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INHIBITION OF CORROSION OF MILD STEEL IN ACIDIC SOLUTIONS USING N - BENZYL DIMETHYLAMINE

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The corrosion behaviour of mild steel in acidic solutions and inhibition efficiency of N-benzyldimethylamine have been evaluated by galvanostatic polarisation method. In this investigation 0.1 N to 1 N HCl and H_2SO_4 acids and 1 x 10^{-4} *M* to 5 x 10^{-3} *M* N-benzyldimethyl amine were used. It has been found that N-benzyldimethylamine is very effective inhibitor for both HCl and H_2SO_4 medium. The inhibitor efficiency 1 N HCl and H_2SO_4 acids were found to be 80% in 1 N concentrations of acids with 5 x 10^{-3} *M* concentration of inhibitor. This inhibition efficiency on mild steel is dependent on concentration of inhibitor and also the efficiency increases with the increasing concentration of acids.

Keywords: Corrosion, inhibition efficiency, galvanostatic polarisation inhibitor, N-benzyldimethylamine.

INTRODUCTION

HCl and H_2SO_4 acids are the most important pickling acids which are widely used in steel and ferrous alloy industry. These acid solutions are widely used for removal of undesirable scales and rust. Inhibitors are often used for these process mainly to control the metal dissolution and acid consumption. Kunitsa et al [1] investigated some of the by-products of aromatic diamine which was found to be good pickling inhibitor. Earlier study by Singh et al [2] also investigated amine type inhibitor for mild steel electrode in acid medium which gave good inhibition efficiency. The mechanistic study by Carkin et al [3] have shown that aliphatic long hydrocarbon chain compound gave maximum corrosion protection. The present investigation deals with the inhibitive behaviour of N- benzyldimethylamine in 0.1 N, 0.5 N and 1 N concentrations for HCl and H_2SO_4 acid medium for mild steel specimen.

EXPERIMENTAL DETAILS

Mild steel electrode having 1 cm^2 area was used in the present study. The electrode was polished well and degreased by trichloro ethylene. 0.1 N, 0.5 N and 1 N of HCl and H_2SO_4 acid solutions were used in the presence of 0.0001 *M* to 0.005 *M* concentration of N-benzyldimethylamine.

A conventional three electrode cell consisting of mild steel as working electrode of 1 cm^2 area, platinum electrode of

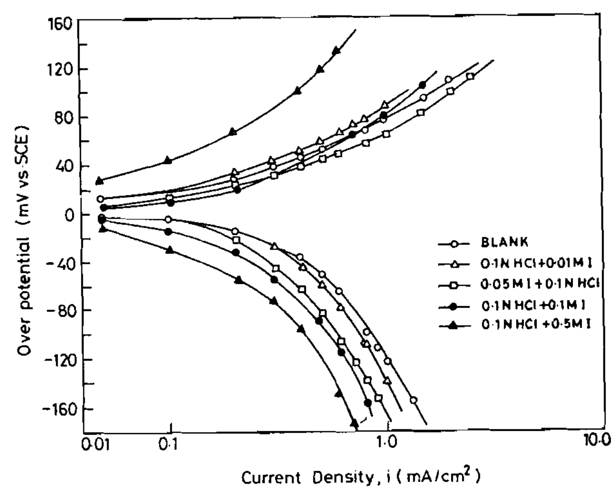

Fig. 1: Corrosion parameters for mild steel in 0.1 N HCl containing various concentrations of N-benzyldimethylamine

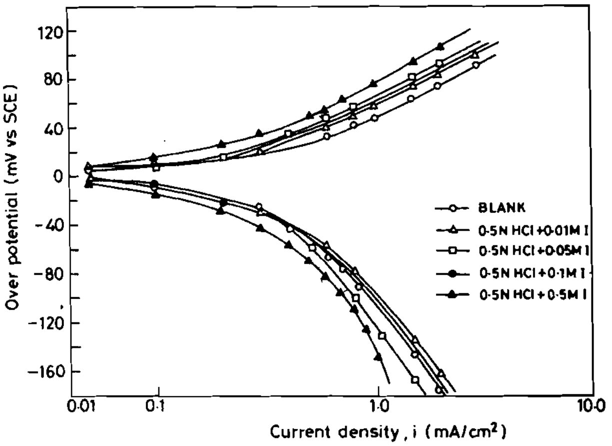

Fig. 2: Corrosion parameters for mild steel in 0.5 N HCl containing various concentrations of N-benzyldimethylamine

2 cm^2 area as counter electrode and saturated calomel were employed. The anodic and cathodic polarisation curves were recorded manually by using galvanostat (Model 173) Universal programmer (Model 175).

RESULTS AND DISCUSSION

The inhibition of corrosion of mild steel in HCl and H_2SO_4 by N-benzyldimethylamine has been studied by galvanostatic polarisation method at 303 K. The same study was carried out by Levichev et al [4] by using various types of amine inhibitors. The effect of inhibitor concentration and acid concentration on inhibitor efficiency have been found out. The adsorption characteristics of this inhibitor has also been determined.

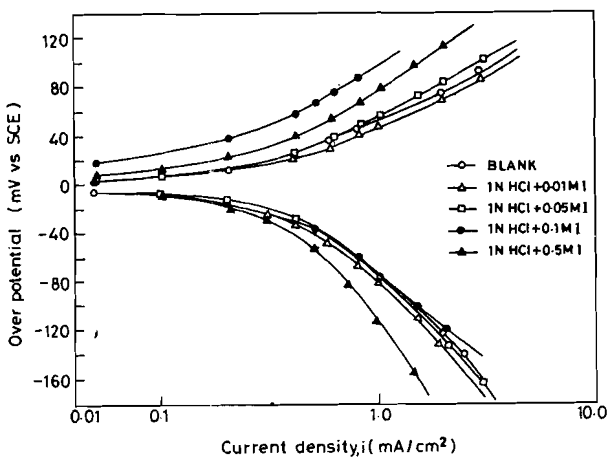

Fig. 3: Corrosion parameters for mild steel in 1.0 N HCl containing various concentrations of N-benzyldimethylamine

TABLE I: Corrosion parameters for mild steel in 0.1 N HCl containing various concentrations of N-benzyldimethylamine

Concn of inhibitor *M*	E_{corr} mV vs SCE	b_a mV/dec	b_c mV/dec	I_{corr} mA/cm^2	Inhibition efficiency %
0	-508	60	110	0.25	-----
1 x 10^{-4}	-510	60	118	0.18	28
5 x 10^{-4}	-520	64	116	0.14	44
1 x 10^{-3}	-525	60	120	0.12	52
5 x 10^{-3}	-532	55	118	0.08	67

Inhibition of corrosion of mild steel in HCl acid

The measurement of corrosion current by polarization method for mild steel in 0.1 N to 1 N HCl containing different concentrations of N-benzyldimethylamine has been made. Figs. 1 to 3 show the polarisation curves for mild steel in HCl containing various concentration of inhibitor.

TABLE II: Corrosion parameters for mild steel in 0.5 N HCl containing various concentrations of N-benzyldimethylamine

Concn of inhibitor *M*	E_{corr} mV vs SCE	b_a mV/dec	b_c mV/dec	I_{corr} mA/cm^2	Inhibition efficiency %
0	-488	60	120	0.30	-----
1 x 10^{-4}	-500	56	118	0.17	43
5 x 10^{-4}	-515	56	114	0.14	53
1 x 10^{-3}	-520	59	100	0.11	63
5 x 10^{-3}	-525	55	120	0.09	70

TABLE III: Corrosion parameters for mild steel in 1 N HCl containing various concentrations of N-benzyldimethylamine

Concn of inhibitor *M*	E_{corr} mV vs SCE	b_a mV/dec	b_c mV/dec	I_{corr} mA/cm^2	Inhibition efficiency %
0	-485	60	110	0.350	-----
1 x 10^{-4}	-495	56	120	0.170	51
5 x 10^{-4}	-510	57	118	0.130	63
1 x 10^{-3}	-516	60	120	0.090	74
5 x 10^{-3}	-522	56	115	0.054	82

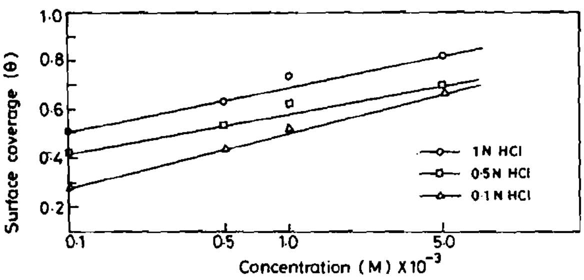

Fig. 4: Temkin adsorption of mild steel in HCl containing various concentrations of N-benzyldimethylamine

Corrosion currents have been obtained by extrapolation of the anodic and cathodic lines to the zero overvoltage. Tables I to III give the corrosion parameters for mild steel in HCl containing various concentration of inhibitor. The anodic and cathodic Tafel slopes are found to be 55-60 mV/decade and 110-120 mV/decade respectively. The inhibition efficiency is found to be increasing with the increase of N-benzyldimethylamine concentrations. Similar investigation carried out by Abdennahi et al [5] on the inhibition behaviour of benzyl group compound BDBT have

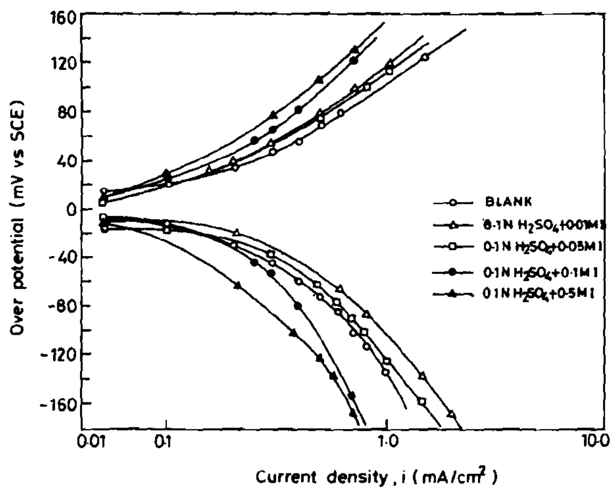

Fig. 5: Corrosion parameters for mild steel in 0.1 N H_2SO_4 containing various concentrations of N-benzyldimethylamine

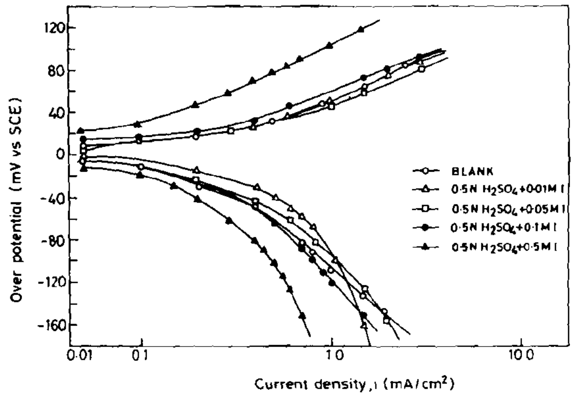

Fig. 6: Corrosion parameters for mild steel in 0.5 N H_2SO_4 containing various concentrations of N-benzyldimethylamine

given 95% inhibitor efficiency for mild steel in 1% HCl with 50 ppm of inhibitor concentration. Since the inhibitor does not affect the Tafel slopes much it can be concluded that the inhibitor inhibits through blocking of reaction sites by adsorption. Jha et al [6] studied the adsorption and subsequent formation of solid intermediate by inhibitor with halide ions such as I^-, Cl^-. The variation of θ vs log c is shown in Fig. 4. The linear relationship between θ and log c suggest that N-benzyldimethylamine obeys Temkin adsorption isotherm.

Inhibition of corrosion of mild steel in H_2SO_4

Polarisation measurements have been carried out by Iva G.Betova et al [7] in 1 *M* H_2SO_4 concentrations of acid in steel specimen for the evaluation of dimethyl amino phenyl group inhibitor. In this present study galvanostatic polarisation measurements have been carried out in different concentrations of sulphuric acid containing different concentrations of N-benzyldimethylamines (Figs. 5 to 7). Tables IV to VI give the corrosion parameters calculated from the polarisation curves with and without inhibitor. The anodic and cathodic Tafel slopes in 0.1 N, 0.5 N and 1 N H_2SO_4 are found to be 60-70 mV and 110-120 mV respectively. The corrosion current density increases with increase in acid concentration. It can also be seen that the corrosion current density decreases with increase in inhibitor concentration.

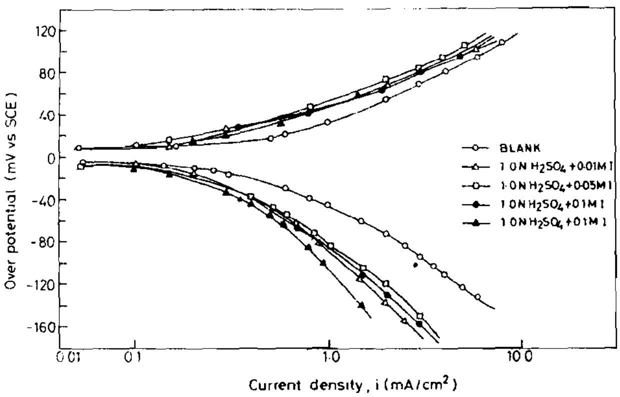

Fig. 7: Corrosion parameters for mild steel in 1 N H_2SO_4 containing various concentrations of N-benzyldimethylamine

TABLE IV: Corrosion parameters for mild steel in 0.1 N H_2SO_4 containing various concentrations of N-benzyldimethylamine

Concn of inhibitor M	E_{corr} mV vs SCE	b_a mV/dec	b_c mV/dec	I_{corr} mA/cm^2	Inhibition efficiency %
0	-530	70	120	0.150	-----
1×10^{-4}	-532	60	110	0.120	20
5×10^{-4}	-540	60	116	0.100	33
1×10^{-3}	-550	65	118	0.064	57
5×10^{-3}	-555	65	120	0.052	65

Fig. 8, shows the variation of surface coverage (θ) vs log concentration (c). The linear relationship between θ vs log c suggest that inhibitor obeys Temkin's adsorption isotherm.

TABLE V: Corrosion parameters for mild steel in 0.5 N H_2SO_4 containing various concentrations of N-benzyldimethylamine

Concn of inhibitor M	E_{corr} mV vs SCE	b_a mV/dec	b_c mV/dec	I_{corr} mA/cm^2	Inhibition efficiency %
0	-500	60	120	0.190	-----
1×10^{-4}	-518	52	118	0.120	37
5×10^{-4}	-515	57	114	0.096	49
1×10^{-3}	-518	54	120	0.070	63
5×10^{-3}	-523	52	120	0.056	71

TABLE VI: Corrosion parameters for mild steel in 1 N H_2SO_4 containing various concentrations of N-benzyldimethylamine

Concn of inhibitor M	E_{corr} mV vs SCE	b_a mV/dec	b_c mV/dec	I_{corr} mA/cm^2	Inhibition efficiency %
0	-498	65	110	0.49	-----
1×10^{-4}	-500	50	112	0.29	41
5×10^{-4}	-505	60	118	0.16	67
1×10^{-3}	-510	58	116	0.11	76
5×10^{-3}	-515	60	120	0.10	80

Inhibition efficiency with acid concentration

Tables I to VI give the inhibition efficiency for mild steel in HCl and H_2SO_4 of different acid concentrations containing different inhibitor concentrations. It can be seen that the inhibition efficiency increases with increase in both HCl and H_2SO_4 acid concentrations. This type of inhibition can be explained interms of adsorption of the protonated species [8,9] and also explained on the basis of structure of N-benzyldimethylamine compound.

CONCLUSION

It can be concluded that N-benzyldimethylamine is found to be a good inhibitor for mild steel in HCl and H_2SO_4. It is very effective at the concentration 1 N acid and inhibitor concentration 5×10^{-3} M. The amount of inhibition of mild steel dissolution is found to be dependent on concentration of inhibitor. The inhibition efficiency is found to be increasing with acid concentrations. This indicates that this

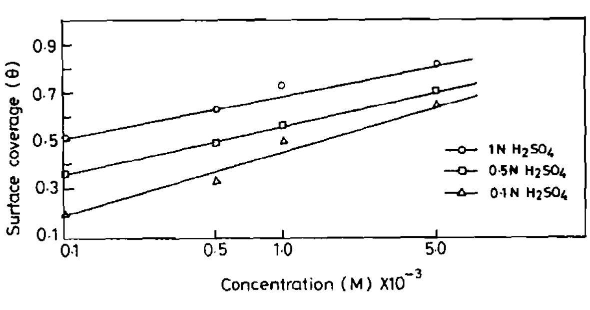

Fig. 8: Temkin adsorption of mild steel in HCl containing various concentrations of N-benzyldimethylamine

inhibitor adsorbs through protonated form. The inhibition is found to obey Temkin adsorption isotherm.

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