ARCN International Journal of Sustainable Development
ISSN: 2384-5341. Volume 13, Issue 6, (March, 2023) pages 87 - 91
DOI: 2726457311367
arcnjournals@gmail.com
www.arcnjournals.org

Efficacy of *Senna Occidentalis* on Corrosion Inhibition of Mild Structural Member (Mild Steel Gutter Plate) Using Rainwater as Media

Fantami Ali[2]., Maina, M.N[2]., Bunu, M[3]., Sheriff, B[4].
[1]Department of Architecture Technology, School of Environmental, Ramat Polytechnic, Maiduguri P.M.B 1070, Borno State, Nigeria.
[2]Department of Mechanical Engineering Technology, School of Engineering, Ramat Polytechnic, Maiduguri P.M.B 1070, Borno State, Nigeria.
[3&4]Department of Agricultural Engineering Technology, School of Engineering, Ramat Polytechnic Maiduguri P.M.B 1070, Borno State, Nigeria.
Corresponding Email:(fantami24@gmail.com)

Abstract: *The inhibitive effect of* Senna Occidentalis *leaf extract on mild steel corrosion in 1M HCl solution was studied using weight loss method. The weight loss results showed that the plant extract was an excellent corrosion inhibitor. It was observed that with increase in concentration of Senna Occidentalis leaf 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 Senna Occidentalis leaf extract could act as an excellent corrosion inhibitor.*

Key words: *Corrosion inhibition,* Senna Occidentalis, *Mild steel, Weight loss.*

ITRODUCTION

Corrosion of metals such as mild steel is chemical or electrochemical reaction which can cause the degradation and batter of the physical and chemical properties of the metal. The word mild steel (MS) stands for an alloy of carbon and iron in which carbon is present in less amount due to this less amount of carbon mild steel have wide range of applications in mechanical industries like water cooling system, pipelining, in welding etc. due to its properties like ductility, malleability etc. So it preferred than other metals and steels with high amount of carbon but mild steel comes with a huge drawback that it can easily undergo corrosion. MS is also called as the carbon steel which is a low carbon (0.3%) steel with superior strength (Gaya *et al,* 2019). It is used when large amount of steel is needed and can be twisted and welded into an infinite range of shapes for uses in vehicles, construction material and vessels fabrication etc. In many industries, MS is the material of choice in the fabrication of reaction vessels, storage tanks etc. which get corroded easily in the presence of acids (Gaya *et al,* 2019). In spite of this, estimate shows that 25-30% of this could be avoided if corrosion prevention technologies are put in place (NACE, 2002).

Inorganic acids like HCl and H_2SO_4 are used in the industries for many purposes like drilling, fracturing and acid stimulations at various stages in oil exploration, production and/or descaling operations. Wet acidic gases such as CO_2, H_2S and weak acetic and formic acids cause significant amount of corrosion for steel pipelines and storage processing facilities used in the oil and gas production networks (Ibrahim *et al.,* 2011).

Among the several methods of corrosion control and prevention, the use of corrosion inhibitors is very popular. Corrosion inhibitors are substances which when added in small concentrations to corrosive media decrease or prevent the reaction of the metal with the media (Singh *et al.,* 2012). Inhibitors are added to many systems, namely, cooling systems, refinery units, chemicals, oil and gas production units, boiler, and so forth. Most of the effective inhibitors are used to contain heteroatom such as O, N, and S and multiple bonds in their molecules through which they are adsorbed on the metal surface. It has been observed that adsorption depends mainly on certain physicochemical properties of the inhibitor group, such as functional groups, electron density at the donor atom, π-orbital character, and the electronic structure of the molecule. Though many synthetic compounds showed good anticorrosive activity, most of them are highly toxic to both human beings and environment. The use of chemical inhibitors has been limited because of the environmental threat, recently, due to environmental regulations. These inhibitors may cause reversible (temporary) or irreversible (permanent) damage to organ system, namely, kidneys or liver, or disturbing a biochemical process or disturbing an enzyme system at some site in the body. The toxicity may be manifest either during the synthesis of the compound or during its applications. These known hazardous effects of most synthetic corrosion inhibitors are the motivation for the use of some natural products as corrosion inhibitors. Plant extracts have become important because they are environmentally acceptable, inexpensive, readily available, and renewable sources of materials, and ecologically acceptable. Plant products are organic in nature, and some of the constituents including tannins, organic and amino acids, alkaloids, and pigments are known to exhibit inhibiting action. Moreover, they can be extracted by simple procedures at low cost. In the present work, the effect of *Senna Occidentalis* on corrosion inhibition of structural members in acidic media was investigated using the weight loss method.

METHODOLOGY

Sample Collection

Fresh leaf of *Senna Occidentalis* will be collected from Ramat Polytechnic school farm, and will be taken for identification by a Plant Taxonomist, in the Department of Biological Science Faculty of Science, University of Maiduguri.

Sample Preparation

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

Sample Extraction

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

Corrosion Efficiency

Weight loss method and thermodynamic method will be used for the evaluation of corrosion inhibition efficiency of the extracts.

Weight Loss Method

Cylindrical coupons of 10mm diameter and 10mm in length will be used in this research as earlier stated- Four solutions of 250. 500, 750 and 1000 ppm of extract concentration will be prepared for each extract of; leaves of leptadenia hastata in each test media of H_2SO_4 and HCl acid respectively, by dissolving 0.025g: 0.05g, 0.075g and 0.1g of each extract in different beaker containing 100ml of 1M Rain water. In addition, one beaker containing 100ml of 1M Rain water will be used as control. The corrosion inhibition and immersion test will be carried out in accordance with ASTM G3 1 -72. The coupons removed from the desiccator six each as a group, after individual weighing, will be introduced into each beaker ranging from the control to the inhibited acid solutions as thread aided suspensions, at ambient temperature. An exposure period of 432hr (18 days) total will observed, at 72hr (3days) interval of measurement respectively. Unit specimen removed from each beaker at this interval will be cleaned off corrosion products, dried and reweighed. The change in weight recorded, will be used to calculate the rate of corrosion measured in millimeter per year (mmpy) as described by Yawas, (2005):

Corrosion rate (CR) = $\frac{87.6\ x\ W}{P\ x\ \ A\ x\ T}\ (mmpy)$ ... 3.4

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% ... 3.5

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 (∅) = $\frac{CR_0-CR}{CR_0}$ ….3.6

Where;

CR_0 = the corrosion rates without inhibitor

CR = the corrosion rates with inhibitor.

RESULTS AND CONCLUSION

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 1 M HCl for the time intervals 72hr, 192hrs, 312hrs, 432hrs, 504hrs and 576hrs tabulated in table 1 & 2. It was shown that with increase in concentration of *Senna Occidentalis* leaf 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 *Senna Occidentalis* leaf extract could act as an excellent corrosion inhibitor. Even with increase in immersion period, *Senna Occidentalis* leaf 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 1M HCl at different concentration of leaf extract.

Exposed time/Concentration	0	250	500	750	1000
72	1.4932	1.4843	1.4706	1.4671	1.4537
192	1.6684	1.6475	1.5983	1.5679	1.5332
312	1.6988	1.6967	1.6879	1.6784	1.6712
432	1.7657	1.7301	1.7230	1.7001	1.6992
504	1.7935	1.7827	1.7750	1.6937	1.6607
576	1.8789	1.8638	1.8337	1.7063	1.6936

CONCLUSION

From the result of the weight loss measurement for the investigation of the corrosion inhibition properties of the plant extract *Senna Occidentalis* leaf in hydrochloric acid solution, the following conclusions were made:

i. *Senna Occidentalis* leaf extract is effective corrosion inhibitor for mild steel in acidic medium.
ii. Increase in inhibitor concentration from 0ppm to 1000ppm decreases the corrosion rate but increases as the exposure time increases.
iii. Finally the extract of *Senna Occidentalis* leaf serve as a good corrosion inhibitor.

REFERENCE

ASTM G31-72 (2004): "practice for laboratory immersion corrosion test of metals". American Society of Testing and Materials, westconshohocke.PA, ww.astm.org.

ASTM G59-97 (2014): "Test Methods for Conducting Potential Dynamic Polarisation Resistance Measurements", American National Standard Institute,New York.

Gaya, H. S.,. Shawai, S. A., Yusuf, G. A., Abubakar, I. H. (2019). "Plants Extract for Corrosion Control of Mild Steel in Acidic Medium". World Academic Journal of Engineering Sciences. 6(1):47-51.

Ibrahim, H. T., Chehade, Y. and Mohamed, A. Z., (2011). "Corrosion Inhibition of Mild Steel using Potato Peel Extract in 2M HCI Solution", Int.J. Electrochemical Science. (6542 – 6556).

Ibrahim, T. and Habbab, M. (2011) "Corrosion Inhibition of Mild Steel in 2M HCI using Aqueous Extract of Eggplant Peel" Int. J. Electrochemical Science, 6, pp (5357- 5371).

NACE.2002 "Corrosion Costs and Preventive Strategies in the United States" NACE International. Available at: http:www.nace.org. Sourced: [5 December. 2016]. A review. *Chemical Science Review and Letters, 1(1),* 1-8.

Singh, A., Ebenso, E. E., Quraishi, M. A. (2012). "Corrosion Inhibition of Carbon Steel in HCl Solution bySome Plant Extracts". International Journal of Corrosion. 2012(1): 1-21

Yahaya, I. A.,Nok, A. J. and Bonire. J. J. (2013). "Chemical Studies of the Peel of *Xanthosomasagittifolium* (Tannia Cocoyam)" Pakistan Journal of Nutrition12 (I): 40-44.

Yawas, D.S., (2005). "Suitability Assessment of some Plant Extracts and Fatty acid vegetable oils as corosion inhibitors" *Ph.DDessertation in the Department of Mechanical Engineering, ABU, Zaria - Nigeria.*