Banana Trunk as Green Corrosion Inhibitor for Carbon Steel in Subsea Applications

A.Ismail, A.N. Mat Nawi
Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400 Johor, Malaysia.

Email*: azzura@uthm.edu.my

Abstract
International legislation body has drawn offshore chemical into several categories based on biodegradation, bioaccumulation and toxicity. Otherwise, the inhibitors are not accepted to be used as they are harmful to environment. Therefore, most industries are looking for green inhibitor. Electrochemical test has been carried out for Tafel polarization to determine the corrosion rate of carbon steel. This research aimed to investigate the potential corrosion of carbon steel in seven different immersion periods (1, 2, 7, 14, 21, 28 and 35 days) in seawater (3.5 % NaCl). The effect of temperature was using 25% inhibitor added with seawater in temperature 5°C, 10°C, 20°C and 30°C. Corrosion rate decreases as the immersion time increased and corrosion rate increased as temperature increase as expected.

Introduction
Corrosion is a natural process that occurs in a variety of metals [1]. The use of inhibitor is one of the most practical methods for protection against corrosion and prevention of unexpected metal dissolution. Different organic and inorganic compound have been studied as inhibitors to protect metals from corrosion attack.

Methodology
The sample was soldered and embedded in resin for polishing until previous coarse scratch by sectioning are removed. The optical observation was made before and after electrochemistry analysis using Potentiostat/galvanostat in conjunction with three electrodes at different temperatures (5 °C, 10 °C, 20°C and 30°C). The polarization scan is plotted as potential versus logarithm of the current.

Results and Discussion
FT-IR spectrum of inhibitor banana trunk is shown in Fig.1. Original absorption at 3291 cm^{-1} (associated hydroxyl) was overlapped by the strong stretching mode of bonded N-H [2].

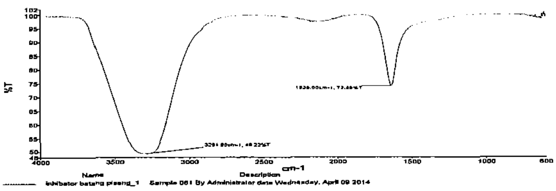


Fig. 1: FT-IR result for inhibitor

Fig. 2 shows the corrosion rate for seven different immersion periods (1, 2, 7, 14, 21, 28 and 35 days). Generally, the corrosion rate decreased as the immersion time increased. This is due to soluble corrosion protection build on carbon steel was inhibit the substrate for further attack.

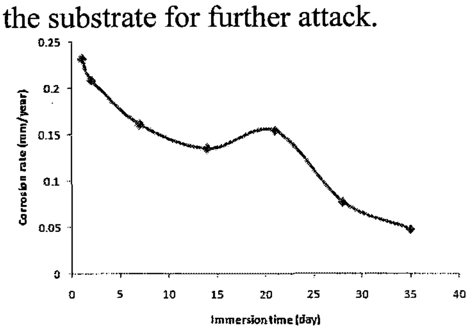
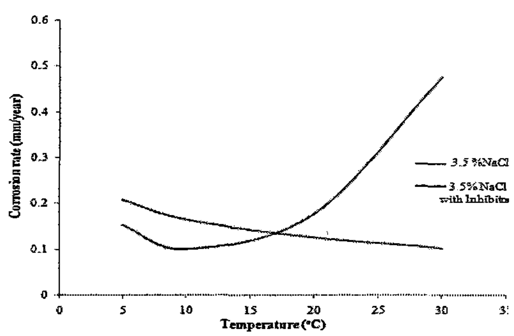


Fig. 2: Corrosion rate of carbon steel against different time for immersion

However, after 15 days, the corrosion attack was increased and linearly decreased after 25 days. The sudden increased is due to dissolution of corrosion product and increasing the immersion time decreased the corrosion rate continuously.

Fig. 3 reveals that increasing the temperature of 3.5% NaCl increased the corrosion rate of carbon steel as expected. The corrosion rate of carbon steel with and without inhibitor in 3.5% NaCl is in presents in Fig. 3. The corrosion rate remarkably decreased as the solutions were added with inhibitor and at increasing temperature. The results reveal that inhibitor was successfully provided a protective film on carbon steel even at increasing temperature.



The surface observation reveals a destructive corrosion attack on carbon steel is at higher temperature (Fig. 4) and the penetration was occluded by corrosion product (Fig. 5) with longer immersion time.

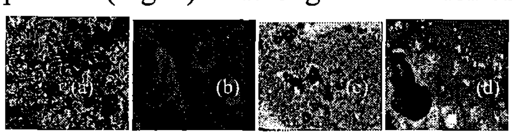


Fig. 4: Microscope observation of carbon steel in 3.5% NaCl at (a) 5°C, (b) 10°C, (c) 20°C and (d) 30°C .

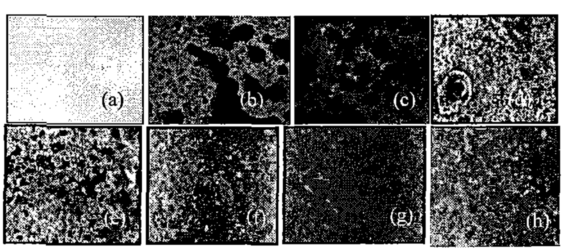


Fig. 5: Microscope observation of carbon steel in immersion at (a) before immersion (b-h) 1, 2, 7, 14, 21, 28 and 35 days respectively.

Fig. 6 reveals a protective passive film was covered the carbon steel which is in 3.5% NaCl added with 25% inhibitor at increasing temperature. The 'rust' can be seen randomly surrounding with porous protective film.

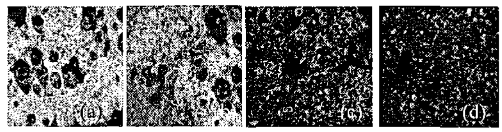


Fig. 6: Microscope observation of carbon steel in 3.5% NaCl with 25% inhibitor at (a) 5°C, (b) 10°C, (c) 20°C and (d) 30°C.

Conclusion

The corrosion rate of carbon steel increased as the temperature increased. In immersion test, porous and soluble corrosion product provide a protective surface for carbon steel and retard for corrosion attack. However, this protection is fluctuate as the time increased. Applying a green inhibitor extracted from banana trunk reduced corrosion rate tremendously even at increasing temperature. This finding can be applied in every sectors as the green inhibitor can directly discharge to environment and we can reduce abundant waste of banana trunk to something recyclable product.

References

[1] M.G. Fontana, *Corrosion Engineering, 3rd Edition,* McGraw-Hill, 2003, pp. 225.

[2] B.Qian, B. Hou, M.Zheng, The inhibition effect of tannic acid on mild steel corrosion in seawater wet/dry cyclic conditions, *Corrosion Science,* [72], 2013, pg 1-9.