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Corrosion Inhibition of Mild Steel in Sulphuric Acid Solution Using Red Peanut Skin Extract and Lasianthera Africana P. Beauv. (Nkanka Leaf) Mucilage

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Abstract:
The inhibition efficiency of red peanut skin extract and lasiantheraafricana P. beauv.mucilage on mild steel deterioration (corrosion) in 2M sulphuric acid was studied by the method of weight loss. The extracts were prepared by immersing the red peanut skin and nkanka leaves in hot water (1000g/l and 100g/0.5l of water respectively). The inhibition efficiencies were studied at various temperatures: 30^{0}C, 40^{0}C and 50^{0}C. Results obtained indicated that mild steel corrosion in sulphuric acid was mitigated significantly by the extracts. As the inhibitor concentration in the acid increased, the inhibition efficiency also increased while temperature increase resulted to a decline in the inhibition efficiency. The active component in red peanut skin extract is catechin while that of lasiantheraafricana p. beauv. (nkanka leaf) mucilage is pectin.

1. Introduction

Corrosion is the weakening in the structure of a material due to interactiob with its surroundings. It can also be described as the destructive attack of materials mostly metals, by electrochemical reactions (Natty, 2010).
Corrosion processes are redox reactions involving oxidation and reduction. (Lebo, et al., 2001).
Mild steel is exposed to the action of acid in industrial processes in which acids have important functions, for example in oil well acidification, acid pickling, acid cleaning, and acid descaling. Corrosion inhibition of mild steel in acid solutions has become one of the most urgent and severe challenges in acid pickling process (Shukla and Qurarishi, 2010; Aljourani et al., 2009).
Corrosion inhibitors are substances added in small quantities to an environment to prevent corrosion of metals (Quarishi, 1999).The use of inhibitors is one of the best options of protecting metals and alloys against corrosion. The selection of inhibitor is controlled by its economic availability, its efficiency to inhibit the substrate material and its environmental side effects.
Most of the efficient acid inhibitors are organic compounds containing nitrogen, sulphur and/or oxygen atoms in their molecule (Sudhish and Quraishi, 2010; Eddy and Ebenso, 2008; Sharma et al., 2008). The toxicity of organic and inorganic corrosion inhibitors to the environment has prompted the search for safer corrosion inhibitors such as green corrosion inhibitors as they are biodegradable and do not contain heavy metals or other toxic compounds. In addition to being environmentally friendly and ecologically acceptable, plant products are inexpensive, readily available and renewable (Eddy and Ebenso, 2008).
In this study, the inhibition efficiency of mild steel corrosion in red peanut skin extract and *lasiantheraafricana* mucilage in sulphuric acid at different concentrations and temperatures was investigated by the method of weight loss.

2. Experimental Procedure

2.1. Preparation of the Metal Coupons

The metal coupons were purchased at steel market, Mile 1, Port Harcourt. They were mechanically press-cut into 4 x 3cmcoupons with a hole, 2mm in diameter at the tip for suspending the metal into the acid solution. The mild steel coupons were not polished any further but was degreased in absolute ethanol and dried in acetone; then stored in a dessicator to prevent any form of contamination before the experiment.

2.2. Preparation of Various Concentrations of Red Peanut Skin Extract

The red skin of roasted peanut was obtained locally from a groundnut seller at Choba junction in Port Harcourt, Rivers State. 1000g of the red peanut skin was boiled in 1litre of water for about 3 hours. Filtration was done after cooling of the mixture. The acid solution (2M H_2SO_4) was added to varied amounts of the extract solution in %v/v using the following procedure:

10%v/v concentration was prepared by adding 90ml of H_2SO_4 to 10ml of the extract in a 250ml beaker; same procedure was followed to prepare other concentrations: 20%v/v, 30%v/v, 40%v/v and50%v/v. Another beaker containing 100ml H_2SO_4 was used as blank for the weight loss experiment.

2.3. Preparation of Mucilage from Nkanka Leaves (*Lasianthera Africana*)

Nkanka leaves (*Lasiantheraafricana*) were obtained locally from a farmland in Etchie Local Government of Rivers State. The leaves were washed, dried, chopped and weighed. 100g of the leaves were completely immersed in 0.5litres of hot water (100^{o}C) for 3 hours till the water turned cold. The mucilage (slimy liquid) was squeezed out of the leaf and filtered with a sieve to remove tiny leaf particles. 2M H_2SO_4 solutionwas added to varied amounts of the extract solution in %v/v.

2.4. Weight Loss Determination

The various concentrations (blank, 10%v/v, 20%v/v, 30%v/v, 40%v/v, and 50%v/v) of both extracts of red peanut skin and mucilage in 2M H_2SO_4 were maintained at 30^{0}C. The mild steel coupons which had been weighed were placed in the corrodent-inhibitor solutions. Each coupon was recovered from these solutions every 24hours consistently for 168hours (7 days). Each retrieved coupon was immediately dropped into distilled water to stop the corrosion reaction, washed, dried and reweighed. The coupon weight difference was recorded as the weight loss. The temperature was raised to 40^{o}C and 50^{o}C and the experiment was performed again in a thermostatic water bath.

Efficiency of the inhibition (%E) was computed from the outlined equation below:

$$\%\,E = \frac{\triangle W_B - \triangle W_i}{\triangle W_B} \times \frac{100}{1} \quad \text{---------- (1)}$$

Where ΔW_B and ΔW_i are the weight loss values of the mild steel coupons in the absence (blank) and presence of an additive respectively.

3. Results and Discussion

The results obtained from the weight loss experiment with inferences drawn from them are discussed below:

3.1. Inhibitory Effect of Red Peanut Skin Extract on Mild Steel Corrosion

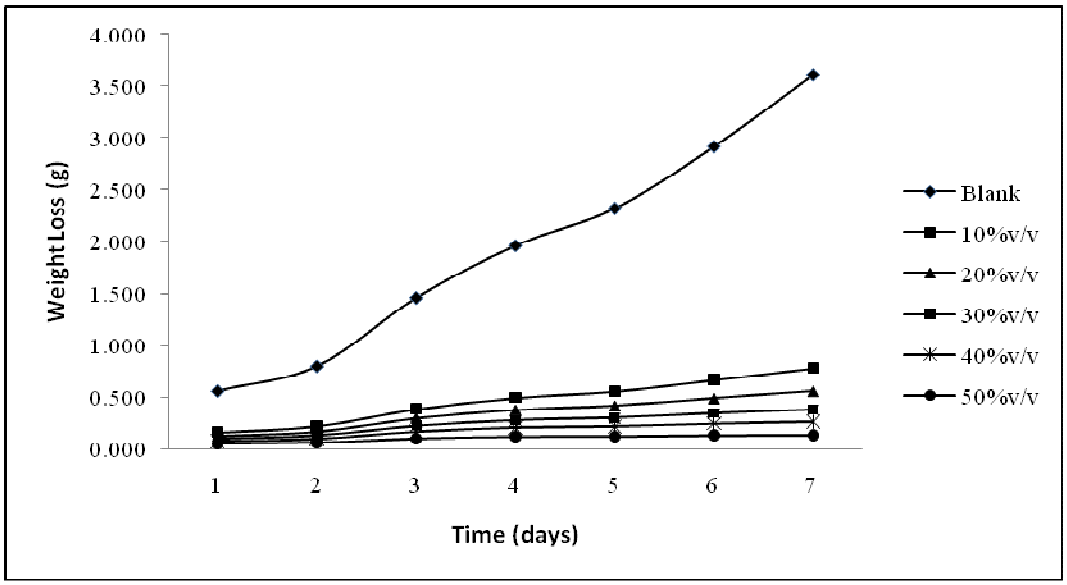

Figure 1: Variation of Weight Loss with Time for Mild Steel Coupons in 2.0M H_2S0_4 and various concentrations of red peanut skin extract solution at 30^{0}C.

From the variation of weight loss with time of exposure of mild steel in 2M sulphuric acid (blank) at 30^{0}C (Figure 1) compared with those containing the additives, there is a remarkable decrease in weight loss signifying corrosion inhibition.

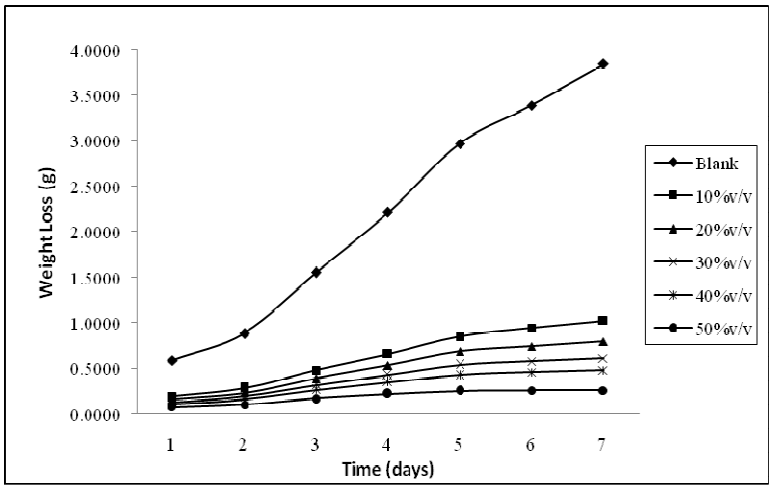

Figure 2: Variation of Weight Loss with Time for Mild Steel Coupons in 2.0M H_2S0_4 and various concentrations of red peanut skin extract solution at 40^0C.

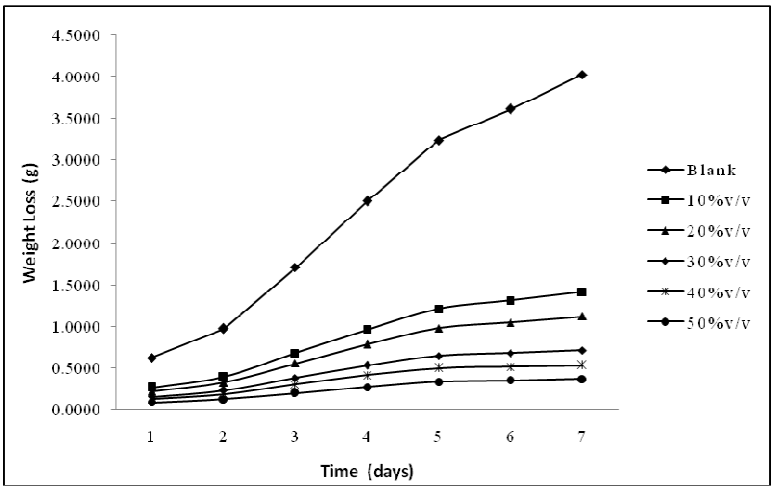

Figure 3: Weight Loss Variation with Time for Mild Steel Coupons in a solution of 2.0M H_2S0_4 and various concentrations of red peanut skin extract at 50^0C.

At 30^0C and 40^0C, there is still a significant decrease in weight loss as illustrated in Figure 2 & 3. This shows that the red peanut skin extract is very economical since it could inhibit corrosion greatly even at small amounts.

3.2. Effect of Temperature on the Inhibition Efficiency of Red Peanut Skin Extract

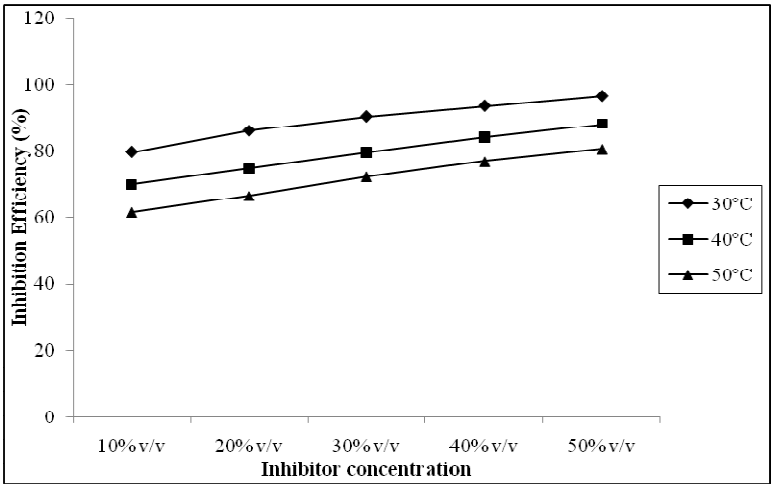

Figure 4: Variation of inhibition efficiency with inhibitor concentration of red peanut skin extract for mild steel corrosion in 2M H_2SO_4 solution at different temperatures.

From Figure 4, it can be seen that as the temperature of the system was increased from 30^0C to 50^0C, the inhibition efficiency decreased. But even at this temperature (50^0C), the red peanut skin extract still inhibited corrosion significantly.

3.3. Effect of lasiantheraafricana mucilage on mild steel corrosion in 2M H_2SO_4 solution:

The figures below show the effect of *lasiantheraafricana mucilage* on the weight loss of mild steel in sulphuric acid solution at the temperatures studied.

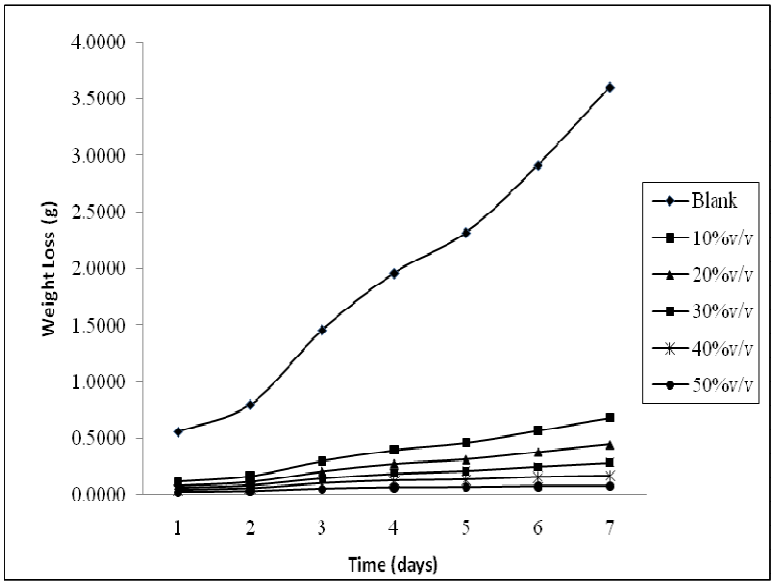

Figure 5: Variation of Weight Loss with Time for Mild Steel Coupons in 2.0M H_2S0_4 solution containing different concentrations of the mucilage extract from lasiantheraafricana (nkanka leaves) at 30^0C.

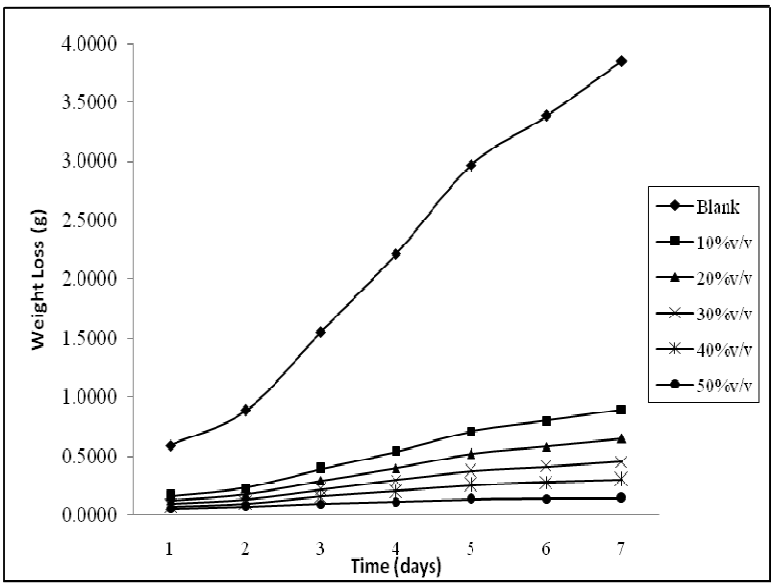

Figure 6: Variation of Weight Loss with Time for Mild Steel Coupons in 2.0M H_2S0_4 solution containing different concentrations of the mucilage extract from lasiantheraafricana (nkanka leaves) at 40^0C.

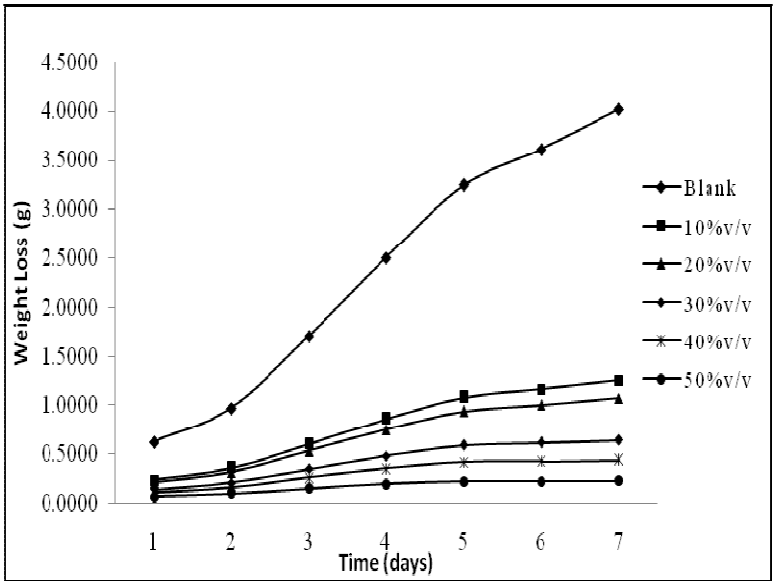

Figure 7: Variation of Weight Loss with Time for Mild Steel Coupons in 2.0M H_2S0_4 solution containing different concentrations of the mucilage extract from lasiantheraafricana (nkanka leaves) at 50^0C.

From figs. 5, 6 & 7, it is observed that as the additive concentration increased, the metal weight loss decreased significantly, with 10%v/v showing the highest weight loss while the highest additive concentration 50%v/v showed the least weight loss at the different temperatures studied. This signifies inhibition of the metal dissolution in sulphuric acid.

3.4. Effect of Temperature on the Inhibition Efficiency of lasiantheraafricana mucilage

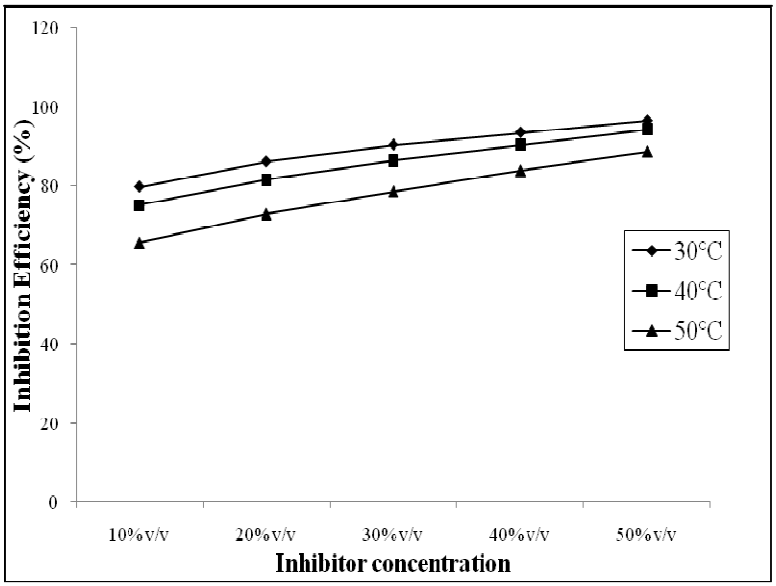

Figure 8: Variation of inhibition efficiency with inhibitor concentration of lasiantheraafricana mucilage for mild steel corrosion in 2M H_2SO_4 solution at different temperatures.

From Figure 8, it can be seen that as the temperature of the system was increased from 30^0C to 50^0C, the inhibition efficiency decreased. But even at this temperature (50^0C), the mucilage still inhibited corrosion significantly.

4. The Active Components in the Exrract and Mucilage

The active component in red peanut skin extract is catechin while that of lasianthera *africana p. beauv.* (nkanka leaf) mucilage is pectin. Both possess electron-rich sites for their adosorption unto the metal surface leading corrosion inhibition.

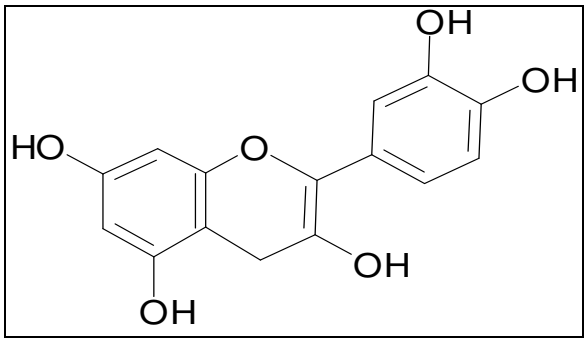

Figure 9: The structure of Catechin (Red Peanut skin).

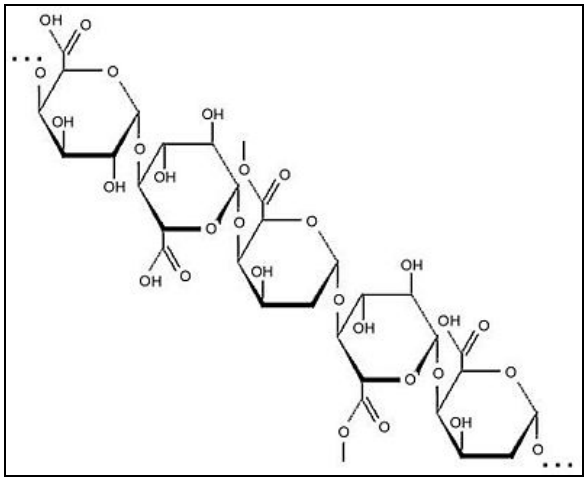

Figure 10: The structure of Pectin (lasiantheraafricanamucilage)

5. Conclusion

The following conclusions were made from this study:

- Red peanut skin extract and *lasiantheraafricana* mucilageare good corrosion inhibitors for mild steel in 2M H_2SO_4 solution.
- Inhibition efficiency decreased with increased temperature.
- In both extracts, increase in inhibitor concentration led to an increase in the inhibition efficiency.
- The mucilage extract exhibited greater inhibition efficiencies (max. = 96.49%) than the red peanut skin extract (max. = 93.73) under the same conditions. This may be attributed to the size and nature of their active components; larger structures with larger number of heteroatoms always give a higher inhibition.

Red peanut skin extract and *lasiantheraafricana* mucilage should be employed as eco-friendly corrosion inhibitors and be used to replace toxic organic corrosion-inhibitors.

6. References

i. Aljourani, J., Raeissi, K., Golozar, M.A. (2009). Benzimidazole and its derivatives as corrosion inhibitors for mild steel in 1M HCl solution. Corros. Sci. Journal, 51:1836-1843.

ii. Eddy, N.O., and Ebenso, E.E. (2008). Inhibitive and adsorption properties of ethanol extract of Musa sapientum peels as a green corrosion inhibitor for mild steel. Afr. J. Pure Appl. Chem. 2(6):46-54.

iii. James, A.O., Akaranta, O. and Awatefe, K. J. (2011). Red peanut skin: an excellent green inhibitor for mild steel dissolution in hydrochloric acid solution. Alfa Universal, An International Journal of Chemistry, 2(2): 72 – 78.

iv. Lebo, S. E., Gargulak, J. D. and McNally, T. J. (2001). Encyclopedia of Chemical Technology; 7th ed. John Wiley & Sons Inc. NewYork. pp. 420 – 424.

v. Natty, K. (2010). Corrosion and its Mitigation in the Oil and Gas Industry; Leonardo Journal of Science, 23(6): 12, 19.

vi. Quraishi, M. A. (1999). "Investigation of some green compounds as corrosion and scale inhibitors for cooling systems," Corrosion Journal,55(5) 493–497.

vii. Shukla, S.K., and Quraishi, M.A. (2010). The effects of pharmaceutically active compound doxycycline on the corrosion of mild steel in hydrochloric acid solution. Corros. Sci. 52(1): 314-321.

viii. Sudhish, K.S., and Quraishi, M.A. (2010). Cefalexin drug: A new and efficient corrosion inhibitor for mild steel in hydrochloric acid solution. Mater. Chem. Phys.120:142-147.