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A Green Approach for Corrosion Prevention

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Abstract

Corrosion is defined as the involuntary destruction of substances such as metals and mineral building material by surrounding media, which are usually liquid (i.e. corrosive agents). In our present study we focus on the mitigation of metallic corrosion (mild steel and aluminium) in acidic media with the help of inhibitors obtained by plants. The plant Cordia dichotoma has been selected for this purpose. The study on corrosion inhibition efficiency of extracts of this plant shows that for both the mild steel and aluminium these extracts are very potent inhibitors in acidic media. These show maximum inhibition efficiency up to 94.76 for mild steel and 87.12 for aluminium. The Langmuir adsorption isotherms reveal the adsorption of these inhibitors on to the metal surfaces. The thermodynamic parameters also show that the presence of the inhibitor effectively increases the activation energy of corrosion.

1. Introduction

Mild steel and aluminium are commonly used metals usually these are selected for many mechanical and engineering purposes due to their properties such as strength, ease of fabrication, and cost. But the main disadvantage with their use is that these undergo rapid corrosion in acidic medium. Concentrated mineral acids are used extensively in pickling, cleaning and oil well acidizing of metallic material cause corrosion.[1,2] It has been speculated that organic compounds containing nitrogen and oxygen are good inhibitors for mild steel in acid medium.[3] Our present focus is on the naturally occuring green inhibitors, which are ecofriendly, less expensive, and having no side effects. Numerous naturally occurring products such as *Prosopis juliflora*,[4] *Eugenia jambolans*,[5] *Lawsonia*,[6] *Opuntia*,[7] *Swertia aungustifolia*,[8] *Ficus religeosa*,[9] *Heena*,[10] and *Datura stromonium*[11] plant extracts have been evaluated as potential

corrosion inhibitors. We report here our present study on the inhibitive action of alcoholic extracts of stem, leaves and fruits of *Cordia dichotoma* on the corrosion of mild steel and aluminium in presence of acidic media. Probably the alkaloid Allantoin (Fig. 1) and Flavanoids - Taxifolin (Fig. 2) present in *Cordia dichotoma* are effective for corrosion inhibition activity in acidic media for mild steel and aluminium.

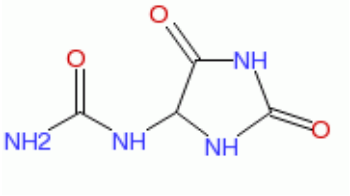

Fig. 1: Allantoin

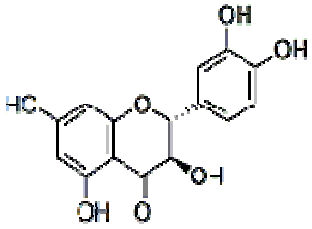

Fig. 2: Taxifolin

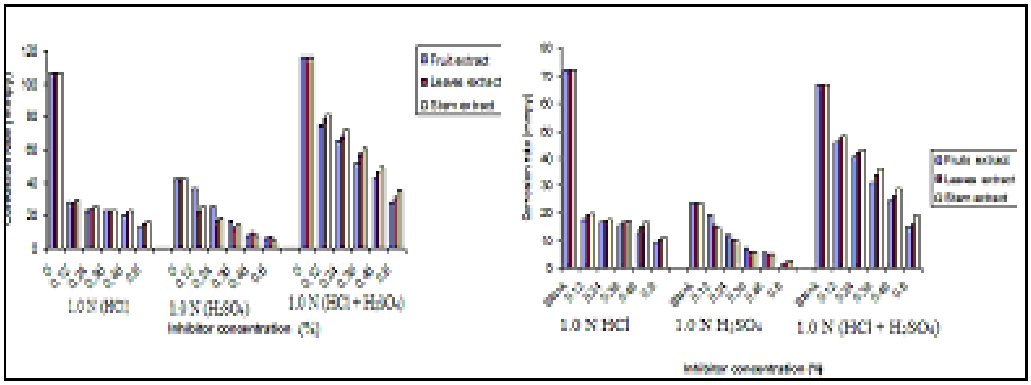

Figure 2: Effect of inhibitor concentration on corrosion rate of mild steel and Al in different acid media respectively.

2. Experimental

To observe the influence of various parameters like inhibitor concentration, acid concentration and time, the corrosion inhibition efficiency (η *%)* of the compounds have been calculated by mass loss method using following equation.[12]

$$\eta\ \% = (\Delta\ Mu - \Delta\ Mi\ )\ /\ \Delta\ Mu \times 100$$

Where Δ Mu is mass loss without inhibitor and Δ Mi is mass loss with inhibitor. The corrosion rate in millimeter penetration per year (mmpy) can be obtained by following equation.[13] Corrosion rate (mmpy) = (Δ M × 87.6) / area × time × metal density

3. Result and Discussion

The inhibition efficacy calculated from the mass loss and thermometric methods for different concentration of HCl, H_2SO_4 and acid mixture solutions are shown in table 1-4. The results showed that the inhibition efficacy increases with the increase in inhibitor concentration for all the three acids. The results show that the fruit extract shows the maximum inhibition efficiency (up to 95.13 %) for mild steel and (up to

97.67 %) for aluminium. It is also concluded from the results that fruit extract is more potent corrosion inhibitor than the leaves and stem extracts.

Table 1: Comparative Mass loss data for mild steel and Al in different acid media with alcoholic extracts of plant *Cordia dichotoma at* 299 ± 0.1 K.

Inhibi. Conc. (%)	**Mild Steel**				**Aluminium**			
	1.0 N HCl		1.0 N H2SO4		1.0 N HCl		1.0 N H2SO4	
	(m)	(η) (%)	(m)	(η) (%)	(m)	(η) (%)	(m)	(η) (%)
BLANK	554		650		132		43	
Fruits extract					Fruits extract			
0.12	46	91.70	551	15.23	0.12	32	75.76	35
0.60	27	95.13	247	62.00	0.60	17	87.12	01
Leaves extract					Leaves extract			
0.12	69	87.54	458	29.54	0.12	35	73.48	28
0.60	29	94.77	184	71.69	0.60	19	85.61	03
Stem extract					Stem extract			
0.12	384	30.68	571	12.15	0.12	36	72.73	26
0.60	71	87.18	221	66.00	0.60	21	84.09	04

The efficiencies of inhibitors can be quantitatively related to the amount of adsorbed inhibitors on the metal surface. It is assumed that the corrosion reactions are prevented from occurring over the active sites of the metal surface covered by adsorbed inhibitor, whereas the corrosion reactions occurs normally on the inhibitors free area. The inhibition efficiency is then directly proportional to the fraction of surface covered with adsorbed inhibitor. This assumption has been applied to deduce the effect of concentration on adsorption of inhibitors.

Generally the adsorption of organic molecules on metallic surface involves O, N and S atoms. In the case of plant extracts of *Cordia dichotoma*, the N and O of the alkaloids may be responsible for adsorption. This process may block the active sits on metal surface, hence decreasing the rate of corrosion.

4. Conclusion

The results revealed that these extracts effectively reduce the corrosion rate of mild steel and aluminium in acid solutions, by showing inhibition efficiency upto 97.67% and can be safely used without hydrogen damage, toxic effects and pollution.

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