ANALYSIS OF THE EFFECT OF COATING INHIBITORS ON CORROSION RATE AND STRUCTURE IN 2024 ALUMINUM

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ABSTRACT

Aircraft is one of the means of mass transportation that is currently widely used by the public and is a choice because of its time efficiency. The use of lightweight aircraft structural materials is very important. In commercial aviation, 2024 aluminum is widely used in the use of structural materials. Aircraft structures are materials that are susceptible to corrosion. Corrosion is a decrease in the quality of a metal caused by an electrochemical reaction between the metal and its environment. Coating is a way of coating a metal or material with a material, so that the metal or material is protected from corrosion. The method used is weight loss in accordance with ASTM G31-72 with an international interseal 670 hs epoxy primer coating inhibitor with treatment without washing and washing every 144 hours with seawater media which has a salt content of 3.5% and structural change tests using a dino eye camera. Based on weight loss testing and structural changes carried out on Aluminum Alloy 2024 with immersion test, then in weight loss testing obtained results with the addition of coating inhibitors on aluminum 2024 with treatment washed every 144 hours can withstand corrosion rates up to 288 hours with a weight loss value of 0.058% and on aluminum 2024 which is given a coating with unwashed treatment can withstand corrosion rates up to 144 hours with a weight loss value of 0.062%. In testing changes in structure, the results obtained for aluminum that is given a coating occurs surface corrosion and aluminum that is not given a coating occurs uniform corrosion.

Keywords: Aluminum 2024, Corrosion Rate, Coating

1. INTRODUCTION

Aircraft is one of the means of mass transportation that is currently widely used by the public and is an option because of its time efficiency. Aircraft operations that move from one area to another with changes in temperature and weather differences both on land and in the air. Aircraft structures are materials that are prone to corrosion.

The use of lightweight aircraft structural materials is very important. In commercial aviation, aluminum is used for almost 80% of the overall structural material usage. The aluminum material here is certainly different from the aluminum we encounter in everyday life in kitchen utensils and decorations, aluminum for aircraft structures is combined with several mixed materials (such as copper, magnesium, zinc and manganese) which can increase its strength, stiffness and toughness (Wiratama, 2017).

Corrosion is a decrease in the quality of a metal caused by an electrochemical reaction between the metal and its environment which has a great opportunity for corrosion because the aircraft is mostly made of metal that is in direct/indirect contact with liquids that are acidic and highly corrosive. Some factors that can affect the speed of corrosion events include air humidity, oxygen content in the air, the presence of water, the availability of H^+ ions that can come from acids, and also the presence of salt. Corrosion in aircraft occurs in several places and is a major problem for the aircraft itself. Corrosion can occur in the body or wing or engine on the aircraft (Rosyidin, 2017). Corrosion is caused by an oxidation reaction between metal and oxygen in the environment. Meanwhile, the corrosion rate will occur faster if the environment has a pH of 4 to 9 (Machfuroh et al., 2021).

The selection of the right material is very helpful in inhibiting corrosion, therefore the author is interested in then trying to conduct research on corrosion rate analysis between Aluminum Alloy. This corrosion rate aims to calculate the comparison of the corrosion rate per year of each material.

According to the Federal Aviation Administration (2018) corrosion can be caused by several factors such as environmental pollution conditions, chemicals on runways and taxiways used to prevent icing, humidity, temperature and weather. This amount can accelerate the rate of corrosion that occurs on the material depending on the nature of the material itself.

The outside of the aircraft often corrodes due to direct contamination of the aircraft with air from seawater. Sea water causes the corrosion rate process to increase (Budiyanto, 2021).

The purpose of corrosion testing is to determine the corrosion rate of the metal of a structure so that by knowing the corrosion rate we can predict when and how long the structure can withstand corrosion attack. Corrosion testing techniques can be divided into several methods, namely kinetics (weight loss) and electrochemistry (polarization diagram, linear polarization resistance, electrochemical impedance spectroscope, corrosion potential, and electrochemical noise).

One way to prevent corrosion is by coating. Coating is a way of coating metal or material with a material, so that the metal or material is protected from corrosion.

Therefore, the authors are interested in trying to conduct research on the effect of coatings on the corrosion rate of Aluminum Alloy 2024. This corrosion rate aims to calculate the comparison of the corrosion rate of Aluminum Alloy 2024. Based on the above background and research that has been done, the authors are interested in conducting research by taking the title **"ANALYSIS OF THE INFLUENCE OF COATING INHIBITORS ON CORROSION RATE AND STRUCTURE ON ALUMINIUM 2024"**

2. METHODS

The method in this corrosion rate study is weight loss test and structural change test by comparing immersion for 720 hours between Aluminum 2024 which is given a coating and not given a coating with the treatment of being washed every 144 hours and not washed. The addition of international interseal 670 hs primary epoxy coating on Aluminum 2024 with a thickness of 0.20 mm.

2.1 Soaking Process

This immersion process is carried out in accordance with ASTM G31-72 using Sodium Chloride solution with the aim of knowing the effect of NaCl solution on the corrosion rate of Aluminum Alloy 2024 with coating inhibitor treatment. The soaking process is as follows:

1. Clean the specimen using distilled water on every surface.
2. Weigh the weight of each specimen using digital scales
3. Prepare the specimen to be immersed
4. Prepare the soaking area
5. Pour NaCl solution in the place
6. Place the specimen on a place that has been filled with NaCl solution
7. Close the place so that no dust / dirt gets in.
8. Lift the specimen according to the predetermined time.

2.2. Weight Loss Test

Aiming to determine the weight loss and corrosion rate of Aluminum Alloy 2024 which has been immersed using NaCl solution testing the implementation of weight loss is as follows:

1. Put the specimen that has been soaked on the scales
2. Weigh and record the final weight of the specimen
3. Calculate using the corrosion rate formula

$$Corrosion\ Rate = \frac{kw}{\rho At}$$

2.3 Structure Change Test

Microstructure testing is carried out with the aim of knowing the structural changes of Aluminum Alloy 2024 which has been soaked using NaCl solution. Implementation of microstructure testing is as follows:

1. Put the specimen that has been soaked on the microscope.
2. Focus the camera on the microscope to see the structure of the specimen.

3. RESULTS AND DISCUSSION

Based on the explanation of the previous research methodology, the author will present the results of the specimen tests that have been obtained both in the weight loss test and the structural change test.

3.1 Treatment of Aluminum 2024 With Washed

The test of aluminum 2024 in sodium chloride solution for 720 hours coated with a thickness of 0.20 mm with a washed treatment obtained weight loss data, with the following results:

1. Immersion of specimens up to 288 hours no weight loss occurred.
2. After 288 hours of immersion, the specimen lost weight by 0.001 gram (0.058%).
3. Immersion of specimens at 432, 576, and 720 hours occurred the same weight loss increase of 0.001 grams.

The test of aluminum 2024 in sodium chloride solution for 720 hours that is not coated with washed treatment obtained weight loss data, with the following results:

1. Weight loss of 0.001 grams every 144 hours immersion up to 576 hours immersion.
2. After soaking for 576 hours there was an increase in weight loss of 0.002 grams at the 720th hour.

The corrosion rate of Aluminum 2024 in sodium chloride solution for 720 hours coated with a thickness of 0.20 mm with washed treatment obtained the following corrosion rate data:

1. The addition of coating inhibitor on aluminum 2024 with washing treatment every 144 hours is able to inhibit the corrosion rate up to 288 hours immersion.
2. Corrosion occurred after 288 hours of immersion with a corrosion rate of 0.509 mpy and the corrosion rate decreased.
3. Epoxy coating is able to suppress the corrosion rate up to 40%

The corrosion rate of Aluminum 2024 in sodium chloride solution for 720 hours that was not coated with washed treatment obtained the following corrosion rate data:

1. Specimens with 144 hours immersion immediately corroded with the same corrosion rate value until 576 hours with a value of 1.529 mpy.
2. There was an increase in corrosion rate after 576 hours with a value of 1.835 mpy at hour 720.

Figure 1. Comparison of Corrosion Rate with Washed

1. Specimens using coatings with washing treatment every 144 hours can withstand corrosion rates up to 288 hours and there is an increase in corrosion rates but not high at 432 hours to 720 hours with a corrosion rate value of 0.917 mpy at 720 hours.
2. Specimens that do not use coating with washing treatment every 144 hours immediately corrode but the corrosion rate is the same until 576 hours and an increase occurs at 720 hours.

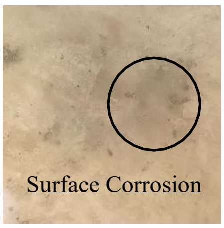

Figure 2. With Coating after soaking 432 hours

After soaking for 432 hours, changes began to occur on the metal surface so that the metal surface began to occur corrosion, namely Surface Corrosion which is characterized by the appearance of an opaque surface due to osmotic heating which will result in contaminants under the protective paint.

Figure 3. Without Coating after 288 hours immersion

after soaking for 288 hours crystallization began to occur on the metal surface so that the metal surface began to occur corrosion, namely uniform corrosion which occurs due to chemical reactions due to low pH water and humid air, so that the longer the metal becomes thinner and thinner.

3.2 Treatment of Aluminum 2024 Unwashed

The test of aluminum 2024 in sodium chloride solution for 720 hours coated with a thickness of 0.20 mm with unwashed treatment obtained weight loss data, with the following results:

1. Immersion of specimens up to 144 hours no weight loss occurred.
2. After 144 hours of immersion up to 432 hours and after 576 hours of immersion, the specimen lost weight by 0.001 grams.
3. Immersion specimens after 432 hours occurred weight loss of 0.002 grams.

The test of 2024 aluminum in sodium chloride solution for 720 hours which is not coated with unwashed treatment obtained weight loss data, with the following results:

1. Weight loss of 0.001 grams every 144 hours immersion up to 288 hours immersion.
2. Immersion at 432 and 720 hours there was a weight loss of 0.002 grams.
3. After soaking to 432 hours there was an increase in weight loss of 0.003 grams.

The corrosion rate of Aluminum 2024 in sodium chloride solution for 720 hours coated with 0.20 mm thickness with unwashed treatment obtained the following corrosion rate data:

1. Specimens that have been subjected to immersion tests for 144 hours have not corroded.
2. After 144 hours of immersion, the corrosion rate was 0.764 mpy and decreased after 288 hours of immersion up to 432 hours.
3. There is an increase in the corrosion rate after 432 hours of immersion but the corrosion rate is the same until the 720th hour.

The corrosion rate of Aluminum 2024 in sodium chloride solution for 720 hours that was not coated with washed treatment obtained the following corrosion rate data:

1. The specimens corroded immediately with the same value after immersion test up to 288 hours.
2. After 288 hours of immersion, an increase in corrosion rate occurred until 576 hours and a

decrease in corrosion rate occurred after 576 hours.

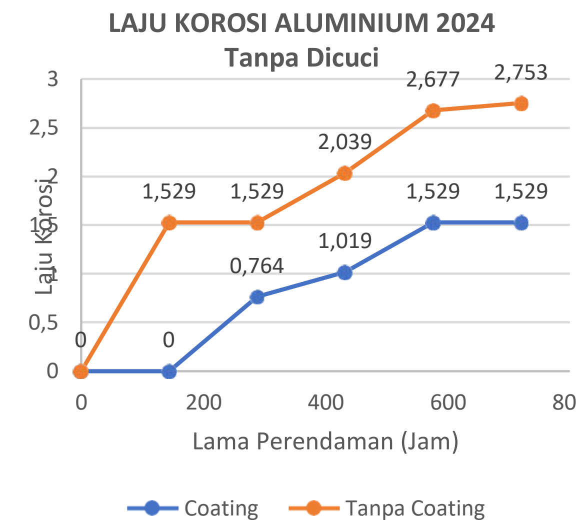

Figure 4. Comparison of Unwashed Corrosion Rate

1. Specimens using coatings with treatment without washing every 144 hours can withstand corrosion rates up to 144 hours and corrosion occurs at 288 hours with a value of 0.764 mpy but decreases at 432 hours and the same corrosion rate increases after immersion 432 hours to 720 hours with a value of 1.529.
2. Specimens that do not use coatings with the treatment of being washed every 144 hours immediately corrode at 144 hours with a corrosion rate of 1.529 mpy, there is an increase in the corrosion rate after immersion 288 to 720 hours.

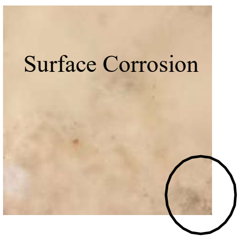

Figure 5. With Coating After 288 hours Immersion

After soaking for 288 hours, changes began to occur on the metal surface so that the metal surface began to occur corrosion, namely Surface Corrosion which is characterized by the appearance of an opaque surface due to osmotic heating which will result in contaminants under the protective paint.

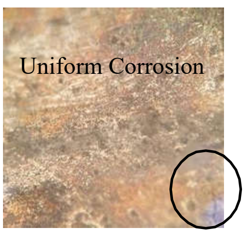

Figure 6. Without Coating After 288 hours Immersion

After soaking for 288 hours, crystallization began to occur on the metal surface so that the metal surface began to experience corrosion, namely uniform corrosion which occurs due to chemical reactions due to low pH water and humid air, so that the longer the metal becomes thinner.

Figure 7. Comparison Chart of Aluminum with Washed and Unwashed Coatings

1. In 0-144 hours of immersion, the corrosion rate is the same, but after 144 hours of aluminum with unwashed treatment there is an increase in corrosion rate of 0.764 mpy at 288 hours of immersion and an increase in corrosion rate after 432 hours to 720 hours with the same value of 1.529 mpy,
2. Aluminum with washed treatment every 144 hours interval has no increase in corrosion rate until 288 hours, but after 288 hours immersion aluminum with washed treatment occurs corrosion with a value of 0.509 mpy until the 720th hour with a value of 0.917 mpy but the corrosion rate value decreases every 144 hours after 432 hours immersion.

Figure 8. Comparison Chart of Uncoated Aluminum with washed and unwashed

1. Immersion at 0-288 hours the corrosion rate is the same at 1.529 mpy, but after 288 hours of aluminum with unwashed treatment there is an increase in corrosion rate until 720 hours with a value of 2.753 mpy.
2. Aluminum with washed treatment every 144 hours interval can slow down the corrosion rate so that at 0-576 hours the corrosion rate is the same at 1.529 mpy and there is only an increase in the corrosion rate at 720 hours of 1.835 mpy.

4. CONCLUSIONS

In the tests carried out, we can draw the following conclusions:

1. The addition of International Interseal 670HS Epoxy Primer coating inhibitor on Aluminum 2024 with washing treatment every 144 hours interval is able to inhibit corrosion up to 288 hours in Natriun Chloride solution immersion.
2. The addition of Epoxy Primer International Interseal 670HS coating inhibitor on Aluminum 2024 with unwashed treatment is able to inhibit corrosion up to 144 hours in Natriun Chloride solution immersion.
3. Aluminum 2024 without the addition of International Interseal 670HS Epoxy Primer coating inhibitor with washed and unwashed treatment corroded immediately at 144 hours.
4. NaCl solution causes structural changes that cause corrosion to form on Aluminum 2024, the type of corrosion formed from Aluminum 2024 which is coated and immersed in NaCl solution is Surface Corrosion.
5. NaCl solution causes structural changes that lead to the formation of corrosion on Aluminum 2024, the type of corrosion formed from Aluminum 2024 that is not coated and immersed in NaCl solution is Uniform Corrosion.

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