Effect of Immersion and Green Inhibitor to Corrosion Rate of Carbon Steel

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Abstract
Corrosion is the reaction between the material and the environment that cause degradation of the material. Carbon steel is very susceptible to corrosion attack and the use of inhibitors is one of the best options to protect against corrosion on metals and alloys especially in a closed system. Inhibitor is a chemical substance which can reduce corrosion attack when added into electrolyte. The organic inhibitor used in this study was from banana peel (scientific name *Musa sapieutum*) to extract *tannin*-a compound which can provide protective layer on metal [1]. This research provide a set of data elucidated that corrosion product developed on carbon steel during immersion test cannot provide corrosion protection on carbon steel, however, using green inhibitor in high concentrations which is purely not harmful to environment could prevent corrosion attack on carbon steel.

Keywords: Inhibitor, Musa sapieutum, corrosion rate, adsorption isotherm

Experimental Method

The tannin was extracted from banana peel and added with different concentrations (5%, 10%, 15%, 20% and 25%) into 3.5% NaCl. Carbon steel specimen of exposed area 10 mm^2 was grinded into mirror image before electrochemistry analysis. Prior to each polarization, sample was allowed to corrode freely until open-circuit potential (OCP) and the potentiodynamic Tafel measurement were started from cathodic to the anodic direction, with scan rate of 0.5mV/s.

Results and Discussion

FTIR spectrum of inhibitor presents the functional groups present in banana peel. The peak amount of Tannin is at 2100 cm^{-1} which is the percentages is about 97% for 100% banana peels extract. It contain of 5 major peaks along small with small peaks indicating present of more than 5 compounds.

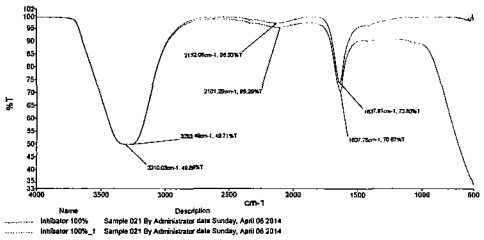

Fig. 1: FTIR spectra of banana peel (*Musa sapieutum*) for 100% concentration

The corrosion rate of inhibitor has been studied Tafel plots and inhibitor efficiency are shown in Fig. 2. Anodic scan shifted towards positive value indicates the banana's peel inhibitor extract work as mixed-type with predominant anodic effectiveness. However, Fig. 2 presents that Tafel polarisation of 3.5% NaCl with inhibitor having lower OCP and E_{corr} compared to 3.5% NaCl, showing that the carbon steel is more active in inhibitor. The corrosion rate fluctuated at increasing concentrations of inhibitor, however incresing the concentrations more from 10% was reduced the corrosion rate on carbon steel. The critical of increasing the corrosion rate is marked in red elips. Optical observation in different concentration of inhibitor is showing in Fig 3(a-c).

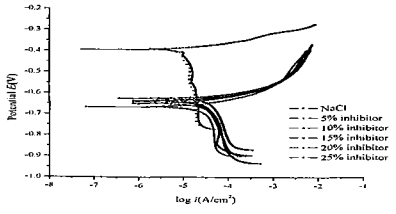

Fig. 2: Tafel plots of carbon steel in inhibitor

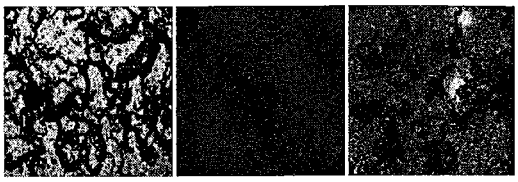

Fig. 3: (a) 5% (b)15% (c) 25% inhibitor.

The immersion test was done in 3.5% NaCl for 1, 3, 5 and 9 weeks. Fig. 4 elucidate that the corrosion product developed on carbon steel was fluctuated to corrosion rate. This reveals that the corrosion product is soluble and non protective to carbon steel. The bare metal exposed for another corrosion attack when the corrosion product collapsed. This phenomenon continuousy occur until the structure fail. The optical observation reveals some pitting surrounding of corrosion product in the first 5 weeks (Fig. 5(a)). The corrosion product starts to crack after 7 weeks and exposed the bare metal for another corrosion attack. After 9 weeks the corrosion product clearly cracks and may collapsed (Fig. 5(c)) and Fig. 6 presents the Tafel plot after immersion. Increasing the duration increased the OCP and E_{corr}.

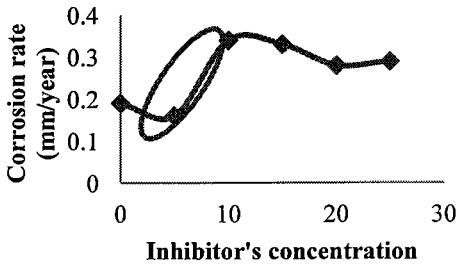

Fig. 4: Corrosion rate in different immersion period

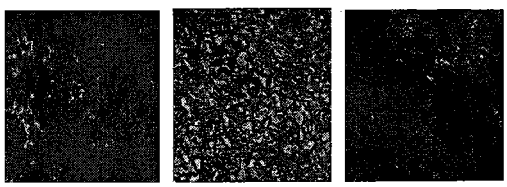

Fig. 5: Optical observation observed some pitting after immersion (a) 5 weeks (b) 7 weeks (c) 9 weeks.

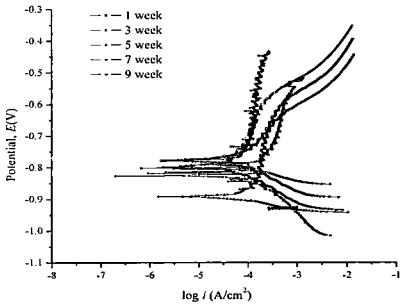

Fig. 6: Tafel plots of carbon steel in NaCl for immersion test

Interactions between inhibitor and carbon steel can be identified by the adsorption isotherm. The inhibitor is absorbed is calculated by assuming no change in the cathode reaction mechanisms and the relation plot shows that absorption of inhibitor obey the Langmuir adsorption isotherm [2].

Conclusion

Inhibitor efficiency up to 72% has been achieved for 10% of inhibitor concentration at 27°C shows the effective amount of inhibitor used in NaCl solution were identified from this study. The inhibitor acts as a mixed-type inhibitor with predominant anodic effectiveness without modifying the mechanism of hydrogen evolution and adsorption of inhibitor molecules of banana peel on carbon steel is found to obey the Langmuir adsorption isotherm.

References

[1] T. Tartrakoon, N. Chalearmsan, T. Vearasilp and U. Meulen, The Nutritive Value of Banana Peel (Musa sapieutum L.) in Growing Pigs, 1999, Deutscher Tropentag, Sustainable Technology Development in Animal Agriculture.

[2] Beloglazov S.M., Beloglazov G.S., Inhibitors of Steel Corrosion and Hydrogen Adsorption in Two-Phase System of Gas Pipelines,1994, pp. 64