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IMPACT OF FAIDHERBIA ALBIDA ON CORROSION PREVENTION OF MILD STEEL WHEN EXPOSED TO HYDROCHLORIC ACID (HCL)

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Abstract: *Corrosion phenomena, control and prevention are unavoidable scientific issues that must be addressed daily as far as there are increasing needs for metallic materials in all facets of technological development. The use of natural inhibitors is the best option to prevent corrosion owing to the fact that it is environmental friendly, inexpensive, easily sourced and renewable. This research shows a locally sourced plant that is not eatable, meaning has little or of no used to the cultivator. Faidherbia Albida seeds was tested on Mild steel in presence of 1 M of HCl to determine the potency of prevention of corrosion and also comparing the inhibitive properties of the seeds of the plant. Soxhlet technique was used for extraction of the seeds of the plant with ethanol as the solvent. Weight loss method was used to determine the corrosion rate of the mild steel coupon with an exposure period of 432hr (18 days) at 72hr (3days) interval of measurement respectively. The results obtained show that, the extract of Faidherbia Albida seeds have a high significant effect on the reduction of the corrosion of mild steel at room temperature as a result of the formation of films on the substrate thereby displacing water molecules from the metal surface when compare with the blank. It is clear that corrosion rate is high for samples without inhibitor and have better performance in inhibited solutions. As the concentration of inhibitors increased (with 250 ppm increment), the rate of corrosion decreased with at least 0.045mm/yr. The efficiency of the inhibitors increase with increased in concentration indicating that the extract of Faidherbia Albida seeds can be used as corrosion inhibitor.*

Keywords: *Corrosion, Faidherbia Albida, Mild steel, Weight loss.*

INTRODUCTION

Of all metallurgical problems that face civilization, only a few can be economically more important than the prevention of metallic corrosion. Environmental attack on metal produces a destructive effect on their physical and mechanical properties which consequently, contributes to economic loses, impairs the safety of operating equipment and invariably depletes our metal reserves (Njoku, 2002).

Due to the problems arising from corrosion, several methods of corrosion control and preventions have been innovated: use of protective coatings, proper selection of material, alloying, proper design, cathodic protection, the use of inhibitors, etc. The method used for any specific application is based on economic considerations, nature of the corrosive environment, efficiency and cost consideration (Rozenfeld, 1981). According to Gosta, 1982 and Schmitt, 1984, inhibitors are used in a wide range of applications such as in oil pipelines, domestic central heating systems, industrial central cooling systems, corrosion protection of machines, in power generating plant, metal extraction, oil extraction, chemical processing and protection of metals operating under corrosive environment. Inhibitors are also used in the chemical removal of surface oxides from metal surface by immersion in acid solution; a process referred

to as pickling. Ferrous oxides dissolve readily in acid solutions during pickling in such a way that the oxides are attacked first making it easier for scale removal (Rozenfeld, 1981). Development in pickling techniques (ultrasonic pickling) does not eliminate the use of inhibitors but rather proffers solution to the problems of environmental pollution and improvement of pickling yield (Goode *et al*, 1996).

METHODOLOGY

Sample Collection

Fresh seed of Faidherbia Albida was collected from Ramat Polytechnic school farm, and was taken for identification by a Plant Taxonomist, in the Department of Biological Science Faculty of Science, University of Maiduguri.

Sample Preparation

The plant seed material was air-dried in the laboratory at room temperature. The seed of the plant was ground to fine powder using wooden mortar and pestle and the sample was stored in the research laboratory of Science Laboratory Technology Department of Ramat Polytechnic Maiduguri Borno state for further analysis.

Sample Extraction

The ground seed material (2,000g) was extracted with 85% ethanol using Soxhlet technique. The crude extract was concentrated under reduced temperature. The crude extract was then stored in a desiccator. The chaff was socked in distilled water for three hours and the mixture was filtered, concentrated and stored under pressure and reduced temperature.

Corrosion Efficiency

Weight loss method was used for the evaluation of corrosion inhibition efficiency of the extracts.

Weight Loss Method

cylindrical coupons of 10mm diameter and 10mm in length was used in this research for four solutions of 250. 500, 750 and 1000 ppm of extract concentration. In each test media of 1 M HCl, 0.025g: 0.05g, 0.075g and 0.1g of Faidherbia Albida seed extract was dissolved in different beaker containing 100ml of 1M HCl. In addition, one beaker containing 100ml of 1M HCl was used as control. The corrosion inhibition and immersion test was carried out in accordance with ASTM G3 1 -72. The coupons removed from the desiccator six each as a group, after individual weighing, were introduced into each beaker ranging from the control to the inhibited Rain water solutions as thread aided suspensions, at ambient temperature. An exposure period of 432hr (18 days) total was observed, at 72hr (3days) interval of measurement respectively. Unit specimen removed from each beaker at this interval was cleaned off corrosion products, dried and reweighed. The change in weight recorded, was used to calculate the rate of corrosion measured in millimeter per year (mmpy) as described by Yawas, (2005):

$$\text{Corrosion rate (CR)} = \frac{87.6\,x\,W}{P\,x\,A\,x\,T}\ (mmpy) \qquad \ldots\ldots 1$$

Where:

W = The weight loss in mg, P = The metal density in g/cm^3.

A = The exposed area of the test coupon in cm^2.

T = The exposure time in hrs.

However, the inhibition performance can also be calculated as follows (Ibrahim et al., 2011):

Inhibition Efficiency (IE) = $\frac{CR_0 - CR}{CR_0}$ x 100% ... ….2

The surface degree of coverage (∅) at each inhibitor concentration, defined as the degree of surface of material coverage by the inhibitor will be calculated as;

Degree of Surface Coverage (∅) = $\frac{CR_0 - CR}{CR_0}$ ……3

Where;

CR_0 = The corrosion rates without inhibitor

CR = The corrosion rates with inhibitor.

RESULTS AND CONCLUSION

As presented in table 1 the corrosion parameters such as corrosion rate and inhibition efficiency were studied for five different concentrations of inhibitor ranging from 0 ppm to 1000 ppm in Rain water for the time intervals 72hr, 192hrs, 312hrs, 432hrs, 504hrs and 576hrs as shown in figure 1. It was shown that with increase in concentration of *Faidherbia Albida seed* extract from 0 ppm to 1000 ppm, the corrosion rate of mild steel decreases while it increases as the exposure time increases. The obtained results indicate that the *Faidherbia Albida seed* extract could act as an excellent corrosion inhibitor. Even with increase in immersion period, *Faidherbia Albida seed* extract showed maximum inhibition efficiency. This could be due to the maximum adsorption of inhibitor molecules on to the metal surface.

Table: 1 Variation of corrosion rate against exposure time (hrs) of mild steel in 1 M HCl at different concentration of seed extract.

From the results obtained on the corrosion rate against exposure time at different inhibitor concentrations plotted in Figure 1; it is clear that corrosion rate is high for samples without inhibitor and have better performance in inhibited solutions. As the concentration of inhibitors increased (with 250 ppm increment), the rate of corrosion decreased with at least 0.045mm/yr.

S/N	Exposure time (hrs)	Weight Loss (g)	Corrosion Rate (mm/yr)	Θ	IE (%)
1	72	0.068	0.509	0.736	73.1
2	192	0.098	0.368	0.720	72.0
3	312	0.121	0.304	0.715	71.5
4	432	0.151	0.284	0.690	69.0
5	504	0.175	0.264	0.666	66.6
6	576	0.181	0.259	0.593	65.0

CONCLUSION

The study on the impact of Faidherbia Albida seed extract on corrosion prevention of mild steel in 1 M HCl demonstrated the extract's effectiveness as a natural corrosion inhibitor. Results from weight loss measurements revealed that the corrosion rate of mild steel decreased significantly with increasing concentrations of the extract, indicating strong inhibition efficiency. The extract acts by forming an adsorptive protective layer on the steel surface, displacing water molecules and reducing corrosion. While the inhibitor showed maximum efficiency at the initial 72-hour exposure, its performance remained satisfactory even with prolonged immersion up to 576 hours. This research highlights the potential of Faidherbia Albida seed extract as an eco-friendly, cost-effective, and renewable corrosion inhibitor for industrial applications.

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