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Study of Plant Cannabis Extract as Green Corrosion Inhibitor for Mild Steel in Acid Media

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Abstract: *The corrosion inhibition of mild steel using extracts of Cannabis in different acid media was investigated by mass loss and thermometric methods. The experiments were carried out at 299±0.2 K in presence of different concentrations of dry fruit, leaves and stem extracts. The results reveal that the alcoholic extracts of Cannabis is a better corrosion inhibitor than that of toxic chemicals. The fruit extract is more potent than leaves and stem extracts to inhibit the corrosion rate.*

Keywords: Cannabis, Mild steel, Mass loss method, Thermometric method, Green corrosion inhibitor

I. INTRODUCTION

Mild steel, the most commonly used metal; usually it is selected for many mechanical and engineering purposes due to its properties such as strength, ease of fabrication and cost. But the main disadvantage with its use is that it undergoes rapid corrosion in acidic medium. Concentrated mineral acids are used extensively in pickling, cleaning and oil well acidising of metallic material cause corrosion1,2,. It has been speculated that organic compounds containing nitrogen and oxygen are good inhibitors for mild steel in acid medium3. There are many substances available for this purpose but 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 juliflora4, Eugenia jambolans5, Lawsonia6, opuntia7, Swertia aungustifolia8, Ficus religeosa9, heena10, Datura stromonium11 and calotropis plant extracts12 have been evaluated as potential corrosion inhibitors. The present study is based on inhibitive action of alcoholic extracts of stem, leaves and fruits of Cannabis on the corrosion of mild steel in presence of acidic media.

Material and Method :According to ASTM as reported already13 rectangular specimens of mild steel of dimensions2.55 x 1.50 x 0.02 cm with a small hole of about 2 mm diameter near the upper edge were employed for the determination of mass loss measurements. Specimens were cleaned by buffing to produce mirror finish with the help of emery paper and were then degreased with acetone. Each specimen was suspended by a glass hook and immersed in a beaker containing 50 mL of test solution and left expose to air. Duplicate experiments were performed in each case and mean value of mass losses were calculated.

The hydrochloric and sulfuric acid solutions of 0.5 N were prepared using doubly distilled water. The extracts of different parts of *Cannabis* were obtained by refluxing respective part in a soxhlet in ethanol.

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[14].

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

Where ΔMu is mass loss without inhibitor and ΔMi is mass loss with inhibitor. The degree of surface coverage (θ) can be calculated as:

$$(\theta) = (\Delta Mu - \Delta Mi) / \Delta Mu$$

The corrosion rate in millimeter penetration per year (mmpy) can be obtained byfollowing equation[15].

Corrosion rate (mmpy) = (ΔM×87.6) / area × time × metal density. Where ΔM mass loss expressed in mg, area expressed in square cms of metal surface exposed, time expressed in hours of exposure and metal density expressed in g / cm^3.

II. THERMOMETRIC CALCULATION

Inhibition efficiencies were also determined by thermometric method[16]. In this method, the variation of temperature is followed as a function of time. The specimens of size 2.54x1.52x.02 cm were immersed in 50 mL of acid solution. The tests were carried out in different concentrations of HCl solutions. The inhibition studies were carried out in the concentrations 0.12%, 0.24%, 0.36% 0.48% and 0.60% of the extract of *Cannabis* and observations were carried out in an insulated chamber. The results were used to calculate reaction number (RN) and inhibition efficiency (*η%)*. Reaction number can be calculated by the following equation-

$$RN = (T_m - T_i) / t$$

Where T_m and T_i are initial and maximum temperatures respectively and 't' is the time inminutes to attain Tm during the observations. The inhibition efficiency can be calculated as:

$$\eta\ \% = (RN_{free} - RN_i) / RN_{free} \times 100$$

where, RN_{free} and RNi are reaction numbers in blank and inhibited system respectively.

III. RESULTS AND DISCUSSIONS

The inhibition efficacy calculated from the mass loss and thermometric methods for differentconcentration of HCl, H_2SO_4 and acid mixture solutions are shown in Table 1. The results showed that the inhibition efficacy increases with the increase in inhibitor concentration for all the three acids. The results revealed that all the three extracts show maximum inhibition efficiency at their highest concentration *i.e.* 0.60%. The stem extract of 0.60% concentration shows maximum IE 93.48% in 0.1 N sulphuric acid.

The inhibition efficacy calculated from the mass loss method for different acids like HCl, H_2SO_4 and mixture of acids. The results showed that the different extracts of *Cannabis* shows higher inhibition efficacy in presence of H_2SO_4 solutions as compared to the hydrochloric acid and mixture of acids. The maximum inhibition efficiency is 93.48% in 0.1 N H_2SO_4 solution for 0.60% concentration of inhibitor (stem extract).

Table 1. Mass loss and inhibition efficiency for mild steel in different acid solution with alcoholic extracts of plant *Cannabis* at 299±0.2 K (Area of exposure - 7.75 cm^2 Time of exposure - 20 h)

S. No.	Inhibitor concentration, %	0.1 N HCl		0.1 N H_2SO_4		0.1N (HCl + H_2SO_4)	
	Fruit extract	M	η, %	M	η, %	M	η, %
1	Blank	0.068		0.435		0.411	
2	0.12	0.013	43.10	0.065	85.39	0.091	79.38
3	0.24	0.030	48.28	0.058	86.97	0.082	80.52
4	0.36	0.024	58.62	0.050	88.76	0.062	85.27
5	0.48	0.022	62.07	0.041	90.79	0.047	88.84
6	0.60	0.014	75.86	0.032	92.81	0.032	92.39
		Leaves	extract				
1	Blank	0.068		0.435		0.411	
2	0.12	0.034	41.37	0.078	82.48	0.095	78.43
3	0.24	0.031	46.55	0.070	84.27	0.088	79.10
4	0.36	0.028	51.72	0.066	85.17	0.064	84.79
5	0.48	0.027	53.45	0.053	88.09	0.049	88.36
6	0.60	0.019	67.24	0.030	93.25	0.037	91.21
Stem extract							
1	Blank	0.068		0.435		0.411	
2	0.12	0.057	1.72	0.041	90.79	0.101	74.01
3	0.24	0.055	5.17	0.034	92.36	0.097	76.96
4	0.36	0.051	12.06	0.033	92.58	0.075	82.18
5	0.48	0.042	27.59	0.030	93.26	0.053	87.41
6	0.60	0.031	46.55	0.029	93.48	0.042	89.39

The efficiencies of inhibitors expressed as the relative reduction in corrosion rate 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.. This process may block the active sits on metal surface, hence decreasing the rate of corrosion. Due to the higher electron density the N atom of the alkaloid acts as the reaction centre, resulting in the formation of a monolayer on the metal surface. Organic inhibitors with active portions generally contain large hydrocarbon chains or rings with positively charged amine N group at the one end. In acids and water the terminal primary, secondary and tertiary amines groups take additional hydrogen that gives them a net cationic charge. The polar amine group is adsorbed on the metal and hydrocarbon portion forms an oily water repellent surface film. The molecular dissymmetry helps these materials to act as surfactants and can stabilize emulsions of oil and water. The Organic corrosion inhibitor may function by the following factors:

- Chemisorption on the metallic surface.
- Neutralizing the corrodent
- Adsorbing the corrodent

They offer large coverage due to the long hydrocarbon chain and by the presence of - NH groups. Being hydrophilic in nature, the -NH group counteracted the effects of chain length and ensured higher solubility. It has been observed that the fruit extract of Cannabis has maximum inhibition efficiency as compared to leaves and stem extracts. This may be attributed to the presence of alkaloids. In the fruit extract the electron repelling hydroxyl group on the alkaloid is present; as a result the electron density at the N atom becomes more than the any other additives. This process increased the adsorptivity of the fruit extract on the corroding site of the metal. This explains the higher inhibition efficacy displayed by the fruit extract for 0.6% concentration.

IV. CONCLUSION

In the present work, mass loss and thermometric methods were used to study the ability of extracts of Cannabis to inhibit the corrosion of mild steel in acidic conditions. The principle conclusions are:

- The inhibition efficiency increases with the increase in the inhibitor concentration.
- The corrosion rate increases and the inhibition efficiency decreases with the increase in acid concentration.
- It is anticipated that the proposed investigation on green corrosion inhibitor may be useful for preventing losses caused due to corrosion without causing any harm to the environment.

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