Effect of Imipramine drug on the corrosion of steel hydrochloric acid medium.

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Abstract : The corrosion behaviour of steel in the presence of Imipramine drug in 1M and 2M HCl at 25 ^{0}C and 35 ^{0}C investigated. The corrosion studies were followed by different concentration of the solution by weight loss and potantodynamic polarisation methods. The percentage protection efficiency Was also studied, polarisation curves for different concentration(ppm) were plotted the percentage of protection efficiency was also studied. The percentage protection efficiency was higher at 25 ^{o}C. The Imipramine inhibitor showed 96.20% inhibition at 300ppm.

Key words: Polarisation, protection efficiency, corrosion.

I. INTRODUCTION

Carbon steel is an industrially important material. It gets corroded up on exposure to industrial environments. Among many metals the steel has got numerous industrial applications and hence its surface undergo deterioration. Most of the well known acid inhibitors are chemical compounds containing nitrogen, sulphur, and oxygen with aromatic and heterocyclic rings. (1-5)

The inhibitors are added to the environment, where the metal surface is exposed and the inhibitor modifies the environment around the metal (6). The inhibitors are employed to control the dissolution of steel by acid in acidizing of oil wells, cleaning of boilers and heat exchangers etc. The inhibitors are generally organic compounds with electron donor elements (7).

The majority of acid inhibitors are organic compounds having unsaturated bonds (8). The compounds with unsaturated bonds and functional groups like – -NH,- N=N-, -CHO, R-OH and R=R impart extraordinary property of adsorption over active areas on the metal surface by replacing water molecule at the interface to protect the metal from corrosion and provides sort of barriers between metal and surrounding. This barrier protects the metal from corrosion. (9-12).

Imipramine sold as Tofranil and also known as melipramine, is a tricyclic antidepressant (TCA) of the dibenzazepine group. Imipramine is mainly used in the treatment of major depression and enuresis(inability to control urination).It has also been evaluated for use in panic disorder(13). It is similar in efficacy to the antidepressant drug moclobemide(14).

The literature survey reveals that there are no reports on the inhibition property of the Imiprimaine on mild steel in HCl medium.The effect of Imipramine on mild steel corrosion in HCl at different temperature have been investigated. The present work deals with the use of Imipramine as corrosion inhibitors for steel in hydrochloric acid medium.

II. MATERIALS AND METHODS

Surface preparation of mild steel.

Mild steel samples containing the composition C = 0.14, Mn = 0.25, Si = 0.03, P = 0.10, S = 0.02, Ni = 0.01, Cu = 0.01 and Cr = 0.01 and size 1 X 5 X 0.1 cm were used. The specimens were mechanically polished with emery papers of various grit size, rinsed with distilled water, degreased with trichloroethylene, washed with doubly distilled water, rinsed in alcohol and dried. The specimens were weighed before placing them in test solution. After a known time, the samples were removed, washed in a current of water, rinsed with alcohol and the weight was measured.

All reagents that were used for the study were of analytical grades and double distilled water.

Organic Compound: Imipramine is an organo-nitrogen compound. The molecular formula of Imipramine is $C_{19}H_{24}N_2$.

Imipramine was purchased from Sigma- Aldrich and used as the inhibitor alone. The molecular structure of Imipramine compound is:

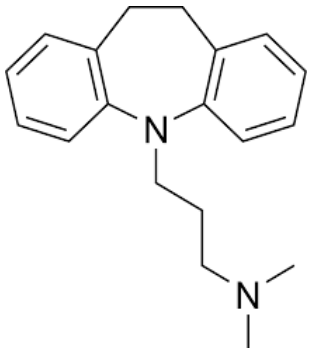


Figure 1: molecular structure of imipramine

Electrochemical polarisation experiments were performed by using model EA-201 Electroanalyser (EA-201 Chemilink system). The potentials reported were measured against the saturated calomel electrode. To obtain the Tafel plots, polarization curves were performed by polarizing to ±1000 mV with respect to free corrosion potential (E_{corr}) at a scan rate of 0.5 mV/S.

Weight loss measurements carried out by immersing the prepared steel specimens in the acid solution containing various concentration of Imipramine. These solutions were placed in a water bath. After attaining the required temperature, the weighed steel sample was immersed in the test solution. This procedure was repeated with all the samples with varying inhibitors concentrations from 100 ppm to 500 ppm and at a temperature of 30 ^{0}C.

Preparation of Imipramine and Hydrochloric acid solutions:

1M and 2 HCl solutions are prepared in distilled water and used for the weight loss measurements. Imipramine drug is soluble in water. And prepared different concentrations in ppm.

Corrosion measurement:

For weight loss methods, Corrosion Inhibition Determination through Corrosion :

The corrosion inhibition efficiency (IE) was calculated using the equation

$$IE\ \% = \frac{W_0 - W}{W_0}\ x\ 100 \qquad (1)$$

Where, W_0 is the weight loss in the absence of inhibitor in solution and W is the weight loss in the presence of inhibitor in he the solution.

For **polarization exeperiments.** In acid solutions the anodic process of corrosion is the passage of metal ions from metal surface into the solution, and the principal cathodic process is the discharge of hydrogen ions to produce hydrogen gas or reduction of oxygen. The inhibitor may affect either of them or both anodic and processes.

The surface coverage θ is calculated as,

$$\theta = \frac{[\text{icorr(uninh)} - \text{icorr(inh)}]}{\text{icorr (uninh)}} \qquad (2)$$

Therefore, percentage protection efficiency,

$$\%\ \text{PE} = \theta \times 100 \qquad (3)$$

III. RESULTS AND DISCUSSIONS

Weight loss measurements:

The corrosion behaviour of mild steel in imipramine in the absence and the presence of various concentrations in 1M and 2M HCl at 25 ^{0}C ± 1 ^{0}C was studied. The results of weight loss measurement are given in the Table 1 and 2. The percent inhibition efficiency was calculated.

Table:1 Corrosion parameters obtained from weight loss measurements in 1M HCl containing different concentrations of imipramine at 25 ^{0}C ± 1 ^{0}C.

Concentrations	Weight loss (mg)	Inhibition efficiency (%)
1M HCl	536.2	-
100 ppm	223.2	58.4
200 ppm	184.1	65.7
300 ppm	153.3	71.4
400 ppm	121.4	77.35
500ppm	70.6	86.83

Table:2: Corrosion parameters obtained from weight loss measurements in 2M HCl containing different concentrations of Imipramine at 25 ^{0}C ± 1 ^{0}C.

Concentrations	**Weight loss (mg)**	**Inhibition efficiency (%)**
1M HCl	760.6	-
100 ppm	524.2	31.0
200 ppm	410.3	46.0
300 ppm	360.4	52.6
400 ppm	306.3	59.7
500 ppm	284.6	62.6

Table 1 & 2 shows the variation of inhibition efficiency (0% IE) With the concentration of Imipramine the weight loss of the specimens was decreased with increasing the concentration of Imipramine . The maximum inhibition efficiency of 62.6% was achieved at 500 ppm in 2 M HCl).

There was a rapid fall in IE in the acid Concentration 2M to 3M the results indicate that at higher acid strengths there was decrease on the inhibition efficiency (13).

Potentiodynamic polarisation measurements :

The anodic and cathodic polarization behaviors of carbon steel in the absence and presence of Imipramine are shown in the figures. The results indicate that the mild steel in absence of inhibitor corrosion rate is shigtly less in 1M HCl, at higher temperature the drug Imipramine failed to from barrier to restrict the diffusion of iron and hence corrosion will not be prevented(14).

The figures shows anodic and cathodic potenio dynamic polarisation curve for mild steel in 1M HCl in presence of Imipramine drug at various concentrations.

From all the above observations, it shows that values of I_{corr} decreases with increasing inhibitor concentration, with increase in inhibitor concentration anodic current densities decreased(15,16). Similar change was not observed in higher temperatures. That is as the temperature increases I_{corr} value also increases. Thus the corrosion inhibition on mild steel of the Imipramine drug is less.

Table 3 Polarisation data and inhibition efficiency (IE%) if Imipramine drug for steel in IM HCl at 25 ^{0}C.

System	E_{corr} (mV)	I_{coor} (mA, cm^{-2})	IE(%)
1M HCl	-490	2.64	------
Imipramine			
100ppm	-488	0.31	87.65
200ppm	-492	0.28	89.70
300ppm	-493	0.24	94.70
400ppm	494	0.18	90.59

Table 4 Polarisation data and inhibition efficiency (IE%) if Imipramine drug for steel in 1M HCl at 35 ^{0}C.

System	Ecorr (mV)	Icoor (mA cm^{-2})	IE(%)
1M HCl	-450	36.0	------
100ppm	-388	16.0	
200ppm	-300	10.0	55.5
300ppm	-280	5.00	72.2
400ppm	-250	3.00	86.1

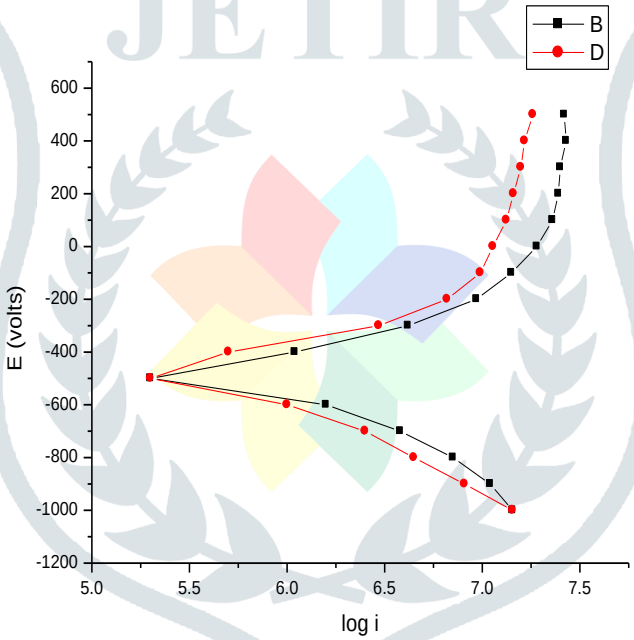
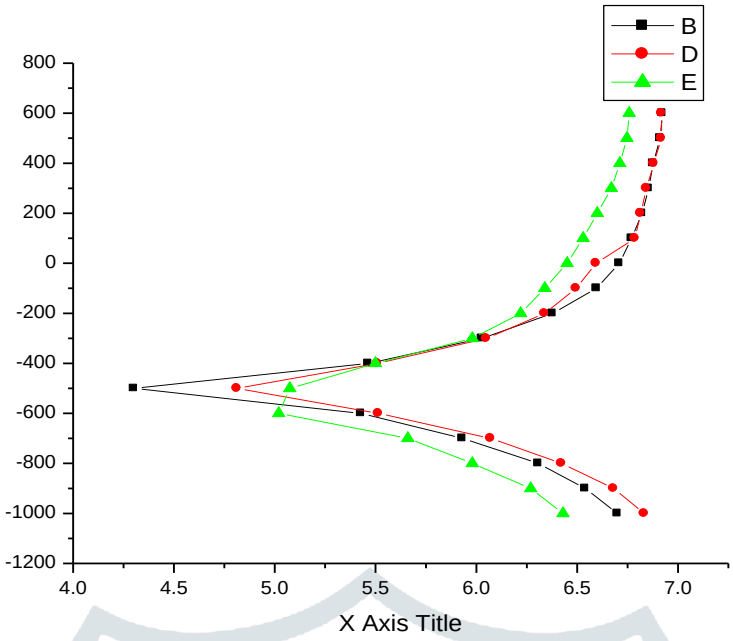


Figure 2 Potentiodynamic polarization curves of cold rolled steel in 1 M HCl of different inhibitor concentration at 25 ^{0}C.

B and D shows the polarization curves for 100ppm and 200ppm inhibitor concentration.



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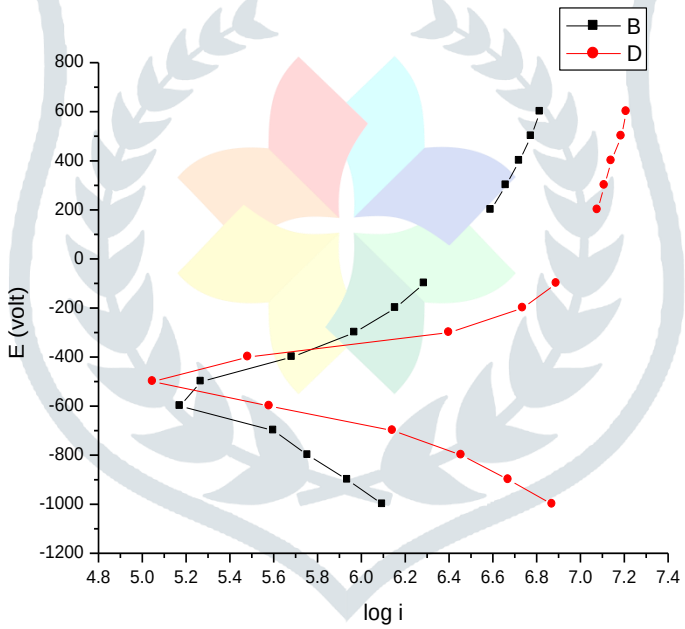

Figure 4 Potentiodynamic polarization curves of cold rolled steel in 1 M HCl of different inhibitor concentration at 35 ^{0}C.

B, D shows the polarization curve for 100ppm and 200ppm inhibitor concentration.

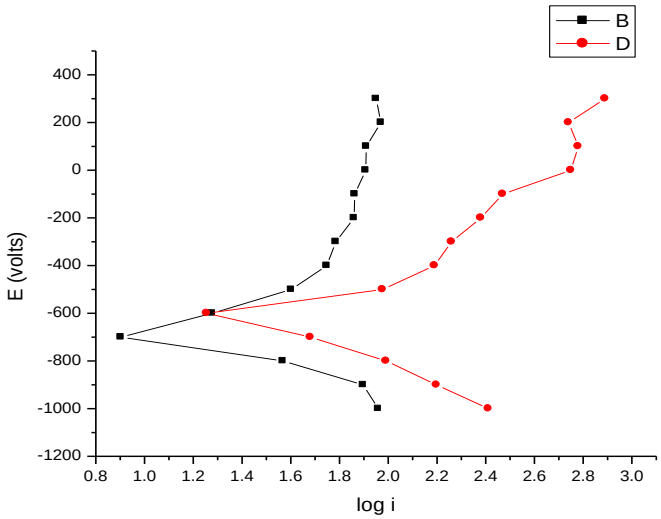

Figure 5 Potentiodynamic polarization curves of cold rolled steel in 1 M HCl of different inhibitor concentration at 35 ^{0}C

B and D shows the polarization curve for 300ppm and 400ppm inhibitor concentration.

IV. CONCLUSIONS

Imipramine drug behaves as an inhibitor for the mild steel corrosion in 1M HCl at lower temperature only. The Imipramine inhibited the corrosion of mild steel in acid medium by chemisorption and the adsorption of the compound on the metal surface at 25$^{\cdot 0}$C and 35$^{\cdot 0}$C. At 35$^{\cdot 0}$C Imipramine is not an effective inhibitor, but at higher temperature, the drug Imipramine failed to form a barrier to restrict the diffusion of ions and hence corrosion will not be prevented.

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