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Anticorrosion Behaviour of *Zenthoxylum alatum* Extract in Acidic Media

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The commercial non-ionic surfactant plant used as a medicine, namely *Zenthoxylum alatum* were tested as inhibitors for the corrosion of copper and aluminium in 0.1 M solution of HCl. Weight loss measurement and potentiometry polarization technique were used in this study. It was found that this compound acts as a good inhibitor for the acid corrosion of copper and aluminium. the inhibition efficiencies obtained by the two technique were almost the same, and increased with the increasing the concentration of inhibitors. The polarization technique shows that the compound acts as an inhibitor. The inhibition action of the surfactant is interpreted in view of the adsorption on the metal surface making a barrier to mass and charge transfer. It was found that the adsorption of the compound follows Langmuir adsorption isotherm. The values of free energy of adsorption for them were calculated. It was found that the adsorption process is spontaneous and increases, for the different surfactant, in the same direction as inhibition efficiency.

Key Words: Copper and aluminium, Anticorrosion, *Zenthoxylum alatum* extract.

INTRODUCTION

Copper and aluminium are the most important metals and used in large number of applications. Pure copper and aluminium are corrosive elements so it most to protect it from the corrosion. Many researchers published[1-4] about the usage of inhibitors for the copper and aluminium corrosion in acidic solutions. Most of the tested inhibitors are organic compounds containing sulfur or nitrogen atoms. It was found that the such kind of compounds chemically adsorbed on the surface of copper and aluminium and formed a barrier for the mass and charge transfer and consequently decreasing the rate of corrosion. Unfortunately, most of them are harmful for the human being and environment.

EXPERIMENTAL

The sheets of pure copper and aluminium with dimensions of 1 cm × 2 cm were used in weight loss experiments. For the potentiostatic polarization technique, a cylindrical rods are used. Before each experiment, the electrode was polished top a mirror finish with different grades of emery papers, degreased with acetone and finally rinsed with distilled water. BDH and AR grade HCl was used for the preparation of the test solutions.

Weight loss measurement were carried out by the same method as described elsewhere. Each of the copper and aluminium sheet was immersed for the 2 h, in 50 mL of 0.1 M HCl solution containing different concentration of *Zenthoxylum alatum* at 30-40 ºC. A electrode cell with saturated calomel reference electrode and Pt electrode was used in polarization experiments. The inhibitor, *Zenthoxylum alatum* showed high activity for the surfactant properties and naturally available at relatively low price.

RESULTS AND DISCUSSION

Weight loss method: The losses of weight of copper and aluminium sheet due to there immersion in 0.1 M solution of HCl containing different concentrations of *Zenthoxylum alatum* were measured. It was found that the addition of the used *Zenthoxylum alatum* lowers the weight loss of the sheets in the acidic medium. This result indicated that *Zenthoxylum alatum* acts as inhibitor for the metallic surface and behave as a anticorrosion surfactant in acidic medium. The inhibitive action of *Zenthoxylum alatum* could be attributed to the adsorption on the metallic surface, forming a barrier between the metal surface and corrosive environment. The surface activity of the plant extract *Zenthoxylum alatum* only due to the nitrogen and carbonyl group, in their structures facilitates the surface adsorption. The surfactant molecule adsorbed on the metallic surface *via* their functional groups, while their hydrophobic nature, they repelled the aqueous solution. The inhibition efficiencies of different concentration of the *Zenthoxylum alatum* extract are given in Table-1. The inhibition efficiency was calculated using following equation:

$$\text{Inhibition efficiency (IE) \%} = \frac{W_f - W_i}{W_f} \times 100$$

where W_f, W_i are weight loss of copper and aluminium sheets in free and inhibited media, respectively.

TABLE-1
DEPENDENCE OF IE OF EXTRACT COMPOUNDS ON THEIR CONCENTRATION AS REVEALED FROM WEIGHT LOSS MEASUREMENTS

Concentration (ppm)	IE (%)
50	49.53
100	68.12
200	78.60
400	82.90
600	92.46
800	98.28

Table-1 revealed that the inhibition efficiency increases as the inhibitor concentration increased. The behaviour could be attributed to the increases of the metal surface area covered by the adsorbed inhibitor molecules with the inhibitor concentration.

Potentiostatic polarization: Fig. 1 represented the anodic and cathodic polarization of copper and aluminium in 0.1 M HCl solution containing different concentration of *Zenthoxylum alatum* extract. Fig. 1 revealed that both the anodic and cathodic polarization curves are shifted to less current density values in the presence of the extract. This behaviour suggested the inhibitive action of the *Zenthoxylum alatum* extract. The extent of the shift in current density increases in with increasing concentration of *Zenthoxylum alatum* extract.

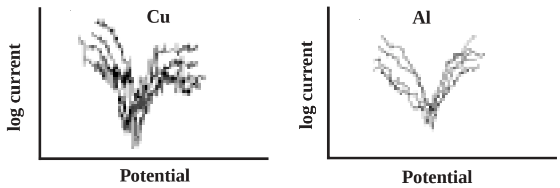


Fig. 1. Polarization curves of copper and aluminium the in 0.1 M solution containing different concentration of extract

The values of corrosion current density, corrosion and potential, anodic Tafel constant, excluded from polarization curves are given in Table-2. The corrosion potential of copper and aluminium in the acidic solution is largely shifted to less negative values upon addition of the extract[3-5]. The magnitude of this shift increases with the increasing of associated number of moles of extract.

TABLE-2
ELECTROCHEMICAL PARAMETERS OF Cu AND Al CORROSION IN FREE AND INHIBITION BY 0.1 HCl

Inhibitor concentration	E-Corrosion	I-Corrosion	βa	βc	IE (%)	θ
50	-280	11.4600	285	638	45.5	0.45
100	-76	6.1248	177	420	62.5	0.62
200	-65	4.2680	175	405	79.0	0.79
600	-54	1.1150	158	385	90.3	0.89
800	-35	1.1120	149	379	95.8	0.95

On the other hand, the corrosion current density is greatly reduced upon addition of extract. These results suggest that the inhibitive effects of *Zenthoxylum alatum* extract. Table-2 revealed that the values of inhibition efficiency obtained by polarization method are comparable to those obtained by the weight loss measurements.

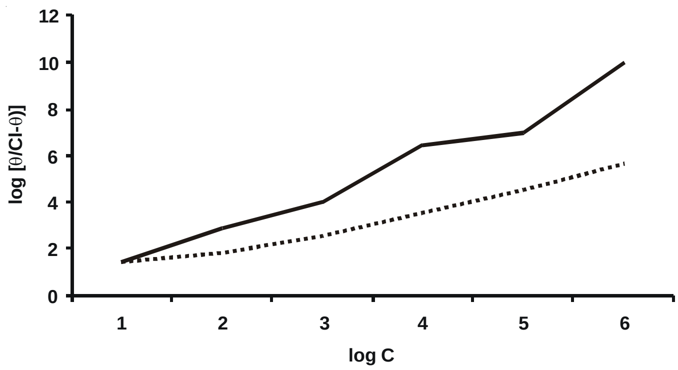
It is interested to note in this sequence is the same like that obtained by weight loss method. From Table-2, addition of *Zenthoxylum alatum* extract into the solution resulted in the decreasing value of both the anodic and cathodic Tafel constant[6,7]. This means that the surfacent molecules adsorbed on both the cathode and anode sites. The metal surface area occupied by adsorbed molecules show that the higher efficiency of inhibition is a parameter action of the metal surface which represent the fraction of the metal surface covered by adsorbed molecules is calculated using the following equation:

$$\theta = I_f - I_i / I_f$$

where I_f and I_i are the corrosion current in free and inhibited acidic solutions, respectively.

$$\log [\theta/(1-\theta)] = \log C + \log k$$
$$\log k = -1.74 - [\Delta G/2.303 RT]$$

Plotting of log [θ/(1-θ)] *vs.* log C gives a straight lines with the slope close to unity for the compounds, which suggested that the adsorption of the *Zenthoxylum alatum* extract on the surface of copper and aluminium follows Langmuir isotherm.



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