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INHIBITION EFFECT OF ORANGE SEED EXTRACT ON ALUMINIUM CORROSION IN 1M HYDROCHLORIC ACID SOLUTION

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ABSTRACT

Corrosion of metals has become a critical environmental challenge which has gained more attention over the years especially in oil and gas industries. The use of plants or organic extracts as corrosion inhibitor has become imperative as a result of their environmental acceptability, local availability as well as being renewable sources for a wide range of green inhibitors. The use of natural or organic products such as leaves and seed extracts has been widely reported but a few works have been done on the use of orange fruit seed extract as an eco-friendly corrosion inhibitor for Aluminum. Hence, in this study, the inhibiting effect of Orange fruit (Citrus synensis) seed extract on Aluminum corrosion in 1M Hydrochloric (HCL) Acid solution was investigated using weight loss measurement and phytochemical analysis. The study was conducted at a temperature of 30^oC with concentration of inhibitor varied from 0-0.3g/l in the acidic medium for 10 days. It was observed that the corrosion rate increases as the concentration of the inhibitor decreases with time. The result showed that at the inhibition concentration of

30%, the inhibition efficiency and corrosion rate obtained in HCL solution are 38.37% and 0.012 g/m² respectively, thereby giving the highest inhibition effect. Thus, it can be concluded that orange seed extract is a good corrosion inhibitor.

Keywords: Aluminum, Corrosion, Orange fruit seed, Inhibition, Weight loss

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1. INTRODUCTION

Aluminum is one of the metals largely utilized in production industries due to its availability, low cost and excellent mechanical properties, but it is susceptible to corrosion on exposure to corrosive environment. Metals naturally have the tendency of combining with other chemical elements, thereby returning to their lowest energy states. As a result, the metals frequently combine with oxygen and water which are abundant in most natural environment to form hydrated iron oxides (rust) [1]. Nevertheless, metallic materials such as brass, bronze, stainless steel, zinc and pure aluminum play a major role in the construction of equipment used in agriculture, oil and gas, petrochemical, process and allied industries. However, research works have been on-going by industries and academia into corrosion of these metals; its processes and its means of prevention [2]. The use of inhibitors has been one of the most desirable methods of preventing metals against corrosion. Inhibitors reduce corrosion rate by adsorption of ions/molecules onto the metal surface. Most of the corrosion inhibitors are synthetic chemicals, which are usually expensive and hazardous to the environment. Moreover, the use of synthetic inhibitors has been seriously discouraged due to its high cost, non-biodegradability and harmfulness. Also, due to the toxicity of some organic corrosion inhibitors, there has been increasing search for 'green' corrosion inhibitors. Hence, it is crucial to source for eco-friendly or environmental safe inhibitors which exceeds the cost benefits, performance and versatility of conventional products [3]. Recent studies on green inhibitors showed that they are more effective and highly environmentally friendly compared to organic and inorganic inhibitors used in chemical and petrochemical industries [4]. Researchers have revealed that natural products of plants e.g. grape fruits juice, orange seed extract, bitter leaves and root extracts contain organic compounds (e.g. alkaloids, tannins, pigments) that exhibit strong inhibitive ability, and are thus considered as good sources of green corrosion inhibitors [5-10]. The use of phytochemicals as corrosion inhibitors can be traced back to 1960s when tannins and their derivatives were used to protect steel from corrosion. Till date, extracts of plant leaves and fruit seeds also known as green inhibitors such as Pectin [11]; *Coriandum sativum L[12]*; *Euphoria hirta [13]*; Apricot juice [14]; *Spirulina platensis[15]*; among others have been investigated for corrosion inhibition of metals in different media. The present study aimed at investigating the inhibitive effects of *Citrus synensis* (Orange fruit) seed extract on the corrosion of Aluminum in 1M Hydrochloric Acid solution. Orange is one of the most delicious and most common type of fruits around the world today, but the seeds from this fruit are usually discarded as waste products making them of non-economic value.

2. MATERIALS AND METHODS

2.1 Preparation of the Specimen

Aluminum was machined into 40mm by 30mm dimension with area of 0.08mm dimension of 16 coupons were used for this study. The surface area treatment was done by degreasing using absolute ethanol. This was further dried in acetone and stored in moisture free desiccators. The Orange seeds used were those collected from Omu-Aran community in Kwara State Nigeria. Orange seed powder of 200g was completely soaked in ethanol solution for 24 hours with moderate stirring, and then filtered to obtain a high yield concentration of the filtrate. The filtrate was subjected to evaporation to obtain the pure extract and stored in a desiccator. The finely ground powder obtained was refluxed with dilute HCl at 90 ºC for 3 hours in a water bath (40 g of orange powder to 200 ml of HCl). After 3 hours, the beaker was removed from the water bath and left to cool for 2 hours after which the reflux of different acidic media was filtered out to get the filtrate by passing it through filter paper and the pure extract from different acidic media were collected and stored. Acetone was used to dry and preserve the extract in a desiccator to prevent it from reacting with the environment. During the phytochemical analysis of the extract, 10 g of orange powder was used for the analysis to determine the presence of active compounds such as saponins, alkaloids, tannins and flavonoid respectively.

2.2 Weight Loss Measurement

Aluminum coupon samples were weighed and then completely immersed in the prepared solution in the beakers in the presence and absence of the studied inhibitor in concentration ranges 0-30% test solution at 30 ºC; which was maintained in a thermostatic water bath. The immersed aluminum coupon were removed every 24 h, washed thoroughly to remove the corrosion product with emery paper, rinsed with distilled water and acetone then dried in air. The coupons were then reweighed and recorded to determine the weight loss, corrosion rate and inhibition efficiency were determined using equations (a) and (b):

$$I.E. = \left(\frac{CR1-CR2}{CR1}\right) x\ 100\ \% \quad (a)$$

$$C.R. = \frac{\Delta W}{Ax\,T} \quad (b)$$

Where, W_1= Weight of Aluminum sheet before immersion.

W_2= Weight loss of Aluminum sheet after immersion.

CR1= Corrosion rate of the Aluminum sheet in the absence of inhibitors.

CR2= Corrosion rate of the Aluminum sheet in the presence of inhibitors.

A= Surface area of the coupon in cm^2

$\Delta W = W_1 - W_2$

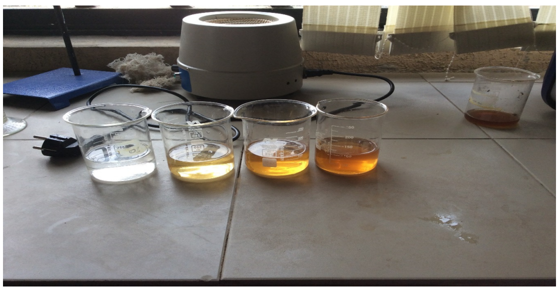

Figure1. Image of Inhibition concentration at varying proportions of HCl solution

3. RESULTS

Table 1: Phytochemical Test

Active compounds	Alkaloids	Saponins	Tannins	Flavonoid

Presence	+	-	+	+

Table 2: Result on Weight loss measurement for HCl

CONCENTRATION (%)	WEIGHT OF COUPON					Weight Loss
INHIBITOR	0 hr.	24 hrs.	48 hrs.	72 hrs.	96 hrs.	
0	1.19	1.01	0.99	0.92	0.82	0.37
10	1.23	1.06	0.99	0.95	0.92	0.31
20	1.18	0.99	0.98	0.96	0.93	0.25
30	1.20	1.06	1.02	0.90	0.96	0.24

Table 3: Results of Corrosion rates, inhibition efficiency, and surface coverage for HCl

Inhibition concentration (%)	Weight loss	Corrosion rate(s)	Inhibition efficiency (%)	Surface coverage
0	0.37	0.01	0	0
10	0.31	0.008	20	0.2
20	0.25	0.007	30	0.3
30	0.24	0.006	38.37	0.4

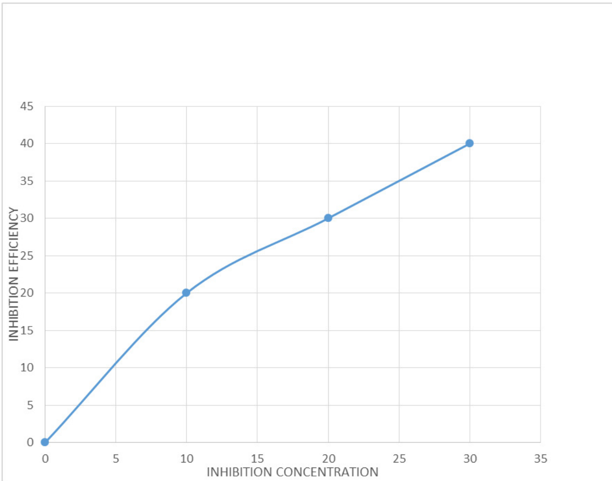

Figure 1: Graph of inhibition efficiency against inhibition concentration

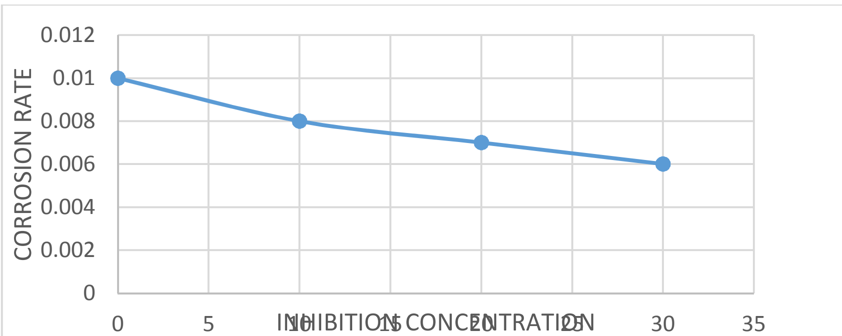

Figure 2: Graph of corrosion rate against inhibition concentration

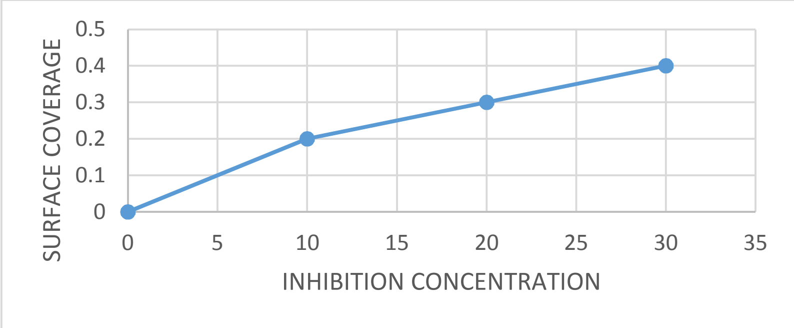

Figure 3: Graph of surface coverage against Inhibition concentration at 96hrs

3.1. Summary

The presence of active compounds as shown in Table 1 revealed that orange fruit seed is a good corrosion inhibitor and this is as confirmed from previous works. Moreover, the inhibition concentration of 30 % gave the highest inhibition efficiency of 38.37%. Table 2 showed the results of weight loss analysis while Table3 showed the result on corrosion rate, rate of inhibition efficiency and surface coverage respectively. It was deduced from Figure 1 that the inhibition efficiency increased as more concentration of the corrosion inhibitor was added. Figure 2 also showed that the rate at which the metal corroded reduced greatly as more concentration of the corrosion inhibitor was added; due to the increased thickness of the protective oxide layer formed on it. In addition, weight loss also reduces with increasing concentration of the inhibiting material.

4. CONCLUSION

The corrosion inhibition of orange seed extract as an inhibitor on Aluminum in 1M HCL was examined by weight loss analysis. It was deduced from this study that the maximum amount of inhibition efficiency at 30 % was 38.37%. Moreover, weight loss decreased with increase in concentration. Thus, it can be concluded from this study that orange seed extract is a very good eco-friendly corrosion inhibitor for aluminum in 1M HCL solution.

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