 5-15
[6] A. Jenny, *Anodic oxidation of Aluminum*, 1981, Pg. 76-80

AUTHORS

First Author – N. B. Ekwe, M.ENG **(**Chemical Engineering), Chemical Engineering Department, University of Abuja, Nigeria**,** E-mail id - banchyme@yahoo.com.
Second Author – D. F. Aloko, PhD (Process analysis and development), Chemical Engineering Department, University of Abuja, Nigeria, E-mail id - alokoduncan@yahoo.com.

.