CORROSION INHIBITION OF MILD STEEL IN SULPHURIC ACID SOLUTION BY THE EXTRACT OF *Lawsonia inermis*

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Abstract: The corrosion behaviour of mild steel in H_2SO_4 solution in the absence and presence of ***Lawsonia inermis*** extract was investigated using weight loss measurement. It was found that, the inhibition efficiency of the extract depends on their concentration. The inhibitive action of this extract was discussed in terms of blocking the electrode surface by adsorption of the components through the active centres contained in their structure.

Introduction

Corrosion is a natural process, defined as the deterioration of a material that results from a chemical or electrochemical reaction with its environment, *ie.* , it converts a refined metal to a more chemically stable form, such as its oxide, hydroxide or sulphide. It is a gradual destruction of materials (usually metals), by chemical and other electrochemical reaction with their environment [1].

Many structural alloys corrode merely from exposure to moisture in air, but the process can be strongly affected by exposure to certain substances. Corrosion can be concentrated locally to form a pit or crack, or it can extent across a wide area more or less uniformly corroding the surface. Because corrosion is a diffusion-controlled process, it occurs on exposed surfaces [2].

Due to corrosion there are indirect costs associated with plant shut down, lower efficiency of equipments, contamination and over design, parts and labour to replace corroded equipments are often minor compared to the loss of production while the plant is nonoperational. Thus leaks in a pipelines and tanks result n loss of costly products and this leaks can also pose a serious environmental problems. Soluble corrosion products can contaminate a system and decontamination is costly. In the absence of adequate corrosion rate information over design is required to ensure reasonable service life. This leads to wastage of resources and for moving parts, greater power requirements.

Iron and its alloys exhibit high electrical and thermal conductivity, high formability, machinability and strength. Because of these favourable properties they are extensively used in a industrial fields.

The first step in effective corrosion control, however, is to have a thorough knowledge about the type of corrosion, the mechanism involved, how and why they occur. In virtually all situations, metal corrosion can be managed, slowed or even stopped by using the proper

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techniques. Corrosion prevention can take a number of forms depending on the circumstances of the metal being corroded [3].

Corrosion inhibitors are either organic or inorganic chemicals that are added in small amounts (parts per million) to corrosive environment in order to delay or decrease the corrosion process of the substance to be protected. Due to the fact that equipment constructed with materials resistant to corrosion is very expensive, it is common to use corrosion inhibitors as a practical, economical and a simple alternative. The effectiveness of a corrosion inhibitor depends on fluid composition, quality of water and flow regime [4].

The term "green inhibitors" or "eco-friendly inhibitor" refers to the substances that have biocompatibility in nature. The inhibitors like plant extracts presumably possess biocompatibility due to their biological origin. Similar to the general classification of inhibitors, 'green inhibitors' can also be grouped into two categories, namely organic green inhibitors and inorganic green inhibitors [5].

Lawsonia inermis belonging to family *Lyrthaceae*, is a medium sized herb with many branches. The leaves, barks, roots and fruits are useful parts of henna plant. Henna has anti-bacterial, anti-fungal, aromatic and cooling properties. Lawsone is the active constituent of henna leaves, which is the main colouring constituent of henna obtained by degradation of hennosides A, B and C. Apart from having medicinal properties, water extracts of henna leaves powder were evaluated as corrosion inhibitors for steel and commercial aluminium in saline, acidic and alkaline medium.

Lawsonia inermis leaf have the components, gallic acid, 2-Hydroxy-1,4-naphthoquinone etc., which contains aromatic rings and high electron density. All this may make *Lawsonia inermis* leaf extract a good corrosion inhibitor.

Experimental

Inhibitor: *Lawsonia inermis* (henna) leaf extract.

Preparation: *Lawsonia inermis*'s leaves were dried under shade for several days. After the complete dehydration of leaves, it was crushed into very fine powder. A mixture of 10g Lawsonia inermis (henna) and 100ml ethanol was taken in a round bottomed flask and was refluxed at 100^{o}C for about 2-3 hours and filtered. The obtained filtrate was concentrated to 50 ml using a water bath. Varying the concentration of the extract, it was subjected to further corrosion studies.

Medium for corrosion: The medium for the study was 1N. H_2SO_4 prepared from reagent grade Sulphuric acid from E. Merk and distilled water.All the tests were done at room temperature and normal atmospheric pressure.

Results and Discussion

Weight loss and corrosion rate: The weight loss experiments were carried out under total immersion conditions in test solutions maintained at room temperature. Iron specimens (mild steel) of required dimensions are initially rubbed with different grades of emery papers. The experiments were carried out in 100 ml beaker containing the solutions. The metal coupons with freshly prepared surfaces were then fully immersed in a corrodent. 1N H_2SO_4 and 0.5 N

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H_2SO_4 inhibitor for 24 hr, 48 hr and 72 hr. All solutions were opened to air. After the exposure period, the specimens were removed , washed initially under running tap water to remove the loosely adhering corrosion products. Then is dried and weighed. From the weight loss each experiment, corrosion rate was calculated in millimetre per year (mm yr^{-1}). The mean corrosion rate (CR) and inhibition efficiency (IE) were calculated from the following equation,

$$CR = \frac{87.6 \times W_i}{D\,A\,T} \text{ in mm/yr} \quad \text{or} \quad CR = \frac{534X\, W_i}{D\,A\,T} \text{ in miles/yr}$$

Where, CR= Corrosion rate, Wi = Weight loss in milligram, D = Density of the metal in g/cm^3 (iron = 7.86), A = Area of metal coupon, T = Time in hours.

The inhibition efficiency values are calculated as follows

$$IE = \frac{W_b - W_i}{W_b} \times 100$$

Wb = Weight loss in blank; Wi = Weight loss in presence of inhibitor.

The result indicated that the introduction of *Lawsonia inermis* leaf extract into the corrosive medium causes a significant reduction in the corrosion of iron. The corrosion inhibition efficiency increased with a corresponding increase in the concentration of the inhibitor. This may have resulted due to the sufficient adsorption and wider coverage by the inhibitor molecule. The calculated values of corrosion rate of mild steel in the corrodent medium were reduced on addition of different concentrations of the inhibitor. It has also been observed that the weight loss increases as the time of exposure increased. It was noted that the Corrosion Rate increases with increase in acid concentration. Results are given in the Tables 1-6.

Table 1. ***Corrosion rate and inhibition efficiency of mild steel in 1N H_2SO_4 at different concentration of Lawsonia inermis leaf extract for 24 hours***

Concentration of the inhibitor (ml)	*Weight of metal before immersion (g)*	*Weight of metal after immersion (g)*	*Weight loss (g)*	*Inhibition efficiency (%)*	*Corrosion rate*
Blank	3.378	2.447	0.931		0.731
1	2.457	2.345	0.112	87.97	0.0880
2	3.424	3.371	0.053	94.31	0.0416
3	3.648	3.596	0.052	94.41	0.0408
5	3.592	3.532	0.060	93.55	0.0471

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Table 2. ***Weight loss of mild steel in different concentrations of H_2SO_4 for 24 hours***

Concentration of acid (N)	*Weight of metal before immersion (g)*	*Weight of metal after immersion (g)*	*Weight loss (g)*	*Corrosion rate*
0.5N	3.522	2.929	0.593	0.4659
1N	3.378	2.447	0.931	0.731

Table 3. ***Corrosion rate and inhibition efficiency of mild steel in 1N H_2SO_4 at different concentrations of Lawsonia inermis leaf extract for 48 hours***

Concentratio n of the inhibitor (ml)	*Weight of metal before immersion (g)*	*Weight of metal after immersion (g)*	*Weight loss (g)*	*Inhibition efficiency (%)*	*Corrosion rate*
Blank	2.507	0.449	2.058		0.8085
1	3.468	2.852	0.616	70.07	0.2420
2	2.152	1.875	0.277	86.54	0.1088
3	3.441	3.087	0.354	82.80	0.1390
5	3.279	3.236	0.043	97.91	0.0168

Table 4. ***Weight loss of mild steel in different concentrations of H_2SO_4 for 48 hours***

Concentration of acid (N)	*Weight of metal before immersion (g)*	*Weight of metal after immersion (g)*	*Weight loss (g)*	*Corrosion rate*
0.5N	3.554	2.439	1.115	0.438
1N	2.507	0.449	2.058	0.808

Table 5. ***Corrosion rate and inhibition efficiency of mild steel in 1N H_2SO_4 at different concentrations of Lawsonia inermis leaf extract for 72 hours***

Concentration of the inhibitor (ml)	*Weight of Metal before immersion (g)*	*Weight of Metal after immersion (g)*	*Weight loss (g)*	*Inhibitio n efficiency (%)*	*Corrosio n rate*
Blank	2.429	0.253	2.176		0.569
1	3.516	2.685	0.831	61.81	0.2176

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2	2.331	2.160	0.171	92.14	0.0448
3	3.570	3.451	0.119	94.53	0.0312
4	3.358	3.304	0.054	97.52	0.0141

Table 6. ***Weight loss of mild steel in different concentrations of H_2SO_4 for 72 hours***

Concentration of acid (N)	*Weight of metal before immersion (g)*	*Weight of Metal after immersion(g)*	*Weightloss (g)*	*Corrosion rate*
0.5N	2.920	1.810	1.110	0.290
1 N	2.429	0.253	2.176	0.569

Conclusions

The following observations are drawn from the present project on co-ordination ability and corrosion inhibition measurements of *Lawsonia inermis* leaf extract derivatives. *Lawsonia inermis* leaf extract is acting as a ligand with Oxygen as the coordinating atom. The results of experimental investigations of the studies *Lawsonia inermis* leaf extract show that, It reduces the corrosion rate of mild steel in acid medium remarkably. The corrosion rate of mild steel reduces remarkably as the concentration of inhibitor increases. Inhibition efficiency of the studied inhibitor decreases with increasing the concentration of the corrodent, H_2SO_4. The study at different exposure time gives the result that the corrosion inhibition efficiency of the inhibitor decreases as exposure time increases.

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