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Study of Corrosion Inhibition on Aluminium by *Prosopis Cineraria Leaves* Extract in Acidic Media

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Abstract – The corrosion inhibition of leaves extract of Prosopis cineraria was studied using gravimetric technique in HCl solutions on aluminum at temperature 30 and 60°C. The results revealed that the leaves extract worked as an excellent and effective inhibitor in acidic medium. Also, the extract overcome the corrosion reaction in acid media. The inhibition efficiency of the extract varied with concentration and temperature. The metal surface covered by the inhibitors and the molecular interaction between the molecular species was also determined. The activation energy (Ea) was evaluated from the dependence of inhibition efficiency on temperature.

Key Words: Corrosion Inhibition, Aluminum, Leaves Extracts, Prosopis Cineraria, Activation Energy

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INTRODUCATION

Corrosion, various corrosion prevention measures for metals are the key problems in many industries, particularly in violent environments, which include the use of metals and alloys [1]. Aluminum and its alloy are commonly employed in a range of violent and corrosive working conditions in diverse industries [2]. One of the most effective strategies to secure metal surfaces is to incorporate appropriate inhibitors to slow the corrosion reaction and reduce the rate of corrosion. The use of naturally occurring inhibitors as a complement to synthesized organic inhibitors for metals subject to the acidic condition has been significant [3].

Plant extracts are becoming relevant today as they are environmentally sustainable, cost-effective, widely accessible and environmental ally viable forms of material. They have inhibitory properties and in plants there are elements such as tannins, alkaloids and saponins. The extraction method is also quick and cost-effective[4].

Many recent literature shows that plant materials such as *Chamaeropshumilis* [5], *Perquetina* [6], *Musa Sapientum* [7], *GossipiumHirsutum* [8] are some inhibitors that are beneficial for metals in aggressive medium. As a contribution to the current condition on environment friendly, green, corrosion inhibitors, the present study investigates the inhibiting effect of pod extract of *Prosopic cineraria leaves* on aluminium corrosion in acidic solutions using the gravimetric technique. The effect of temperature on the inhibition efficiency has also been studied.

MATERIALS AND METHODS

1. Preparation of leaves extract

Prosopis cineraria leaves were air and shade dried and then grinded to powder. This powdered substance was dissolved in a sufficient quantity of purified ethyl alcohol to soak the dried matter. The solution was then extracted to concentrate the compounds that hindered it. The sum of leaf extract was dried and calculated for the present analysis as a corrosion inhibitor.

2. Preparation of metal sheet

Aluminum sheet metal has been used for the experiment with composition of 0.25% Zn, 0.15% Hi, 0.8% Si, 0.7% Fe, 0.4% Cu, 1.2% Mg, 0.35% Cr and 96.15% Aluminum. Aluminum sheets for fast hunging is used as rectangular coupons in the scale 1.0 to 4.0 to 0.2 cm with hole on one end. With various grades of emery paper, degreased with acetone, washed with water and then weighed the surface of the coupons was finished.

3. Weight loss method

Weight loss experiments were performed at a temperature of 303K and held in a thermostat water bathtub with test beakers under total immersion. Aluminum coupons were first weighted and then hung with rod and loop in the beaker. The coupons were restored at a temperature of 303K with various inhibitor values, dried by folding of philter paper and dried overnight. The final weights of the coupons

were obtained after full drying. The weight of the aluminum coupons has been determined by automated balance with ±0.1 mg of sensitivity, before and after immersion in various testing solutions. Related method at various temperatures was replicated.

For calculation of weight loss, the equation below was used:

$$\Delta W = W_1 - W_2 \qquad (1)$$

Where;

W_1= Weight of coupons before immersion (Initial weight)

W_2= Weight of coupons after immersion (Final weight)

ΔW= Weight loss of coupons.

This resulting weight loss data was used to calculate the percentage inhibition efficiency (%IE) :

$$\text{"\%IE.} = [1 - W_{Li}/W_{Lb}] \times 100\text{"} \qquad (2)$$

W_{Li}= Weight loss of coupons of solution with inhibitor.

W_{Lb}= Weight loss of coupons of solution without inhibitor/blank.

RESULT AND DISCUSSION

1. Consequences of inhibitor concentration

The corrosion penetration rate and the inhibition efficiency (%IE) were estimated from the data of weight loss for hydrochloric acid. Table 1 represents the inhibition efficiency of *Prosopis cineraria leaves* extract concentration on aluminum in 1M HCl. The measured values revealed that with the rise in inhibitor concentration, the loss of weight and corrosion rate fell to their optimum amount, there was no noticeable improvement in the inhibitory and corrosion rate after further increase. The maximum inhibition efficiency of inhibitor was 86.67%in HCl optimal concentration of 50ppm. Further there was not any significant change in the inhibition efficiency on increasing the inhibitor concentration.

Table1: Inhibitor efficiency in 1M HCl

Inhibitor concentration (in ppm)	Inhibition efficiency (1M HCl)	
	303K	333K
10	43.75	32.27
20	59.01	44.53
30	62.63	50.07
40	78.86	63.8
50	86.67	75.16

2. Explanation of inhibition

On the basis of process of adsorption and the structure of the constituent present in extract the expected mechanism can be explained. The adsorption of phytochemical constituents on the surface of the metal, present in the extract through oxygen atoms can be reason behind inhibition. With the increasing concentration of *Prosopis cineraria leaves* extract, decrease in the weight loss decreases and on corrosion rate was seen upto an optimal after which not any significant changes were seen on further increase in inhibitor concentration. The figures below shows the data of percentage efficiency on corrosion rate obtained from weight loss method at temperature 303K and 333K of different concentration of leaves extract.

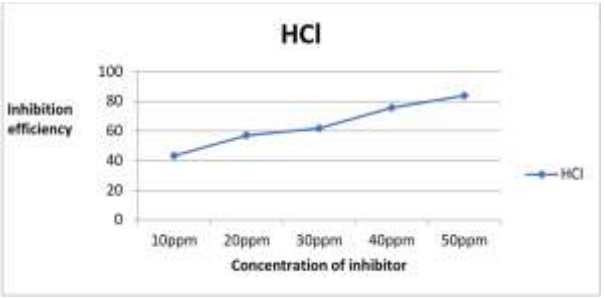

Figure 1: Variation in efficiency with different concentration of inhibitor at 303K

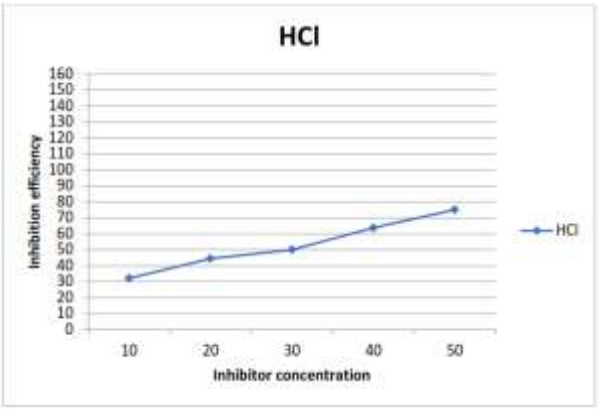

Figure 2: Variation in efficiency with different concentration of inhibitor at 333K

3. Effect of temperature:

The stability of absorbed layer of inhibitor on aluminium surface and the activation parameters of corrosion process were evaluated in acidic medium at a temperature of 303K and 333K. The activation energies (Ea) for the corrosion mechanism were evaluated on the Arrhenius equation when the inhibitor was not present.

$$\log \frac{k_2}{k_1} = \frac{Ea}{2.303R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$$

The mode of surface coverage with temperature was helpful in finding the values of the heats of adsorption (Q_{ads}) from the following equation.

$$Q_{ads} = 2.303R[\log(\theta_2/1-\theta_2) - \log(\theta_1/1-\theta_1)]T_1T_2/T_2-T_1$$

where, K_1 and K_2 are the rate of corrosion temperatures T_1 and T_2 respectively, while θ_1 and θ_2 are the degrees of surface coverage at temperature T_1 and T_2 and R is the molar gas constant. The values of heat of adsorption were calculated for HCl and NaOH at both the temperature range and at different inhibitor concentration. The values revealed that at higher temperature and high inhibitor concentration the heat of adsorption required was more as compared to a lower temperature and inhibitor concentration.

CONCLUSIONS

The findings of this study indicate that Prosopis cineraria extract from blades was found to be an important inhibitor of aluminum corrosion in acidic media. Extract was more successful at the acidic average temperature of 303K. The gravimetric measurements also showed that the performance of the inhibition at a concentration of 50% of the extract for HCl amounted to 86,67%. With improved extract concentration, inhibition efficacy increased to an acceptable concentration of the inhibitor. The physical adsorption process of Prosopis cineraria leaves on the aluminum surface in HCl has the following pattern of solution temperature extract adsorption. The corrosion inhibition energy activation (Ea) was measured. The values showed that activation energy rises as temperature and inhibitor concentration are raised.

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