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Natural Honey as Corrosion Resistant For Aluminium Alloy

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Abstract. The corrosion behaviour of AA6061 aluminium alloy in tropical seawater was investigated using weight loss measurement and electrochemical polarization technique. The electrochemical measurements showed that the presence of natural honey as corrosion resistant significantly decrease the corrosion current densities (i_{corr}) and corrosion rates. It was observed that the inhibition efficiencies increased with the increasing concentrations of the resistant. Potentiodyanamic curves suggested that natural honey suppressed both cathodic and anodic processes. A good fit to Langmuir adsorption isotherm was obtained between the degree of surface coverage and the concentration of natural honey. It can be concluded that natural honey is an excellent corrosion resistant for aluminium alloy immersed in tropical seawater.

Keywords: Corrosion inhibition; Aluminium alloy; Seawater; Adsorption
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INTRODUCTION

Aluminium and its based alloy are widely used in aerospace applications, due to the unique combination of lightweight and high mechanical properties [1]. However, these materials are reactive and prone to corrosion. As such, corrosion of aluminium and its alloy has been a subject of numerous studies due to their importance in the recent years [2, 3]. The most practical method for protection against corrosion is the use of corrosion resistant, such as natural honey. Natural honey compounds offer interesting possibilities for corrosion inhibition and the particular interest because of their safe use and high solubility in water [4]. The adsorption of the surfactant on the metal surface can markedly change the corrosion-resisting property of the metal [5], and so the study of the relations between the adsorption and corrosion inhibition is importance. The present paper reports on the behaviour of natural honey as corrosion resistant for aluminium alloy in tropical seawater.

MATERIALS AND METHODS

The aluminium alloy employed for this study was AA6061. The test media used for the investigation was tropical seawater and the resistant used was natural honeybee. Specimens were cut into 25 x 25 x 3 mm coupon for immersion tests. These samples were polished and cleaned with acetone, washed using distilled water, dried in air and stored over a desiccant. They were weighed for the original weight (w_0) and then hung in test solution for 60 days. The corroded specimens were then removed from the solutions, cleaned with distilled water and dried, then immersed in a nitric acid for 2–3 minutes to remove the corrosion products. Finally, the coupons were washed with distilled water, dried and weighed again in order to obtain the final weight (w_1). The potentiodynamic current-potential curves were recorded by changing the electrode potential automatically from -100 mV to +100 mV with the scanning rate of 10 mVs^{-1}.

RESULTS AND DISCUSSION

Figure 1 illustrates the weight loss of AA6061 alloy in seawater with and without natural honey as corrosion resistant. It shows that the weight loss of AA6061 for all samples increase with the immersion time. Clear differences can be noted between the samples exposed to seawater containing natural honey as compared to that immersed in the absence of the resistant. The test without resistant addition had the higher weight loss. There was a reduction in weight loss; hence reduced the corrosion rate with the introduction of natural honey as corrosion resistant into the seawater. The weight loss of the specimens reduces with increasing the concentrations of the resistant, i.e. the corrosion inhibition enhances with the resistant concentration.

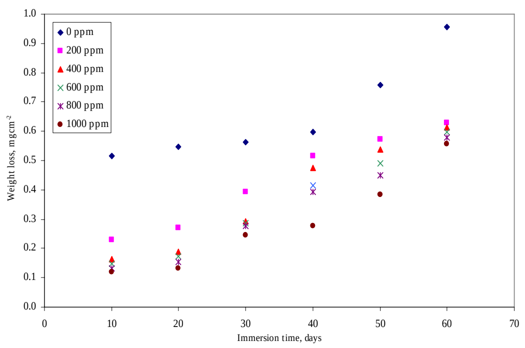

FIGURE 1. Weight loss vs. immersion time for AA6061 in tropical seawater

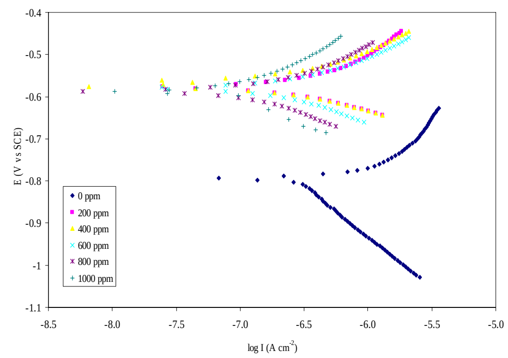

FIGURE 2. Potentiodynamic polarization curves for AA6061 in tropical seawater.

The effects of natural honey on the corrosion reactions were determined by polarization measurements. The changes observed in the polarization curves after addition of the resistant are usually used as criteria to classify resistant as cathodic, anodic or mixed [6]. Fig. 2 represents the potentiodynamic polarization curves of AA6061 in tropical seawater in the absence and the presence of natural honey. The values for the corrosion potentials and corrosion current densities were estimated from the intersection of the anodic and cathodic Tafel lines. The corresponding corrosion potentials (E_{corr}), corrosion current density (i_{corr}), anodic Tafel slopes (b_a) and cathodic Tafel slopes (b_c) are listed in Table 1.

The data of Fig. 2 and Table 1 shows that both of the anodic and cathodic current densities obtained in the presence of natural honey are lower as compared to that of in the absence of the resistant. The E_{corr} values in the presence of resistant are shifted to noble direction; this effect is obviously after the addition of natural honey. These results suggest that natural honey can be classified as mixed type resistant with a predominantly anodic action [7].

TABLE 1. The electrochemical parameters of AA6061 in tropical seawater in absence and presence of different concentrations of natural honey.

c_{inh} (ppm)	Potentiodynamic polarization			
	E_{corr} (mV)	i_{corr} (μAcm^{-2})	b_a (mVdec^{-1})	b_c (mVdec^{-1})
Blank	-796	1.622	101	274
200	-554	0.593	65	93
400	-546	0.551	69	85
600	-553	0.434	75	89
800	-550	0.258	67	92
1000	-556	0.137	48	59

The values of the inhibition efficiency, IE (%) from the weight loss and polarization tests for the samples at different concentration of resistant are given in Table 2 [6]. The inspection of Table 2 reveals that IE of natural honey increase with the resistant concentrations ranges from 200 to 1000 ppm. The two different techniques displayed the same trend of inhibition of the surfactant. The maximum value of IE was 80.6% from the weight loss measurement, while the value obtained from the polarization technique were 91.6% for natural honey at the concentration of 1000 ppm.

TABLE 2. Values of IE for AA6061 in tropical seawater with different concentrations of natural honey

Concentration	IE (%)	
	Weight loss	Polarization
200	55.56	63.43
400	68.25	66.04
600	71.43	73.24
800	76.83	84.12
1000	80.60	91.58

In order to acquire a better understanding of the mode of adsorption of the surfactant on the surface of the aluminium alloy samples at different concentrations, the data obtained from the weight loss and polarization techniques were tested with several adsorption isotherms. Langmuir adsorption isotherm was found to fit well with the experimental data. The adsorption isotherm relationship of Langmuir is represented by the following equation:

$$\frac{c}{\theta} = c + \frac{1}{K} \tag{1}$$

where K is the adsorption equilibrium constant; c is the resistant concentration and θ is the surface coverage. It is clear that the adsorption obtained agrees with the findings reported by other researchers, in which the degree of adsorption by natural honey on ferrous metals follows the Langmuir isotherm [8, 9]. Curves fitting of weight loss and polarization data to Langmuir adsorption isotherm for AA6061 in seawater are shown in Fig. 3.

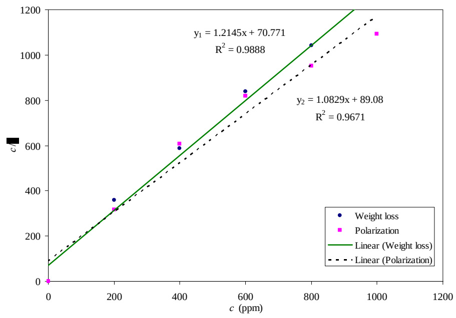

FIGURE 3. Curve-fitting to Langmuir adsorption isotherm for AA6061 in tropical seawater.

CONCLUSIONS

The corrosion studies of AA6061 have been carried out at room temperature using tropical seawater. The results obtained lead to the conclusion that natural honey is an effective corrosion resistant of AA6061 in tropical seawater. The results indicated that the introduction of natural honey obviously minimizes the weight losses and abridged aluminium dissolution in seawater. The potentiodynamic polarization curves suggested a mixed-type character for the inhibition process in seawater. The inhibition efficiency increased with the increasing of resistant concentration. It can be concluded that inhibition efficiency obtained from weight loss and polarization measurements are in a good agreement. Langmuir adsorption isotherm fits well with the experimental data.

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