EFFECT OF ANODIZATION TIME OF WASTE ALUMINUM ALLOY BASED PROPELLERS ON CORROSION RESISTANCE

THESIS

IRUL IRAWADI

20210110051

MECHANICAL ENGINEERING DEPARTMENT

FACULTY OF ENGINEERING, COMPUTERS AND

DESIGN NUSA PUTRA UNIVERSITY

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AUTHOR'S DECLARATION SHEET

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NAME	: IRUL IRAWADI
Student ID	20210110051

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IRUL IRAWADI

Author

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TITLE	: EFFECT OF ANODIZATION TIME OF WASTE ALUMINUM ALLOY BASED PROPELLERS ON CORROSION RESISTANCE
NAME	: IRUL IRAWADI
Student ID	20210110051

This thesis has been reviewed and approved

Sukabumi, September 27, 2025

Head of Mechanical Engineering Department	Acedemic Advisor,
Lazuardi Akmal Islami, M.Si.	Lazuardi Akmal Islami, M.Si.
NIDN. 0415039402	NIDN. 0415039402

THESIS APPROVAL SHEET

TITLE : EFFECT OF ANODIZATION TIME OF WASTE ALUMINUM ALLOY BASED PROPELLERS ON CORROSION RESISTANCE

NAME : IRUL IRAWADI

Student ID 20210110051

This Thesis Has Been Examined And Defended Before The Board Of Examiners At The Thesis Examination On August 29, 2025. In Our Opinion, This Thesis Is Adequate In Terms Of Quality For The Purpose Of Awarding The Degree Of Bachelor Of Engineering.

Sukabumi, September 27, 2025

Academic Advisor	Chief Examiner
Lazuardi Akmal Islami M, Si.	Prof. Dr. Sivakumar N S, B.E., M.E., Ph.D.
NIDN. 0415039402	NIP. 0120240039
Head of Mechanical Engineering Departement	Plh. Dean of the Faculty of Engineering, Computer Science and Design (FECD)
Lazuardi Akmal Islami M, Si.	Ir. Paikun, S.T., M.T., IPM., ASEAN Eng.
NIDN. 0415039402	NIDN. 0402037401

MOTTO

“Aku selalu takut dengan hari ini, namun aku sadar bahwa ketakutan ini hanya akan menghambat proses perjalananku esok hari.”

-Penduduk Bumi-

"Sebuah penantian akan selalu memiliki dua jawaban, pertama sesuai harapan dan yang kedua adalah kekecewaan."

-Kepala Suku-

“Neither God nor the Devil can give aid to those without the will to fight”

-Brook (One Piece)-

This Thesis is Dedicated to My Mother, My Little Brother, My Teachers and My Friends

The One I Love So Much

ABSTRACT

Aluminum waste as a component of ship propeller manufacturing is often faced with the problem of damage due to seawater corrosion. Anodizing methods are required to increase the resistance of the propeller to corrosion. This study was aim to determine the effect of anodizing time on corrosion resistance and alumina layer growth on propellers. The aluminum waste to be anodized is cut according to time variations of (a) 30 minutes, (b) 45 minutes, (c) 60 minutes, and (TP) without treatment with a size of 3cm×3cm×5mm. The tests carried out were corrosion tests (Potentiodynamic Polarization & EIS) and Microstructure Observation (SEM). Results from polarization corrosion and EIS testing on 3.5 wt% NaCl media from samples (a), (b), (c), and (TP). The longer the anodizing time of the sample (c) the polarization test results in a corrosion current (Icorr) of 2.4 × .10-−7. (A/,cm-2.) and its corrosion value is 0.0030 (mmPY). The results of the EIS test obtained 3 graphs, namely the nyquist graph showing that the anodized sample has a graph that tends to be small in the radius of the curve. At the high-frequency range (,10-5.−,10-1.) bode magnitude, sample (c) has a higher magnitude impedance and at a high-frequency phase angle bode of 34.560 Hz indicates sample (c) has a higher phase angle up to -36.403°. The results of microstructure observation (SEM) in samples (a), (b), (c), and (TP). The growth of the alumina layer is seen in the anodized sample. When the corrosion rate value is low, the corrosion resistance value increases. The longer the anodizing time, the more the alumina layer on the surface grows.

Keywords : Anodizing, Propeller, Corrosion, Aluminum Waste, Polarization

FOREWORD

All praise and gratitude the author offers to the presence of Allah SWT., for all the abundance of His grace and gifts, so that the author can complete the thesis entitled "EFFECT OF ANODIZATION TIME OF WASTE ALUMINUM ALLOY BASED PROPELLERS ON CORROSION RESISTANCE" well and as expected.

This thesis was written as one of the requirements to obtain a Bachelor of Engineering degree in the Mechanical Engineering Study Program, Faculty of Engineering, Computer Science, and Design, Nusa Putra University. In the process of compiling this thesis, the author realizes that the completion of this research cannot be separated from the help, support, and guidance of various parties. Therefore, the author humbly expresses his deepest gratitude to:

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Irul Irawadi

Author

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CHAPTER I
INTRODUCTION

1.1 Background of the Study

Aluminum waste is used aluminum material or waste that can be recycled and reused in the production process. Aluminum is one of the most widely used metals in the world due to its various advantages, including light weight, rust resistance, good electrical conductivity, and easy recycling. Therefore, the management of aluminum waste is very important in the context of sustainability and resource management [1]. Aluminum products can be produced through two methods, namely the casting process and the forming process. Aluminum made through the casting process is generally used for household appliances or vehicle parts, such as rims, pistons, engine blocks, and so on [2]. Meanwhile, aluminum resulting from the forming process is usually processed using place, roll, or extrusion techniques to create products such as aluminum profiles and plates that are widely used in the construction sector [3].

Aluminum waste can be used to make propellers. A propeller is a machine element that transmits power by converting rotational motion into thrust. This device operates by harnessing the power of the engine, which is channeled through a shaft to create thrust. Propellers themselves are widely used in several industries, such as aviation, maritime, and various other industries that utilize energy-generating machinery. For this reason, the materials used and the type of testing greatly influence the quality of the propeller [4].

In some cases involving ship propellers, damage is often caused by seawater, which corrodes metal. Corrosion is the destructive result of a chemical reaction between metal or metal alloys and their environment. Corrosion cannot be stopped, but it can be controlled in various ways. One way to control corrosion is by using anodizing. Corrosion is characterized by a slow but continuous process. In some cases, corrosion will form a thin layer like a stain or a collection of spots that function to inhibit further corrosion. In other types, corrosion will form products characterized by corrosion products in the form of oxides and leave traces in the

form of pores that provide no protection against corrosion. As is known, the oxide layer present on the metal surface can protect the metal from further corrosion attacks. Metal corrosion resistance can be improved by anodizing or cladding processes [5].

Anodization is a coating process using an electrolysis method that converts the aluminum surface to be coated into aluminum oxide (Al_2O_3). Based on this explanation, it is known that the main principle of anodization is electrolysis, namely a chemical reaction that is formed due to the flow of electric current. The process includes two important components, namely electrodes and electrolytes. In the electrolysis process, the cathode functions as a negative pole that sends current to the workpiece, while the anode functions as a positive pole that functions as the workpiece itself [5]. The results of anodization are greatly influenced by the selection of anodization process parameters, including current density, potential difference, process time, distance between the anode and cathode, and the type and temperature of the electrolyte solution [6].

A study was conducted by Mochamad Muzaki et al., in his research, it was stated that variations in the anodization process time had an influence on the thickness of the anodized layer formed, where a time variation of 7 minutes produced the thinnest layer of 10.34 microns. While a time variation of 11 minutes produced the thickest layer thickness of 16.73 microns [6]. Muhammad Faruq Alfalah in his research concluded that the longer the anodization time would affect the decrease in the corrosion rate, this was because the longer the anodization time would provide an opportunity for the oxide layer to form pores perfectly [5].

This study investigated the effect of time variations on the corrosion resistance of anodized aluminum waste. Compared to previous studies, this study chose a relatively longer anodization time. This study aimed to further understand the effect of time on the corrosion resistance developed during the anodization process.

1.2 The Problems of the Research

The problem formulation raised in this research is as follows:

1. How does anodizing time affect the increase in corrosion resistance of propellers made from waste aluminum alloy?
2. How does anodizing time affect the growth of the alumina layer on propellers made from waste aluminum alloy?

1.3 The Objectives of the Research

The objectives of this research for the author include:

1. Knowing the effect of anodizing time on corrosion resistance of propellers made from waste aluminum alloy.
2. To determine the effect of anodizing time on the growth of the alumina layer on propellers made from waste aluminum alloy.

1.4 Scope of Problem of the Research

So that this discussion runs as expected and does not become too broad, the scrope of problem in this research include:

1. The material used is Aluminum Waste .
2. The material is coated using the anodizing method.
3. Corrosion Testing with Potentiodynamic Polarization & Electrochemical Impedance Spectroscopy (EIS).
4. Microstructural observation using Scanning Electron Microscopy (SEM).

1.5 The Benefits of the Research

The benefits of this research for the author include:

1. It provides experience for the author in soft skills and hard skills regarding the anodization process and corrosion testing.
2. The application of this post-research can be applied to propellers, especially with waste aluminum material.

CHAPTER V
CONCLUSIONS AND SUGGESTIONS

5.1 Conclusion

From the research conducted on the effect of propeller anodization time on corrosion resistance, the following conclusions can be drawn:

1. Corrosion test results show that anodizing time significantly influences corrosion resistance. The longer the anodizing time, the greater the corrosion resistance.
2. The results of scanning electron microscopy (SEM) images show that the anodization time greatly affects the growth process of the alumina layer, the longer the anodization time, the more barrier layers and pore layers will be formed on the surface of the material.

5.2 Suggestions

In further research, the author has several suggestions that may be used to develop research, including:

1. Find out and explore topics in detail regarding the anodizing process and corrosion testing with supporting references.
2. The time used for the anodizing process must be longer, so that the layer formed on the surface of the material is more even and perfect.
3. Before testing the sample, ensure that the sample is ready to be tested, in order to get good results.

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Nusa Putra
UNIVERSITY
2002
AMOR DEUS, PARENTIUM, CONCERVIS