International Journal of Engineering Research
Volume No.6, Issue No.10, pp : 433-436

ISSN:2319-6890 (online),2347-5013(print)
1 Oct. 2017

Preliminary Study on Dimocarpus Longan Peel as Inhibitors for the Pitting Corrosion of 5052-O and 6061-O Aluminium Alloys in Artificial Brine Solution

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Abstract-The effect of dimocarpus longan peel extract on the pitting corrosion of 5052-O and 6061-O aluminium alloys in an aqueous solution of artificial brine has been studied employing open circuit potential (OCP) and cyclic potentiodynamic polarization techniques. Moreover, surface studies such as scanning electron microscope (SEM) and energy dispersive spectroscopy (EDS) were also applied. The addition of that extract increases pitting potential (E_{pit}) both aluminium alloys, increasing the resistance of pitting corrosion both them. On the other hand, the resistance of pitting corrosion on 6061-O alloy was higher than that of 5052-O alloy during the addition of that extract. The addition of that extract also shifts OCP towards to positive potentials both alloys, which indicates the formation of a passive surface layer on the surface of alloys. On the basis of results, the appearance of pit shows on the surface of 5052-O alloy due to the presence Fe-enrich phase, compared to that of 6061-O alloy. Abstract should be in 100 words (10)

Keywords: Corrosion, Open circuit potential, Pitting potential, Alloy, Polarization, Scanning Electron Microscope

I. Introduction

Corrosion is the deterioration of a metal as a result of electrochemical reactions between it and the surrounding environment. Corrosion problem has a biggest issue of industrial operation. There are various types to control corrosion process, the use of inhibitors is one of the preferred methods for protecting metals against corrosion [i]. Especially, acid commercial inhibitors are primarily used in several units of industrial operations [ii].

Most of the commercial corrosion inhibitors are synthetic compounds which are expensive and very harmful to environments. Due to the toxicity of several corrosion inhibitors, there are many exploration and investigation regarding to green corrosion inhibitors. Green corrosion inhibitors are biodegradable, eco-friendly, cheap, renewable and ecologically anticorrosion substances [iv]. Several research groups have investigated the successful use of naturally occurring compounds to inhibit the corrosion of metals in acidic and alkaline environments [v-xi].

Furthermore, dimocarpus longan is widely distributed in Southeast Asia, such as Indonesia, Vietnam, and Thailand. Longan pericarp tissues contain high amounts of bioactive compounds, such as polyphenolic acids, flavonoids, and polysaccharides [xii]. Furthermore, polyphenols in plant extracts have been reported to account for inhibition of acid corrosion of metals [xiii,xiv]. In addition, Sangeetha and co-workers had investigated Inhibition of corrosion of aluminium and its alloys by extracts of green inhibitors [xv], but not in dimorcapus longan peel extract.

On the other hand, there is no or little investigation of dimocarpus longan peel as a candidate of green corrosion inhibitor in artificial brine water which injected with CO_2 gas. Therefore, the objective present work is to study the correlation between the addition of dimocarpus longan extract and pitting corrosion behaviour of aluminium alloys in acidic solutions.

II. Material and Methodology

2.1 Material and solution preparation

The chemical compositions (wt %) of various aluminium alloys used was as follows in Table 1.

Table 1 Composition of materials investigated

Elements	Al-5052	Al-6061
	Wt.%	
Mg	2.66	0.93
Si	0.13	0.53
Fe	0.27	0.16
Cu	0.0007	0.31
Mn	0.006	0.01
Zn	0.12	0.00
Cr	0.23	0.05
Al	Balance	Balance

The surface of various specimens (1 cm^2) were rubbed using different grade of slica carbide grit papers (400-1200) before the electrochemical measurement. The various aluminium allolys were cleaned by washing with aquades water and acetone respectively, then kept in dried desiccator storage before the measurement. Furthermore, the main artificial brine solutions consist of 12874 mg/L of NaCl, 7374 mg/L Na_2SO_4 and 912 mg/L $NaHCO_3$ mg/L.

2.2 Preparation of inhibitor

Fresh dimocarpus longan peel was collected and washed with aqudes water than shade dried for 3 days. This dried dimorcapous longan peel was powdered into small pieces and 40 g of the dried peels were refluxed with 500 mL of ethanol for 72 hours. After that, the extracted solution then filtered using and concentrated until the water from the extract evaporates using rotary evaporator apparatus at 35°C. The high viscous brown liquid was obtained which is applied to study the corrosion inhibition property on various aluminium alloys. Finnaly, this brown liquid was used to prepare the required concentrations of inhibitor solution.

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2.3. Electrochemical test

Electrochemical experiments were conducted in a round bottom cell of 1000 ml capacity using a potentiostat (Reference 600,Gamry Instrument), interfaced to a personal computer. The potentials were measured using a saturated calomel electrode (SCE). All the potentials referred in this work are with respect to SCE. The surface of the working electrode was covered with resin to expose a working area of 1 cm^2. A platinum wire served as the counter electrode. Prior to anodic polarization test, the open circuit potential (OCP) was monitored and experiments were begun after stabilization of OCP. Those experiments were conducted at a scan rate of 0.167 mV/s. After the experiments, the morphology and distributed elements on the specimen surface was investigated by using SEM and energy dispersive X-ray spectrometer.

III. Results and Discussion

3.1. Open circuit potential in various concentration of inhibitor

Fig.1 shows open circuit potential as a function of immersion time for Al-5052 at various inhibitor concentration at ambient temperature. The variation of OCP of the alloy with the immersion time generally gives valuable information on their corrosion phenomena at which there is no current applied. These potentials may vary with time due to changes in the nature of the surface of the working electrode occur such as formation of the protective layer [xvi].

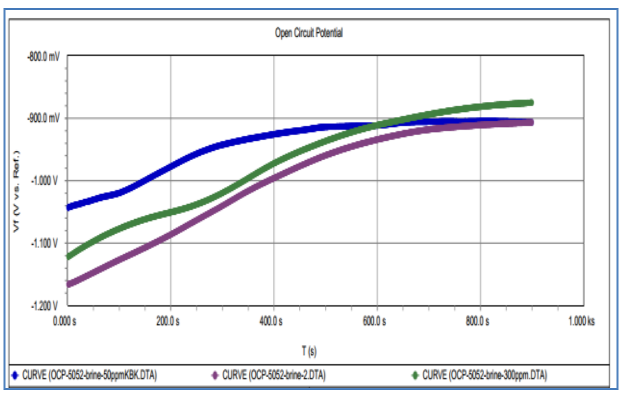

Fig.1. Open circuit potential [mV vs(SCE)] over time for Al-5052 electrode at various inhibitor concentration at ambient temperature; (a) 0 ppm , (b) 50 ppm, and (c) 300 ppm.

Furthermore, during a initial period of immersion, all OCP displacements towards positive potentials were showed in Figure 1 until a final period. These initial increase of OCP values show corresponded to the formation protective film on the metallic surface, improving these corrosion protection resistances [xvii]. On the other hand, Figure 2 shows open circuit potential as a function of immersion time for Al-6062 at various inhbitor concentration at ambient temperature. The same behavior of a positive shift of OCP take places on Al-6062 with increasing immersion time, which the indication of protective film formation occurs on the surface.

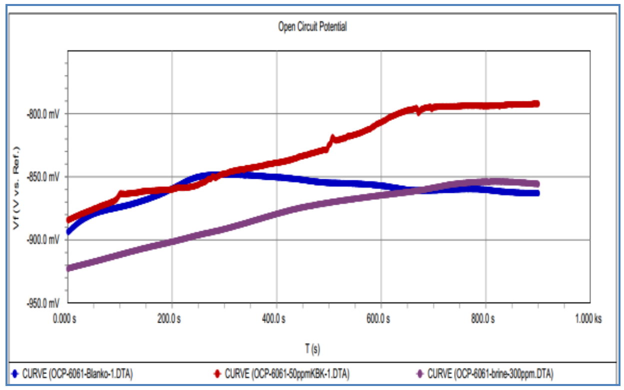

Fig. 2. Open circuit potential [mV vs(SCE)] over time for Al-6061 electrode at various inhibitor concentration at ambient temperature; (a) 0 ppm , (b) 50 ppm, and (c) 300 ppm.

Therefore, it implies that the addition of dimorcapus longan peel extract could shift OCP toward passive region (positive potential), which means the indication of protective layer was formed on entire surface of Al-5052 and Al-6061.

3.2 Determination of pitting potential (E_{pit})

Figure 3 shows polarization curves for Al-5052 in artificial brine solutions with addition of various inhibitor concentrations at ambient temperature. The anodic current densities of these alloys were negligibly low up to a certain applied potential, which corresponded to a passive current density. The anodic current density began to increase above a certain applied potential and increased rapidly with increasing applied potential.

Pitting potential E_{pit} was measured through the extrapolation of the increased anodic current density to the passive current density. Figure 4 also shows anodic polarization curves for Al-6061 alloy in artificial brine solutions with various inhibitor concentrations at ambient temperature. The determination of Epit for Fig.4 was the same method with that for Figure 3.

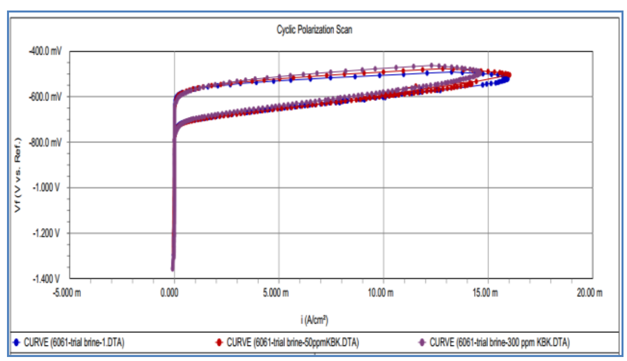

Fig.3. polarization curves for Al-5052 with various Inhibitor concentrations at ambient temperature.

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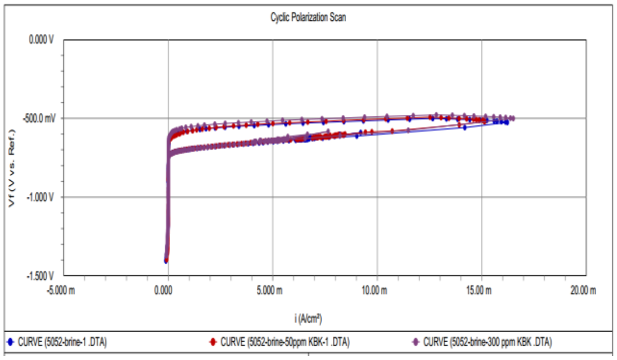

Fig.4. polarization curves for Al-6061 with various Inhibitor concentrations at ambient temperature.

Figure 5 shows inhibitor concentration dependence of pitting potential for Al-5052 alloy dan Al-6061 in addition of dimorcapus longan peel extraxt in main solution at ambient temperature. It was found clearly that pitting potentials of both alloys increased linearly with increasing concentration of inhibitor. Furthermore, the pitting potentials of Al-6061 alloys were more positive than those of Al-5051 alloys. It means that the pitting corrosion resistance of Al-6061 was higher than that of Al-5051. In addition, the addition of inhibitor extract increase the pitting corrosion resistance compared to no addition of it on both aluminium alloys.

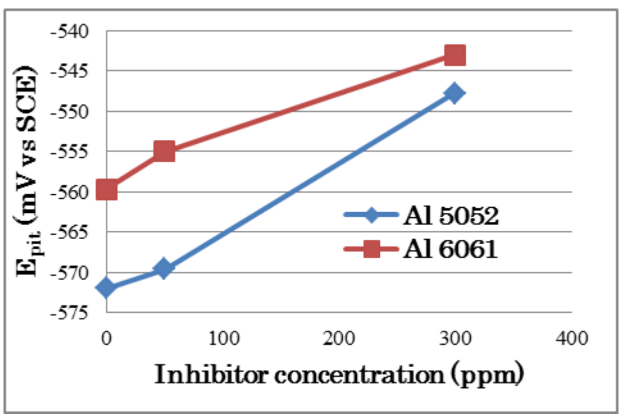

Fig.5 Inhibitor concentration dependence of pitting potential for Al-5052 alloy dan Al-6061 in addition of dimorcapus longan peel extract in main solution at ambient temperature.

3.3. Morphology of corroded surface on various alloys

Figure 6 shows element distribution of Al-5052 alloy after the anodic polarization test in artificial brine solution by adding inhibitor corrosion, where this figure also shows the surface morphology using SEM. In Figure 6, pit occurs after rapid increasing anodic current densities, which breaks passive layer of aluminium alloy. On the other hand, the main component of Al was present uniformly. The element of O was enriched near the edge of the pit, where indicated the presence of aluminium oxide as corrosion product. These present work suggested that the pitting initiated due to galvanic coupling between Al metal (anode) and iron-containing constituents as the cathodeside as well as 5052 alloy in NaCl solution [xvii,xviii]. The galvanic coupling generates the potential difference between Al metal and iron-containing constituents.

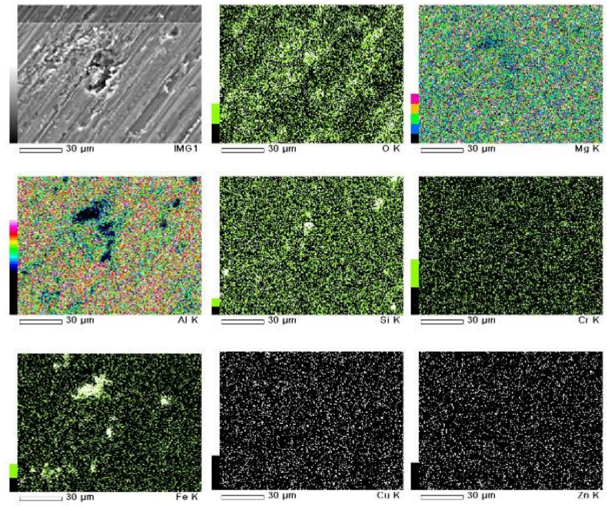

Fig. 6. Element distribution of Al-5052 alloy after the anodic polarization test in artificial brine solution by adding inhibitor corrosion.

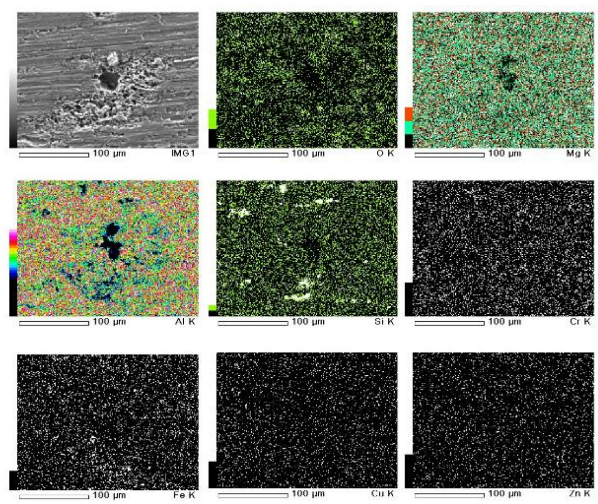

Fig. 7. Element distribution of Al-6061 alloy after the anodic polarization test in artificial brine solution by adding inhibitor corrosion.

Furthermore, Figure 7 shows element distribution of Al-6061 alloy after the anodic polarization test in artificial brine solution by adding inhibitor corrosion, where this figure also shows the surface morphology using SEM. Pit also take places after rapid increasing anodic current densities. The element of O was enriched on entire surface, where indicated the presence of aluminium oxide as corrosion product. The absence of Fe on the surface of Al 6061 showed the smal size of pit compared to that of Al-5052. In addition, Priyotomo and co-workers had reported that corrosion inhibitor of dimarcapus longan peel had succeded to suppress corrosion on mild steel due to polyphenol content [xix] as well as the present work on various aluminium alloys.

Therefore, it implied that the role of polyphenol has beneficial effect to minimize pitting corrosion resistance on both Al-5052 and Al-6061. In addition, the further experiments are going to be conducted to elucidate the inhibitive mechanism and type of protective film on alluminium alloys.

IV. Conclusion

The pitting corrosion behavior of Al-5052 alloy and Al-6061alloy in artificial brine solutions with adding dimorcapus longan peel concentration has been investigated. The following things were obtained as follows

1. The addition of green inhibitor shifts OCP toward positive direction and tends to passive condition in both Al-5052 and Al 6061 alloys.
2. The pitting potential of Al-5052 alloy and Al-6061 increased with increasing green inhibitor concentration.
3. Pitting corrosion resistance of Al-5052 is higher than that of Al-6061.

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