

THE EFFECT OF ELECTRIC VOLTAGE ON THE CORROSION RATE OF ALUMINUM (AA 5083) PLATE IN SEAWATER

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Introduction

Corrosion is a chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties (Joseph et al 2000). There are many factors that led to the corrosion, but also a catalyst that can accelerate the corrosion process itself. There are a lot of factors that researchers manage to identify, such as pH, temperature, electric current density, density of dissolved oxygen, the concentration of ions in a solution, and so forth.

Jones et al (1978) have attributed the acceleration of corrosion rate in present of current to the ability of voltage reduce both anodic and cathodic polarization. Generally, in the present of electric voltage, corrosion potential is shifted toward the negative direction. Chin et al (1983) have mentioned that the exchange current density increases and Tafel slope decreases, correspondingly Jones et al (1978). Electric voltage generally leads to the formation of porous and non-protective layer, in such case localized attack are very likely to occur (Evan 1960). This situation is supported by Goidanich et al (2009) as they stated that the effect of electric current interference on kinetic parameter; the effect on corrosion rate and corrosion mechanism in different solution on different metallic material were determined. Further, the influence of electric voltage on corrosion of kinetics characteristics of carbon steel, galvanized steel, copper and zinc was studied under different experimental conditions (Bosch and Bogaerts 1998; Goidanich et al 2009a, 2009b).

Nowadays ships are constructed using Aluminium. In general small electrical current leakage may available in ships due to of electric cable insulation problem, etc. Then, the ship could be exposed to the danger of corrosion because not all materials are completely Aluminium in Aluminium vessels, particularly in engine room. The detail study of corrosion of Aluminium is more vital for the survival of Aluminium shipping industry. Aluminium alloy is very special metal since its have high resistant of corrosion even though it is exposed to corrosive environment. This advantage is due to passive film or layer, which are thin oxides layer that form naturally on its surface. As a result, this layer will greatly increase the resistant of the metal and thus, it reduces the rate of corrosion of the Aluminium alloy. Such passive film, however, are often susceptible to localized breakdown, resulting in accelerated dissolution of the underlying metal. Corrosion studies for Aluminium were highlighted in the literature for different electrolytes not in seawater (Tan and Chin 1989; Sun 1996).

Therefore, in this research, the effect of electric voltage on correction rate of Aluminium (AA 5083) plate in seawater was studied to overcome the present practical problems. In this experiment, the samples of Aluminium AA 5083 were tested with different levels of voltage via electrochemical test.

Methodology

Test specimens were cut into 25mm×25mm×3mm coupons for electrochemical tests. Before exposure, the samples were mechanically grinded and polished using Grinding & Polishing Machine. The polished samples were cleaned with acetone then washed using distilled water, dried in air and stored over desiccators.

After undergoing the surface preparation procedure according to ASTM G1-03 procedure (ASTM International 2003; Delbridge and Hays 2009), the electrochemical test was conducted by taking the Aluminum AA 5083 plates which was served as anode while mild steel was served as cathode. The circuit of electrochemical system was then connected with DC power supply. Ensured all electrical connections were well connected and the anode and cathode completely immersed in the seawater solution. The DC power supply then was switched on. Then the level of electric voltage supply was adjusted at 1.5 V. The test circuit kept for 10 days, after 10 days the samples were taken out for further test. This procedure was repeated for 20 days, 30 days and 40 days. Then the level of alternating voltage changed to 3V and 4.5 V and tested for 10 days, 20 days, 30 days and 40 days. The morphology test, weight lost test and electrochemical test were used to study the correction rate.

Discussion and Conclusion

Based on observations on the experiment samples, the pitting corrosion can be observed clear and obviously. Every sample show different pattern and trend of pitting condition. From the surface image of every sample was taken, for 0 volt, the oxide layer is obviously diminished, but no pitting corrosion occurred. For 1.5 volt, the oxide layer is completely diminished and pitting corrosion can be observed even with naked eyes. For 3.0 volt, the pitting corrosion became bigger than 1.5 volt experiment set. The pitting seems to affect the adjacent pit, make its pit area became larger. For 4.5 volt experiment set, the no pit is visible due to the sample is completely corroded. Based on morphology test, as the electric voltage increase, the corrosion rate is tended to increase.

Further, based on the weight loss test results the rate of corrosion can be observed and compared. It showed all samples weight is around 4.6 - 4.8 g. After 40 days, the final weight of all samples are differ compare to the other. For 0 volt sample it initial weight was 4.7375 g, it loss it weight approximately 0.0121 g as it final weight was 4.7164 g which is 99.7% of its initial weight. For 1.5 volt sample, the weight loss became higher where it initial weight was 4.7262 g. It experienced decrement as much as 0.8281 g, which make its final weight is at 3.8833 g, 82.4% of its initial weight. Meanwhile, for sample of 3 volt and 4.5 volt, the initial weight of the samples were 4.7225 g and 4.7511 g, respectively, after 40 days, they loss 1.3025 g and 1.5169 g, respectively, which make their final weight as 3.4976 g and 3.2603 g, respectively. Based on this result one can conclude that the electric voltage supplied increase, the weight loss of sample is also increased.

The results obtained lead to the conclusion that electric voltage is one of the factors that can accelerate the corrosion of Aluminum AA5083 in seawater. Further, the results indicated that the introduction of electric voltage obviously maximize the weight losses and enhance Aluminum dissolution in seawater. Pitting corrosion is also induced with the presence of electric voltage and shown in morphology test result.

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