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Research Article

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Study of Corrosion Inhibition of Pineapple Peels Extracts on Mild Steel in 1M HCl

Anaele John Vitus, Ipeghan Jonathan Otaraku

Department of Chemical Engineering, Faculty of Engineering, University of Port Harcourt, Nigeria

Abstract The study of corrosion inhibition of Pineapple peel extract was carried out on mild steel in 1M HCl. The result of the experiment revealed that as the concentration of the inhibitor increase, the rate of corrosion decreases. It also shows that as the concentration of the inhibitor increases, inhibitor efficiency also increases up to an optimum efficiency of approximately 71% for 0.4g/l extract concentration in 1M HC;. At this efficiency, the corrosion rate was shown to be completely satisfactory with a value of 2.6 x 10^{-5} ipy at 0.4g/l extract concentration. It was concluded that pineapple peels extract can be used as corrosion inhibitor as the inhibitor is readily available, cheap, non-toxic and environmental friendly.

Keywords Corrosion Inhibition, Pineapple Peels Extracts, Mild Steel

1. Introduction

Corrosion can be described as the gradual destruction or denaturing of a metal surface as a result of slow chemical reaction between the metal and it environment [1]. It can be likened to the way metals tend to return to their natural occurring state. For a long time now corrosion has been of a major concern in most industries like the oil and gas exploration and production industry, water treatment facilities, product additive industries and chemical industries as a result of chemical reaction between the material or metals and their surrounding environment [2].

A corrosion inhibitor is a substance which, when added to an environment, reduces the rate of attack by the environment. The use of corrosion inhibitors is one of the best methods of combating corrosion [3].

Today many processes of corrosion inhibition have been taken into consideration with great improvement on the result like the use of plant extracts. This is the most economical method in reducing corrosion attack on metals. The popularity and use of synthetic compound as a corrosion inhibitor is diminishing due to the strict environmental regulation and toxic effect of these compounds on human and animal live [4]. Inorganic substances such as phosphates, chromates, dichromate and arsenates which are readily applied in process industry as corrosion inhibitors to reduce corrosion of different types of alloys, mostly mild steels, have a major disadvantage because of their high toxicity, and because of that their use has come under severe criticism [5].

This is why a new class of corrosion inhibitors with low toxicity, and good efficiency is now replacing the synthetic ones. The use of natural products as corrosion inhibitors can be traced back to 1930s when plant extract of chelidoriummajus (celandine) and other plants were used for the first time in H_2SO_4 pickling bath [6]. James and Akaranta [7] studied the inhibiting action of acetone extract of red onion skin on the corrosion of zinc in hydrochloric acid solution using weight loss method. The results of the study revealed that different concentrations of extract inhibit zinc corrosion. Inhibition efficiency is found to vary with concentration and temperature. The inhibition efficiency, greater than 90% was attained at concentration of 0.08 g/L of red onion skin extract. This research paper focus on a way to find more non-toxic, cheap, and effective process for corrosion inhibition, with locally available material, pineapple peels extract is used in 1M of HCL on mild steel.

2. Material and Method

2.1. Preparation of Pineapple Peels solution Extract

The pineapple peels were dried for five days under sun until completely dried. After drying the peels, they were grinded into fine powder. The fine powder of the dried pineapple peels was soaked in 100g of ethanol for 4days (96hrs) after which the mixture was stirred properly in other to have a homogeneous solution and then filtered. The filtrate was subjected to evaporation in other to remove the ethanol in the filtrate. At the end of the evaporation process a pure form of the inhibitor was obtained. Different concentration of solution was prepared by dissolving 0.1, 0.2, 0.3 and 0.4grams of the extract in 500ml (0.5L) of 1.0M HCl respectively. This made it a standard solution for the experiment.

2.2. Preparation of the Metal Specimen (Coupon)

The metal used for this experiment is mild steel which was cut into rectangular shapes of 3by 4cm with the thickness 2mm. The initial weight of the coupon is 6.0-6.5g. The coupons were pre-treated prior to the experiment by polishing it with sand paper of different grades and then cleaned with distilled water, degreased with ethanol(to remove rust and impurities) and dried.

2.3. Weight Loss Measurement

Mild steel specimens were immersed in 500ml of 1M HCl with various extract concentration of 0.1, 0.2, 0.3 and 0.4mg for five days at room temperature, all aggressive solutions were open to the air .one coupon from each of the solution were taken out after 24, 48,72, 96 and 120hrs respectively, washed, dried and reweighed accurately. All the tests were conducted under an aerated 1M HCl. All the specimens were measured in triplicate and average values were recorded. The inhibitor efficiency (n_w(%)) and surface coverage θ was determined using the following equation;

$$\theta = \frac{WO - W1}{WO} \quad \ldots\ldots 1$$

$$n_w = \frac{WO - W1}{WO} \times 100 \quad \ldots\ldots 2$$

Where; W_1=weight loss value in the presence of inhibitor

W_0=weight loss value in the absence of inhibitor

the corrosion rate (CR) of the mild steel was calculated using the correlation;

$$CR = \frac{87.6W}{ATD} \quad \ldots\ldots 3$$

Where;

W=corrosion weight loss of mild steel (mg)

A = area of the coupon (inch^2)

t=exposure time (hr)

D=density of mild steel (g/cm^3)

3. Results and Discussion

Table 1: Weight loss of mild steel bar in different concentration of PPE in 1M HCl at different time interval

Extract	Weight loss of coupon in grams				
Con g/L	24hrs	48 hrs	72 hrs	96 hrs	120 hrs
0	0.11	0.15	0.2	0.24	0.29
0.1	0.08	0.11	0.13	0.14	0.16
0.2	0.06	0.08	0.11	0.12	0.13
0.3	0.05	0.06	0.08	0.09	0.11
0.4	0.04	0.05	0.06	0.07	0.09

Table 1 show that the weight loss of mild steel in 1M HCl decreases with an increase in inhibitor concentration and increases with an increase in time.

Table 2: Inhibition efficiencies for various concentration of PPE in 1M HCl at different time interval

Extract	Inhibition Efficiency of Coupon (%)				
Con g/L	24 hrs	48 hrs	72 hrs	96 hrs	120 hrs
Blank	-	-	-	-	-
0.1	27.27	26.67	35	41	44.83
0.2	45.45	46.67	45	50	55.17
0.3	54.55	60	60	62.5	62.9
0.4	63.64	66.67	70	70.83	71.2

The values of table 2 show that as the inhibitor concentration increases, percentage of inhibitor efficiency also increases which indicates that inhibitor efficiency is directly proportional to inhibitor concentration at a particular time. Work done by, Eddy and Ebenso [8] also show a steady increase of inhibition efficiency with inhibitor concentration. The optimum inhibitor efficiency was approximately 71% which corresponds to 0.4g/l pineapple peels extract in 1M HCl at 120hrs

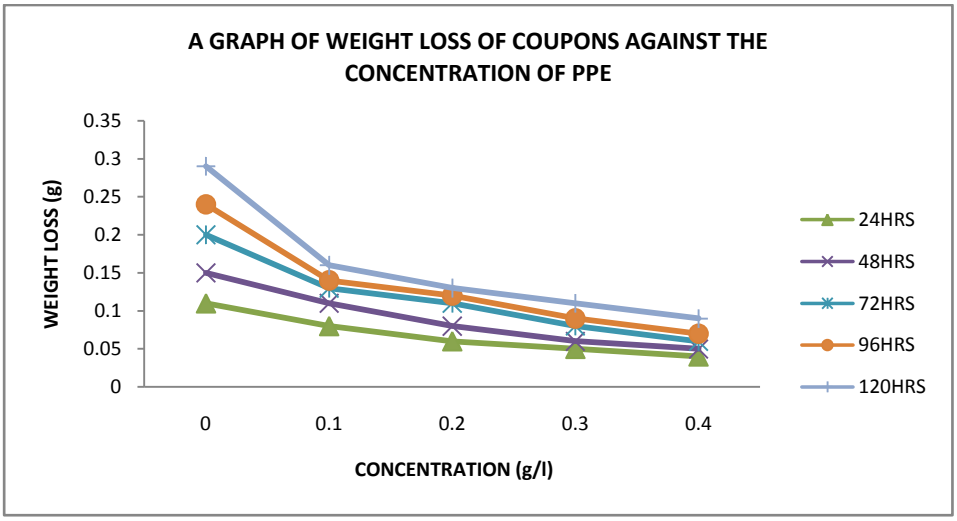

Figure 1: *Agraph of weight loss of mild steel bar against concentration of PPE in 1M HCl at different time*

Here the graph shows a downward slope from left to right which support the inverse relationship between weight loss and inhibitor concentration

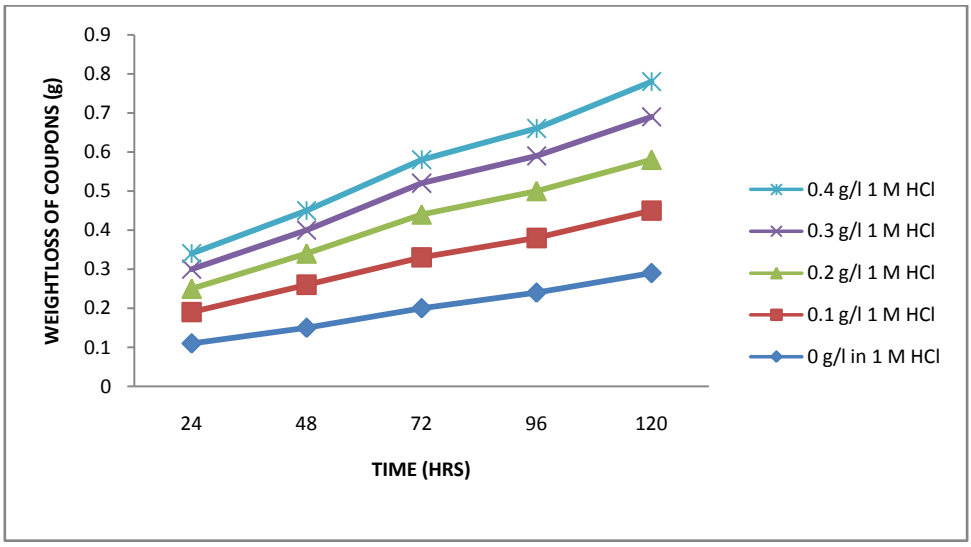

Figure 2: A graph of weight loss of coupons against time

The graph shows an upward slope from left to right which is in line with the direct relationship between weight loss and time

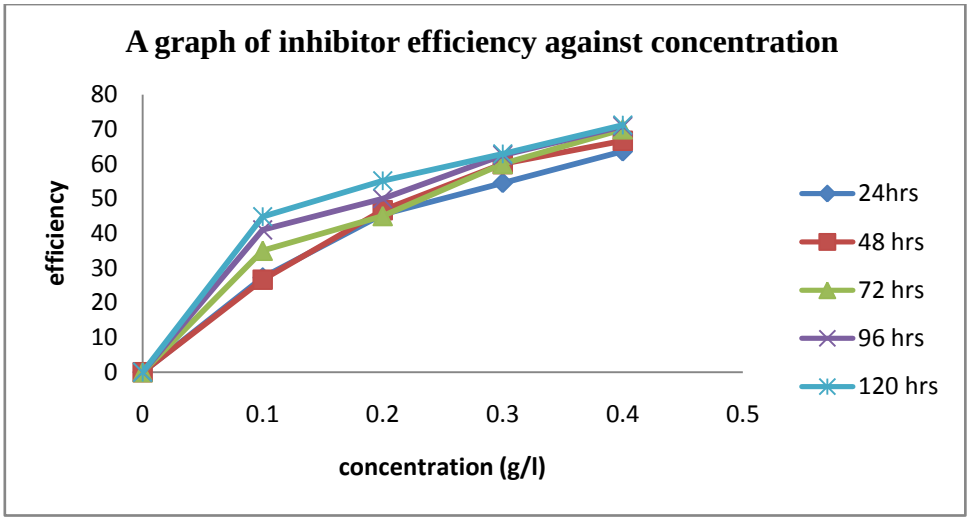

Figure 3: A plot of inhibitor efficiency against concentration

The graph shows an upward slope from left to right which reveals that the inhibitor efficiency increases with an increase in concentration.

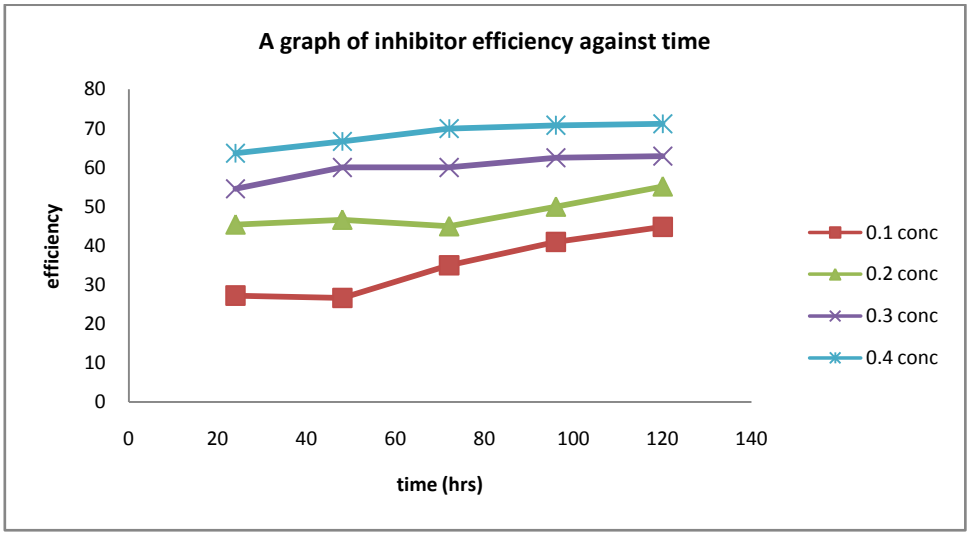

Figure 4: A graph of inhibitor efficiency against time

This graph has a distinct feature for various inhibitor concentrations unlike the graph of %IE against inhibitor concentration which interfere at various time.

This result reveals that pineapple peels extract reduced the corrosion rate as high as 71% for this very research. The inhibitor efficiency is encouraging and this can be used in the industries as a replacement for imported inhibitor.

3.1. Corrosion Rate Calculation

Corrosion rate was calculated using the correlation;

$$Cr = \frac{M(MPY)}{D \times A \times T} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where;

Cr = corrosion rate (mpy)

M = mass loss or weight loss (mg)

D = density (g/cm^3)

A = surface area of metal (inch^2)

T = time or period it take for corrosion to occur(hr)

Table 3: Corrosion Rate of Mild Steel in MPY

Concentration of PPE	24hrs	48 hrs	72 hrs	96 hrs	120 hrs
0	0.157	0.107	0.095	0.086	0.083
0.1	0.114	0.078	0.062	0.050	0.046
0.2	0.086	0.057	0.052	0.043	0.037
0.3	0.071	0.043	0.038	0.032	0.031
0.4	0.057	0.036	0.029	0.025	0.023

Table 3 shows the corrosion rate of mild steel in mpy. This table reveals that corrosion rate decreases with an increase in inhibitor concentration and time.

Sinnott [9] gave a condition for acceptable corrosion rate. This condition is presented in table 4

Table 4: Condition of acceptability at different corrosion rate [9]

	Corrosion Rate	
	IPY	Mm/y
Completely satisfactory	<0.01	0.25
Use with caution	<0.03	0.75
Use only for short exposures	<0.06	1.5
Completely unsatisfactory	>0.06	1.5

The optimum rate of corrosion at 0.4g/l at 120hrs when converted to ipy gives 0.000026 ipy which reveals that the corrosion inhibitor is completely satisfactory.

3.3 Half- life measurement

The kinetics of the corrosion of mild steel was assumed to be of a first order reaction represented as;

$$-\log(w) = \frac{kt}{2.303} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where;

W = weight loss (g/l)

K = the first order reaction rate constant

t = time (hr)

This assumption was as given by Santhi *et al* [10]. Therefore, values of –log w were plotted against time. The plots were linear with r^2 values close to unity. The linear plot supports the assumption that the reaction is first order. Table 5 shows a progressive increase in the half-life of the mild steel with an increase in inhibitor concentration. Salami *et al* [11] also supported this trend.

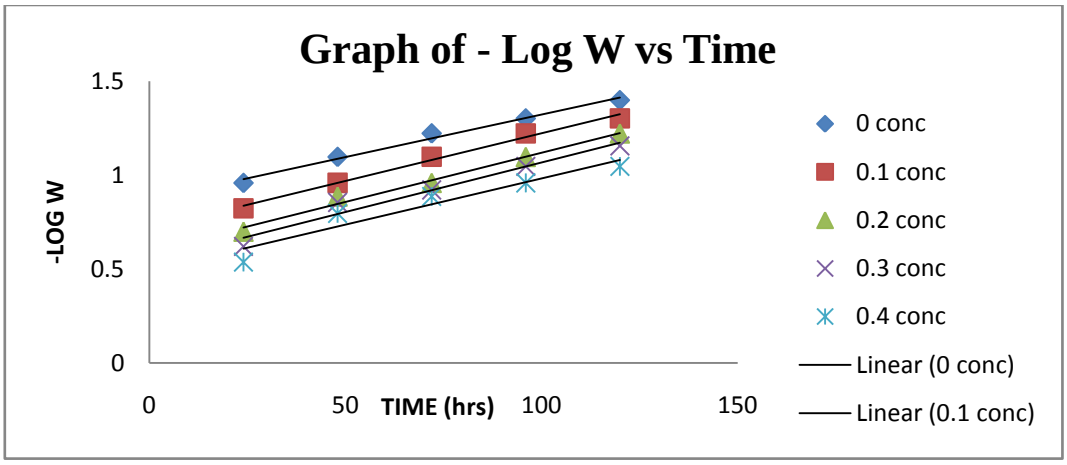

Figure 5: Graph of –log w versus time

Figure 5 gave the slope, the k-values, half-life and r^2-value shown in figure 5. The graph shows an upward slope from left to right which reveals an increase in half-life with increasing inhibitor concentration.

Table 5: Half- life of mild steel in HCl-PPE concentration mixture

	Slope	K-Values (hr^{-1})	Half-Life (hr)	r^2
0	0.0045	0.01036	54.57	0.988
0.1	0.0051	0.01175	56.76	0.991
0.2	0.0052	0.01198	57.85	0.986
0.3	0.0053	0.01221	58.98	0.962
0.4	0.0055	0.01128	66.89	0.915

Table 5 shows the different values of half-life, slopes of figure 4.5, R^2 values and k-values at different inhibitor concentration, and it reveals that half-life increases with an increase in inhibitor concentration.

4.1 Conclusion

The corrosion rate of mild steel in HCl using pineapple peels extract as a case study has been studied, and the following conclusions can be drawn:

- Pineapple peels extract proved to be a good corrosion inhibitor on mild steel in 1M HCl
- The experiment was able to give an inhibition efficiency of 71% which is completely satisfactory.
- The inhibition efficiency value increases with increase in extract concentration
- The inhibition of mild steel by PPE is approximately first order reaction
- An increase in the concentration of PPE brings about an increase in the half- life of mild steel in the corrosive medium.

4.2 Recommendation

- Prevention method should be applied at the design stage so that corrosion can be avoided from onset
- Prompt maintenance culture once a leak is observed to save cost of replacing equipment and thereby minimizing loss and cost
- Pineapple peels extract should be used for inhibition in any industry in other to minimize cost, and have a naturally available environmental friendly chemistry with a good result in preventing corrosion.

Reference

[1]. Uzokwu (2002): The effect of corrosion on carbon steel and mild steel in a marine environment.

[2]. Bradford, and Samuel A. (1993): Corrosion Control. New York: Van Nostrand Reinhold.

[3]. Jerome, E. U., Authur, A., Benson, E. O., & Vitus, A. J. (2015). Corrosion Inhibition of Mild Steel in 1M HCl Using Unripe Plantain Peel Extracts. The International Journal of Science and Technoledge, 3(11), 6.

[4]. Martinez , Stern, (2002): Appl. Surf. Sci. (2002). vol 19, p 83.

[5]. Orubite K.O. and Oforka N.C., Corrrosion inhibition of zinc in HCl using Nypa Fruticans Wurmb extracts, Jour. of Applied Sciences and Environmental management, 8 (1), 56 -61 (2004).

[6]. Sanyal. B, (1981): Organic compounds as corrosion inhibitors in different environments -a review of Progress in Organic Coatings.

[7]. James A. O. and Akaranta O. Inhibition of Corrosion of Zinc in Hydrochloric Acid Solution by Red Onion Skin Acetone Extract ‘’Research Journal of Chemical Sciences, Vol. 1 (1) April (2011) Res. J. Chem. Sci. pp 31-37.

[8]. Eddy. N.O, and Ebenso E.E, (2010): Adsorption and quantum chemical studies on cloxacillin and halides for the corrosion of mild steel in acidic medium. International Journal of Electrochemical Science. vol 5, pp 731.

[9]. Sinnott, R. K.; and Towler, G.. Chemical Engineering Design. 5th ed. Elsevier Science & Technology, Butterworth-Heinemann Ltd., Oxford, England, UK

[10]. Santhi, T., Manonmani, S., & Ravi, S. (2010). Adsorption and inhibitive properties of ethanol extracts of Muntingia calabura as a green corrosion inhibitor for mild steel in acidic media. *Journal of Applied Sciences Research*, *6*(12), 2264-2268.

[11]. Salami, L Wewe, T.O.Y, Akinyemi O.P. and Patinvoh. (2010): A study of the corrosion inhibitor of mild steel in sulphuric acid using musasapientum peels extract.7(4):1133-1137.