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GREEN APPROACH TO CORROSION INHIBITION OF MILD STEEL IN 1 M HCl SOLUTION BY AQUEOUS EXTRACT OF *LANTANA CAMARA L.* LEAVES

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ABSTRACT

Corrosion inhibition of mild steel (MS) by aqueous extract of *Lantana camara* L. leaves (AELCL) has been studied by gravimetric method at different temperatures. The results revealed that inhibition efficiency increases with increase in inhibitor concentration and decreases with increase in temperature within the studied range of concentrations and temperatures. Adsorption of extract at mild steel surface follows Langmuir adsorption isotherm. Maximum inhibition efficiency of 90% was observed with 6% (v/v) concentration of inhibitor at 30°C.

Key words: Corrosion, Mild steel, *Lantana camara*, Gravimetric method, Langmuir adsorption isotherm.

INTRODUCTION

Metals and their alloys may come in contact of different acids in regular practices in industries[1]. Acids have corrosive behavior in their aqueous solutions. Various organic compounds have been studied as corrosion inhibitors for iron[2-4]. These organic compounds have N, O, S atoms[5,6], and they have remarkable inhibition properties due to the presence of these atoms. But these compounds are highly toxic to living beings and expensive too.

This leads to development of ecofriendly, non-toxic and green corrosion inhibitors. Number of plants were studied for their corrosion inhibition properties such as *Fenugreek*[7], *Zea mays*[8], *Carica papaya*[9], *Clerodendrum phlomidis*[9], *Lawsonia inermis*[10], *Acasia Senegal*[11], *Saliva judica*[12], *Centella asiatica*[13], *Allivum sativum*[14], *Tephorosia purpuria*[14], *Eupatorum*

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odoratus[15], *Aquilaria crassna*[16], *Garcinia indica*[17] etc. in different aggressive media for different metals.

The present work aims to study the corrosion inhibition potential of aqueous extract of *Lantana camara L.* leaves (AELCL) on mild steel in 1M HCl solution at different temperatures.

EXPERIMENTAL

Cylindrical mild steel specimens of 0.8 cm diameter and 5 cm length were taken. These were abraded with series of emery papers and then degreased in acetone, washed with double distilled water, dried with hot air and their constant weight was recorded by electronic balance.

For stock solution, 20 g of dried and grounded leaves of *Lantana camara* were heated between 60-70^{o}C in sufficient amount of de-ionised water for one hour using air condenser. This extract was left overnight and then filtered and made up to 500 mL with de-ionised water. Weight loss of mild steel specimens were measured in absence and presence of various concentrations range of AELCL for one hour. After immersion time is over, specimens were taken out, washed, air dried and again weighted accurately by electronic balance. The experiments were carried out at different temperatures.

RESULTS AND DISCUSSION

Effect of temperature on corrosion rates

Corrosion rates (CR) were calculated at different temperatures and at different inhibitor concentrations from the following equation:

$$CR\ (g/cm^2/min) = (W_1 - W_2)/At \qquad \ldots(1)$$

Where W_1 is weight loss of MS specimen without inhibitor and W_2 is weight loss of MS specimen with inhibitor. A is area of MS specimen and t is immersion time.

Calculation of kinetic parameters

Kinetic parameters K (rate constant) and B (reaction constant) were calculated by following equation:

$$\log CR = \log K + B \log C_{inh} \qquad \ldots(2)$$

Where K is rate constant and equals to CR when inhibitor concentration is unity. B is reaction constant, which is a measure of inhibitor effectiveness and C_{inh} is the % concentration (v/v) (mL/100 mL) of AELCL.

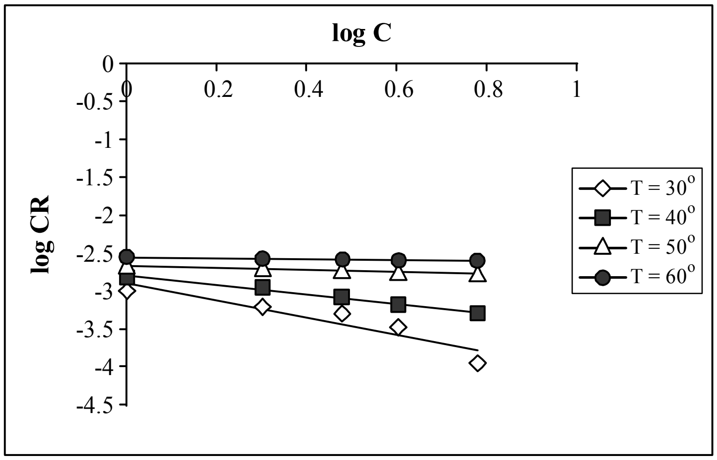

Fig. 1: Variation of log CR with log C_{inh} for mild steel in 1 M HCl with different concentrations of AELCL at different temperatures

Table 1: Kinetic parameters for the corrosion of mild steel in 1 M HCl containing AELCL at different temperatures

Temperature (°C)	Kinetic parameters (B)	k x 10^{-3} (g.cm^2/min)
30	– 1.12	1.247
40	– 0.627	1.603
50	– 0.132	2.208
60	0.059	2.754

Effect of temperature on % inhibition efficiency (% IE)

Inhibition efficiency can be calculated by following equation:

$$\% \text{ IE} = [(CR - CR_{inh})/CR] \times 100 \quad \ldots(3)$$

Where CR and CR_{inh} are the corrosion rates in absence and presence of inhibitor at a particular concentration.

Table 2: Values of corrosion rates and inhibition efficiencies in absence and presence of different concentrations of AELCL at different temperatures obtained from mass loss method

Conc. v/v%	CR x 10^{-3} (g/cm^2/min)				IE (%)			
	30°	40°	50°	60°	30°	40°	50°	60°
0.0	1.00	1.50	2.16	2.70	-	-	-	-
2.0	0.61	1.10	2.00	2.60	40	26	07.4	03.7
3.0	0.50	0.83	1.90	2.57	50	44	16.6	04.8
4.0	0.33	0.66	1.80	2.54	70	56	16.6	05.9
6.0	0.11	0.50	1.70	2.40	90	66	21.2	11

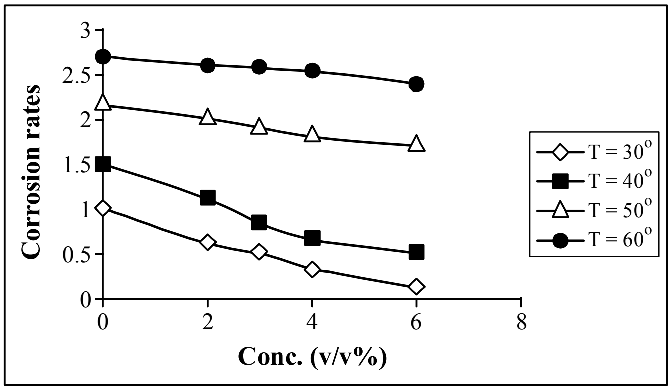

Fig. 2: Variation of CR with different concentration of AELCL at different temperatures

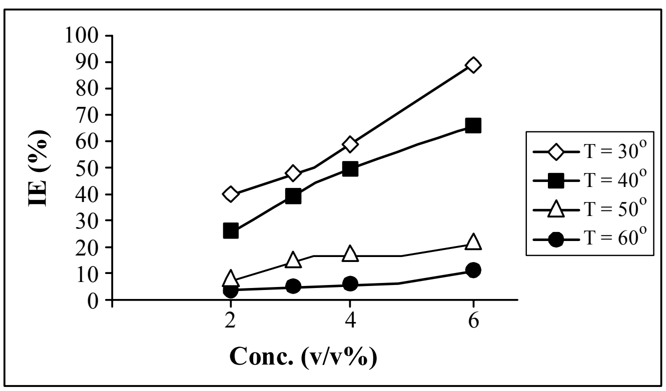

Fig. 3: Variation in % I E with different concentrations of AELCL at different temperatures

Adsorption isotherm

A straight line was obtained between log (θ/1-θ) versus log C in Langmuir adsorption isotherm at different experimental temperatures (Fig. 4). It can be concluded that in inhibition process, adsorption of AELCL occurs on mild steel surface.

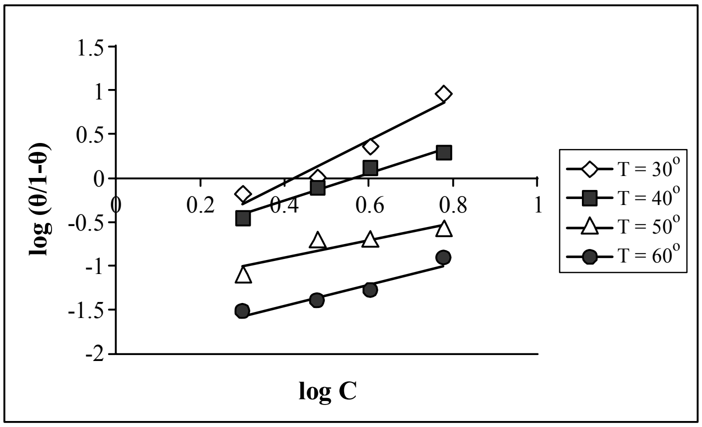

Fig. 4: **Langmuir adsorption isotherm obtained for mild steel surfaces with different AELCL concentrations at different temperatures**

CONCLUSION

(i) The results obtained with *Lantana camara L.* extract has shown good corrosion inhibition properties for mild steel in 1 M HCl solution at experimental conditions.

(ii) The inhibition efficiency is maximum (90%) at 6% (v/v) and at 30°C among studied ranges of concentrations and temperatures. It decreased with increase in temperature.

(iii) Corrosion rate of mild steel in 1 M HCl increased with increase in temperature. This shows the degradation of adsorption layer of AELCL extract at high temperatures.

(iv) The adsorption obeys Langmuir adsorption isotherm as it gave straight line in graph between log (θ/1-θ) versus log C.

Thus, it is concluded that aqueous extract of *Lantana camara* leaves may be used as a good, eco-friendly, economic and green corrosion inhibitor for mild steel in 1 M HCl solution.

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