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KERUING (DIPTEROCARPUS GRANDIFLORUS) OLEORESIN AS ALUMINUM 1100 CORROSION INHIBITOR IN 3,5 % NaCl SOLUTION

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Aluminum and its alloy corrosion inhibition have been important technological subjects due to the increasing application of the material. The corrosion inhibition of aluminum 1100 by Keruing (Dipterocarpus grandiflorus) oleoresin in 3,5 % NaCl solution was investigated using the galvanostatic polarization technique. Aluminum 1100, which had been dissolved in diesel fuel with a concentration of 0 %, 25 %, 50 %, 75 %, and 100 %, was immersed in Keruing oleoresin solution. The results showed that the efficiency of inhibition increases along with the increase of Keruing Oleoresin concentrations. Aluminum 1100 Keruing oleoresin coated with 50 % concentration in diesel fuel had 0,083 MPY corrosion rate, 99,74 % corrosion inhibitor efficiency. Keruing oleoresin can potentially be used as corrosion inhibitor that can be applied to aluminum in coastal areas.

Keywords: aluminum 1100, chemical composition, corrosion, oleoresin, dipterocarpus grandiflorus.

INTRODUCTION

Aluminum has commonly been used as a material for ship parts, including traditional and modern boats. In traditional boats, aluminum propellers are used to drive boats. Besides being used in the main structure of passenger transport boats, aluminum is also used in the structure of the boat dock off the coast. Aluminum is light and strong; it can easily be formed and has high thermal and electrical conductivity; it is also relatively inexpensive. However, if submerged in saltwater or 3,5 % NaCl, it will be easily corroded [1]. The use of inhibitors is a well-known strategy to prevent, control, or retard metal corrosion [2]

Over the years, considerable efforts have been deployed to find suitable corrosion inhibitors, including eco-friendly inhibitors. Currently, “green corrosion inhibitors” or environmentally friendly inhibitors have been developed from natural materials, especially plants. Many tree species grow in the forests of Borneo; one of them is the Keruing species. Keruing can produce oleoresin from the tapping of the tree trunks. One of the Keruing species in Borneo, which produces oleoresin is Dipterocarpus grandiflorus. Dipterocarpus grandiflorus oleoresin is dominated by 69,14 % β-bisabolene [3], high terpenoid groups, which can function as corrosion inhibitors in metals [4].

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Natural oleoresin and its derivatives can be used as natural inhibitors. Oleoresin is a coating that can easily be applied and is free of bisphenol A; it can coat the surface for a long time [5]. Inhibitor materials need to be diluted before being used as anti-corrosion coatings. Oleoresin in the right formula can function as the corrosion inhibitor of aluminum submerged in seawater [6].

One indicator of the success of oleoresin as an inhibitor is that oleoresin coats and protects all the aluminum surfaces perfectly. Aluminum surfaces coated with inhibitors have a lower polarization curve and corrosion rate compared to uncoated aluminum surfaces. The research aimed to examine Keruing (Dipterocarpus grandiflorus) oleoresin as an aluminum inhibitor in saltwater conditions based on the polarization curve and corrosion rate.

EXPERIMENTAL METHODS

The material used for this research was the aluminum 1110 series. Aluminum samples were tested through emission spectroscopy to determine their chemical elements. The corrosion inhibitor was made using Keruing (Dipterocarpus grandiflorus) oleoresin obtained from KHDTK (Special Purposes Forest) Labanan in East Kalimantan. The aluminum 1100, after polishing and cleaning, was immersed in Keruing oleoresin solution which had been dissolved in diesel fuel with a concentration of 0 %, 25 %, 50 %, 75 %, and 100 % as test specimens. After being immersed for 1 hour, the test specimens were dried for 3 days until the Keruing oleoresin on the surface was dry.

For the electrochemical corrosion experiments, samples were cut into 10x10x2 mm. The electrochemical investigations were performed with 3,5 % NaCl solution as corrosion media to substitute seawater. A potentiostat/ galvanostat (PGSTAT101) was used to obtain anodic and cathode polarization curves [7] for coated Aluminum with different concentrations of Keruing oleoresin at 27 ^{0}C. The research was carried out by making Aluminum corrosion polarization curve and Aluminum corrosion rate curve.

RESULTS AND DISCUSSIONS

Composition of Aluminum 1100

Aluminium chemical elements from emission spectroscopy test results can be seen in Table 1.

Table 1 **The composition for Aluminum 1100**

Chemical elements	Sample test	
	Percentage / %	Deviation / %
Al	98,850	0,3629
Si	0,1740	0,1100
Fe	0,1510	0,1750
Cu	0,1500	0,0057
Mn	<0,0200	<0,0000
Mg	<0,0500	<0,0000
Cr	0,0369	0,0379
Ni	0,2600	0,2270
Zn	0,1740	0,0524
Zr	0,0284	0,0163

Based on Table 1, the aluminum sample contained 98,850 %. Pure aluminum 1100 contained 97 % aluminum, 0,15 % copper, 0,09 % zinc, 0,95 % iron, 0,95 % silica, and other substances 0,86 % [8]. Aluminum corrosion began on the surface of the impure aluminum, especially the Al-Cu-Mg or Al-Cu substrate [9]. Aluminum (Al) and Copper (Cu) have different electrochemical potentials so that contact will spur corrosion [10]. The greater the impurity metals other than aluminum, the greater the electrochemical potential and the more corrosion is triggered. The higher the purity of aluminum used; the metal will be more resistant to corrosion [22]. Nickel as an impurity metal in aluminum had a maximum value of 0,03 % so that aluminum had a good corrosion resistance [23]. The aluminum test sample contains impurities, i.e., 0,26 % nickel and 0,15 % copper. It is potentially susceptible to corrosion.

Aluminum corrosion polarization

The polarization curves of the electrochemical test results for aluminum coated with oleoresin on 3,5 % NaCl media can be seen in Figure 1.

Sample Polarization curve is one of the important electrochemical measurements to evaluate corrosion characteristics [11]. Based on Figure 1, the aluminum corrosion polarization curve, aluminum coated with

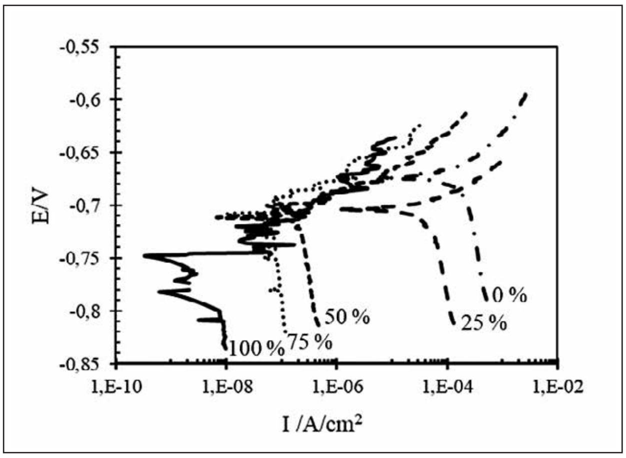

Figure 1 Effect of oleoresin concentration on the aluminum corrosion polarization curve

50 % keruing oleoresin has a current density of 0,198 μA/cm^2 and a corrosion potential value of -0,712 mV. 100 % concentration has the lowest current density of 0,022 μA/cm^2 and a corrosion potential value of -0,750 mV. This value is much smaller than that of aluminum coated with 0 % oleoresin, which has a current density of 76,020 μA/cm^2 and a corrosion potential value of -0,680 mV. The best anti-corrosion material has the smallest current density value [12].

At high inhibitor concentrations, inhibitor molecules coat the metal surface, so that the current density becomes small, and the corrosion potential value decreases [13]. At low concentrations, the inhibitor molecule cannot cover the metal surface so that a corrosion process occurs [14]. Based on Figure 1, the higher the concentration of oleoresin used as a corrosion inhibitor in aluminum, the corrosion polarization curve tends to shift to the left. This means the higher the concentration, the less corrosion occurs.

Aluminum corrosion rate

The results of electrochemical testing of aluminum coated with oleoresin at various concentrations can be seen in Table 2.

Table 2 **The effect of various concentrations of oleoresin to aluminum corrosion**

Oleoresin Conc / %	I-corr / μA/cm^2	Ecorr / mV	Corr-rate / mpy	%IE
0	76,020	-0,680	31,945	0,00
25	40,560	-0,677	17,044	46,65
50	0,198	-0,712	0,083	99,74
75	0,072	-0,709	0,030	99,90
100	0,022	-0,750	0,009	99,97

The electrochemical test results on Table 2 show that the corrosion rate of aluminum coated with oleoresin with a concentration of 25 % was 17,044 MPY and 50 % was 0,083 MPY. Aluminum 1050 immersed in ethanol 50 % had a corrosion rate of 12 MPY [15].

From Table 2, the inhibitor efficiency (IE) of aluminum soaked in oleoresin with a concentration of 25 % value was 46,65 %. Inhibitor efficiency with a concentration of 50 % value was 99,74 %. Hot palm leaf water extract can provide inhibitor efficiency in commercial aluminum immersed in HCl ranging from 40 -88 % [16]. Aluminum 1100 coated with organic thiourea inhibitors with a concentration of 25 % has an inhibitor efficiency value of 52,54 % when immersed in HCl solution for 30 days [17]. Natural inhibitors in the form of furfural resin compounds obtained from onion extract with a concentration of 20 % have the highest inhibitor efficiency of 50,92 % in aluminum metal soaked in sulfuric acid solution [18].

Based on the inhibitor efficiency (IE), 50 % oleoresin concentration already gives a value approaching 100 %. Increasing oleoresin concentration above 50 % does not significantly increase the inhibitor efficiency value. Inhibitor efficiency above 85,74 % or close to 100 % provides good corrosion prevention [19].

CONCLUSION

Keruing (*Dipterocarpus grandiflorus*) oleoresin can be used as a corrosion inhibitor on aluminum 1100. Keruing oleoresin with 50 % concentration in diesel had a 0,083 MPY corrosion rate and 99,74 % corrosion inhibitor efficiency, current density of 0,198 $\mu A/cm^2$ and a corrosion potential value of -0,712 mV.

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