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INVESTIGATION OF THE CORROSION INHIBITION OF MILD STEEL IN ACIDIC MEDIUM BY EXTRACT FROM *CITRULLUS LANATUS* RIND

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ABSTRACT: *Corrosion Inhibition of mild steel in acidic medium by ethanol extract of citrullus lanatus plant has been studied using weight loss method. The result of the study revealed that different concentrations of the extract of citrullus lanatus inhibited mild steel corrosion in 0.2M concentration of hydrogen tetraoxosulphate VI solution. The inhibition ability of the rind extract is attributed to the presence of the photochemical in the extracts. Result for weight loss also revealed that inhibition efficiency increased with increasing inhibitor concentration. Adsorption study revealed that adsorption of the extract of citrullus lanatus on mild steel surface occurred according to Langmuir adsorption isotherm.*

KEYWORDS: Citrullus Lanatus, Weight Loss, Inhibitor Concentration, Mild steel.

INTRODUCTION

In chemical processes, Steel reacts with its environment (corrosive medium) to form an undesirable effect on chemical processing plants. Such corrosive effect occurs in unit operations such as absorber, settling tanks, heat pumps, heat exchangers, boilers, and mixers. Practically, the cost of controlling steel corrosion is very enormous; since it is virtually impossible to stop steel corrosion completely, the use of inhibitors is widely adopted to reduce corrosion to a sustainable level. Inhibitors are chemicals that often work by adsorbing themselves on the metallic surface by forming a film. [Noor, 2008; Ebenso et al, 2009; Ebenso et al, 2008; Oguzie, 2006; Gazquez, 2006; M. Rajendran and D. Devapiriam,2015].They are mostly synthesized from plant extract or sometimes selected from polymeric and organic compounds having electronegative functional groups and π-electrons in triple or conjugated double bonds. Plant extracts constitute several organic compounds which have significant inhibiting abilities. The inhibition ability varies widely depending on the part of the flora. The present study is aimed at investigating the inhibitive properties of ethanol extract of *citrullus Lanatus* rind in acidic medium.

LITERATURE/THEORETICAL UNDERPINNING

Corrosion is the declension of metallic elements or metallic alloy by chemical interaction with their surroundings. The most widely used metal which is mild steel an alloy of iron and carbon is used in this research study. To apprehend the corrosion of mild steel, the concepts of its corrosion needs to be reviewed. Mild steel corrosion occurs by electrochemical reaction which requires an anode, a cathode, an electrolyte, and a circuitry path connecting the anode and the cathode. Mild steel corrodes when it interacts with water system, acidic medium, basic medium, salt, and corrosive vapours. When steel is exposed to any of the corrosive

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environment, it gives up electron, and become a positively charged ion. Oxidation of steel matrix occurs at the anode where the current enters the electrolyte. The anodic reaction is would be:

Anodic Reaction:

$$Fe \longrightarrow Fe^{2+} + 2e^{-} \quad \text{..... (1)}$$

Also, at the cathode end, reduction of oxygen occurs as described below:

Cathodic Reaction:

$$O_2 + 2H_2O + 4e^{-} \longrightarrow 4(OH^{-}) \quad \text{.....(2)}$$

Considering that there is no net gain of electron or loss of electrons, two atoms of iron dissociate to give four electrons needed at the cathode. Thus, the anodic and cathodic reactions would be

$$2Fe \longrightarrow Fe^{2+} + 4e^{-} \text{ (anodic)} \quad \text{.....(3)}$$

$$O_2 + 2H_2O + 4e^{-} \longrightarrow 4(OH^{-}) \text{ (cathodic)} \quad \text{.....(4)}$$

These can be summed to give the overall oxidation – reduction reaction

$$2Fe + O_2 + 2H_2O \longrightarrow 2Fe^{2+} + 4(OH^{-}) \quad \text{.....(5)}$$

MATERIAL AND METHODS

Materials Preparation

The specimen, which is mild steel sheet of 30cm length, 20cm width and 0.12cm thick, was mechanically pressed-cut to form different coupons, each of dimensions, 5×4×0.12 cm using a Gulletin machine. Each coupon was degreased with ethanol solution, rinsed with acetone and stored in a desiccator.

Preparation of Extract and Corrosive Medium.

Fresh samples of *Citrullus Lanatus* were washed under running water, shade dried and cut to separate out into the seed, the rind(exocarp), and the fleshy center (mesocarp and endocarp).The thick rind, the required plant part, was sun dried and ground into powder. The powder obtained from the rinds was soaked in 95%ethanol solution for 72 hours and extracted filtered in batches. The filtrates were evaporated in order to obtain the sample free of the ethanol. The stock solutions of the extracts so obtained were used in preparing different concentrations of the extract by dissolving 1,2, 3, 4 and 5 gram of the extract in 200ml of 0.2 M H_2SO_4.

Weight Loss Determination.

Previously degreased, polished and weighed mild steel coupons of size 5×4×0.12cm were immersed in 200ml of 0.2M H_2SO_4 (corrosive environment) with and without the addition of different concentrations of inhibitors at 25^0C (room temperature) for 24, 48, 72, 96,120,144,and 168 hours exposure time. The mild steel strip coupons were weighed and suspended in the beaker with the help of tripod stand and thread. After 24 hours interval, each sample was

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withdrawn from the test solution, washed twice in distilled water, dried with acetone and re-weighed using B.Bran Electronic Balance. The differences in the weights of the mild steel strip coupons before and after immersion in different test solutions were taken as the weight loss of the coupons. The corrosion rate (C.R) in the presence and absence of inhibitors, the inhibition efficiency (I.E) of the inhibitors, and the degree of surface coverage were calculated.

RESULTS AND FINDING

Weight loss analysis

Weight loss analysis was carried out to obtain information regarding corrosion of mild steel in acidic medium. The weight loss plot for steel in 0.2 M H_2SO_4 solution in the absence and presence of different concentrations of the extracts of *Citrullus Lanatus* inhibitor is shown in Figure1. The figure showed that the weight loss values decreased with increase in concentration of the *Citrullus Lanatus* extract.

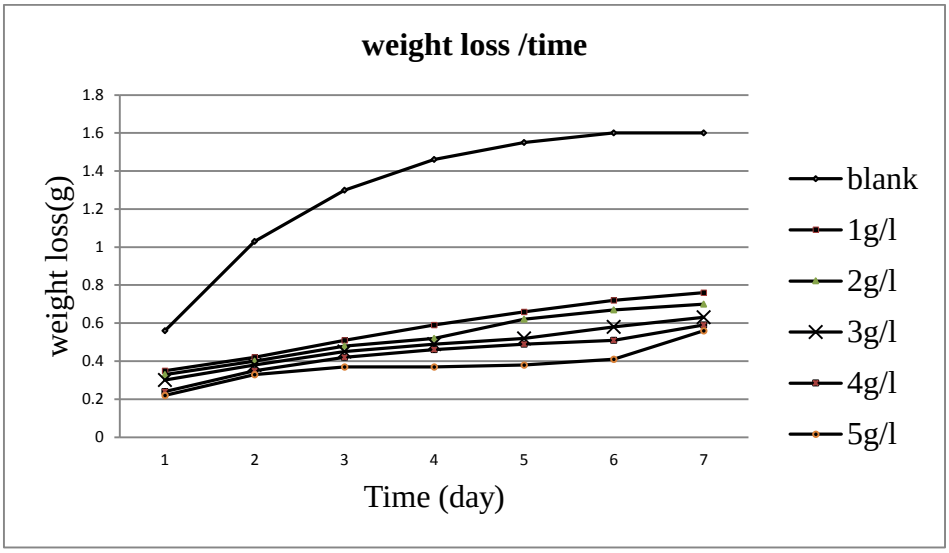

Figure 1. Variation of weight loss with time for steel in 0.2M H_2SO_4

Figure 2 showed the plot of weight loss per day against the inhibitor concentration (g/lit). It is observed that increasing the inhibitor concentration from 2g/lit to 3g/lit significantly decreases the slope of the graph indicating a slowing in the weight loss of steel.

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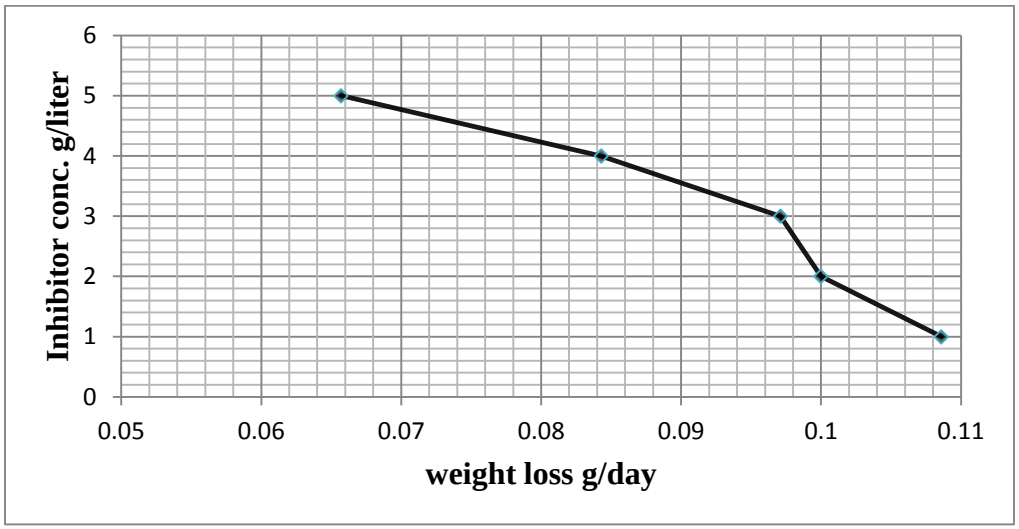

Figure 2. Variation of weight loss (g/day) with inhibitor concentration (g/liter).

Figure 3 showed the adsorption isotherm of *C. lanatus* where values of surface coverage were tested graphically by employing Langmuir adsorption isotherm. The plots yielded a linear graph that confirmed the application of Langmuir adsorption isotherm. The value of correlation coefficient, R^2 tending to unity also indicated strong adherence to the assumptions of Langmuir adsorption isotherm.

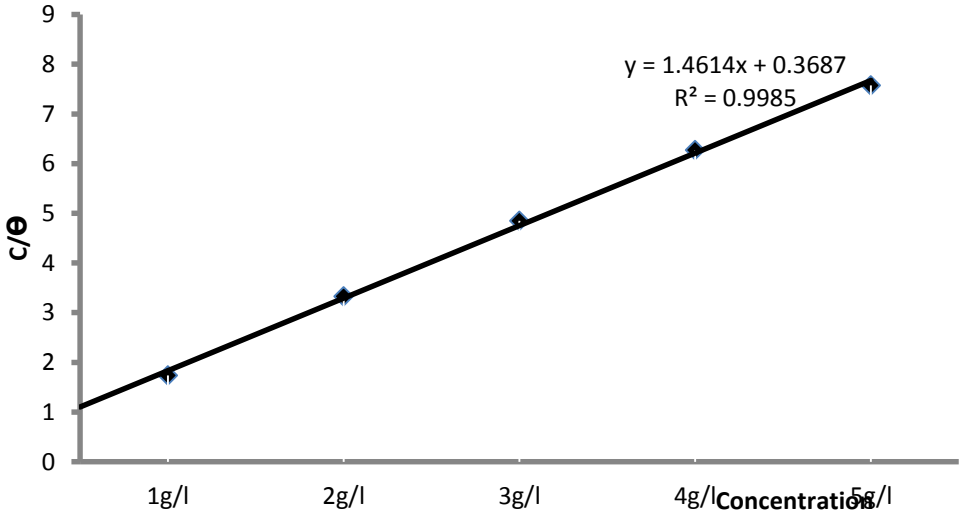

Figure 3 Adsorption isotherm for *C. lanatus* on mild steel in 0.2M H_2SO_4

Table 1 shows the experimental values of Corrosion Rate, Inhibition Efficiency, and Surface Coverage computed from the experiment. The results showed that as the concentration of the inhibitor increases, the inhibition efficiency increases and corrosion rate decreases. The surface coverage increases also with the inhibitor concentration. By adsorption principle, the molecules of the extracted inhibitor adsorb firmly on the Steel Surface and as such block the available reaction sites by formation of inhibitor film on the steel surface which reduces the active surface area available for the attack of the corrosive medium.

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Table 1. Variation of Efficiency, Corrosion rate with Concentration

Inhibitor	Inhibitor Concentration	Inhibition Efficiency	Corrosion Rate	Surface Coverage
Rind	blank	-	2.452	-
	1.0	52.49	1.207	0.524
	2.0	64.99	0.889	0.649
	3.0	65.63	0.873	0.656
	4.0	66.88	0.842	0.668
	5.0	67.50	0.826	0.675

CONCLUSION

The investigation on the corrosion inhibition properties of *citrullus lanatus* by gravimetric technique showed that the extract from c*itrullus lanatus* is a good inhibitor for the corrosion inhibition of mild steel in acidic medium. The gravimetric plot which revealed the sharp steep slope marked off by 2g/litre and 3g/litre inhibitor concentrations along the ordinate axis of figure 2 gave the best optimal zone for the inhibition of mild steel. Thus, the biodegradable extract from *citrullus lanatus* could serve a good replacement for most organic inhibitors which are toxic to living being and environment.

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