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SYNERGISTIC EFFECT OF 2-AMINO-6-CHLORO-BENZOTHIAZOLE ON INHIBITIVE PERFORMANCE OF PROPARGYL ALCOHOL DURING CORROSION OF MILD STEEL IN BOILING HYDROCHLORIC ACID SOLUTION

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The inhibitive action of 2 amino-6-chlorobenzothiazole (ACLBT) and Propargyl alcohol (PA) and their mixture on corrosion of mild steel in 15% HCl under boiling condition has been studied by weight loss method. PA gave maximum IE 99.7% at a concentration of 5000 ppm and ACLBT gave maximum IE of 62% at 4000 ppm. The combination containing 2500 ppm of PA and 1000 ppm of ACLBT gave 99.3% IE. Electrochemical polarization studies reveal that PA, ACLBT and their optimum mixture act as mixed inhibitor.

Keywords: Mild steel, synergistic effect, 2-amino-6- chlorobenzothiazole.

INTRODUCTION

A perusal of literature [1-3] reveals that most of the organic compounds used as effective corrosion inhibitors during acidization include acetylenic compounds especially alcohols, α-alkenylphenones, aromatic α, β-unsaturated aldehydes, nitrogen and sulphur containing heterocyclic compounds, quaternary salts and condensation products of carbonyls and amines. Among various compounds available acetylenic alcohols are considered as excellent inhibitors for low-alloy carbon steels and are found in commercial formulations [4-6]. The vapours of acetylenic alcohols are toxic and they retard the corrosion of steel only at higher concentrations (> 1.0%) [7]. Several attempts were made to synergise PA with organic compounds [8-10].

In the present work we have studied the effect of 2-amino-6-chlorobenzothiazole (ACLBT) on inhibitive performance of propargyl alcohol (PA) on mild steel corrosion in 15% HCl which is normally employed in acidisation under boiling condition.

EXPERIMENTAL

Materials and test solutions

Mild steel (AISI 1079) coupons of size 2 x 2 x 0.6 cm having composition C=0.14%, Mn=0.35%, Si=0.17%, P=0.03% and remainder Fe, were used for weight loss measurements. The experiments were performed in a 500 ml three neck borosil round bottom flask using a condenser for half an hour at 378 ± 2 K. All the experiments were performed as per ASTM G 1-72 and G 31-72 [11]. For potentiodynamic polarization studies, mild steel strips of the same composition embedded in araldite with an exposed area of 1.0 cm^2 were used and the experiments were carried out at constant temperature of 308 ± 2 K as per G 3-74 and G 5-87 [11]. AR grade HCl (MERCK) and double distilled water were used for preparing test solution of 15% HCl for all the experiments. AR grade propargyl alcohol (PA) (MERCK) was used and 2-amino-6-chloro-benzothiazole (ACLBT) was synthesized in the laboratory following the procedure reported elsewhere [12] and the structure of the compound is given below:

Melting point=454 K; Molecular weight=184

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TABLE I: Corrosion parameters for mild steel in boiling 15% HCl in absence and presence of inhibitors, derived from weight loss measurements

Inhibitor conc (ppm)	Corrosion rate (mmpy)	I.E. %
15% HCl (Blank)	12526	—
PA		
1000	10994	12.2
2000	9543	23.8
3000	177	98.5
4000	142	98.8
5000	37	99.7
ACLBT		
1000	9605	23.5
2000	8146	34.9
3000	10347	17.3
4000	4707	62.4
5000	7178	43.1‘
PA + ACLBT		
1000 + 1000	3757	70.0
1000 + 2000	3423	72.6
2000 + 1000	411	96.7
2000 + 2000	444	96.4
2500 + 1000	85	99.3

The potentiodynamic polarization studies were carried out using EG & G PARC Potentiostat/Galvanostat (model 173), Universal programmer (model 175) and with X-Y recorder (model RE 0089). A platinum foil of 3 x 3 cm and a saturated calomel electrode (SCE) were used as auxiliary and reference electrodes, respectively.

RESULTS AND DISCUSSION

Weight loss measurements

Table I shows the values of corrosion rates and percent inhibition efficiencies obtained from weight loss measurements for different concentrations of propargyl alcohol, ACLBT and their mixture in 15% boiling HCl.

It has been found from Table I that percent inhibition efficiency increases with the increase in concentration of propargyl alcohol in 15% boiling HCl. PA gives maximum inhibition efficiency of 99.7% at 5000 ppm and ACLBT shows maximum inhibition (62.4%) at 4000 ppm. The mixture of 2500 ppm of PA and 1000 ppm of ACLBT gave 99.3% inhibition efficiency.

Potentiodynamic polarization studies

Potentiodynamic polarization studies were carried out in 15% HCl without and with different concentrations of both the inhibitors alone and in combinations. The various electrochemical parameters calculated from Tafel plots (Fig. 1) are given in Table II. It can be seen from Table II

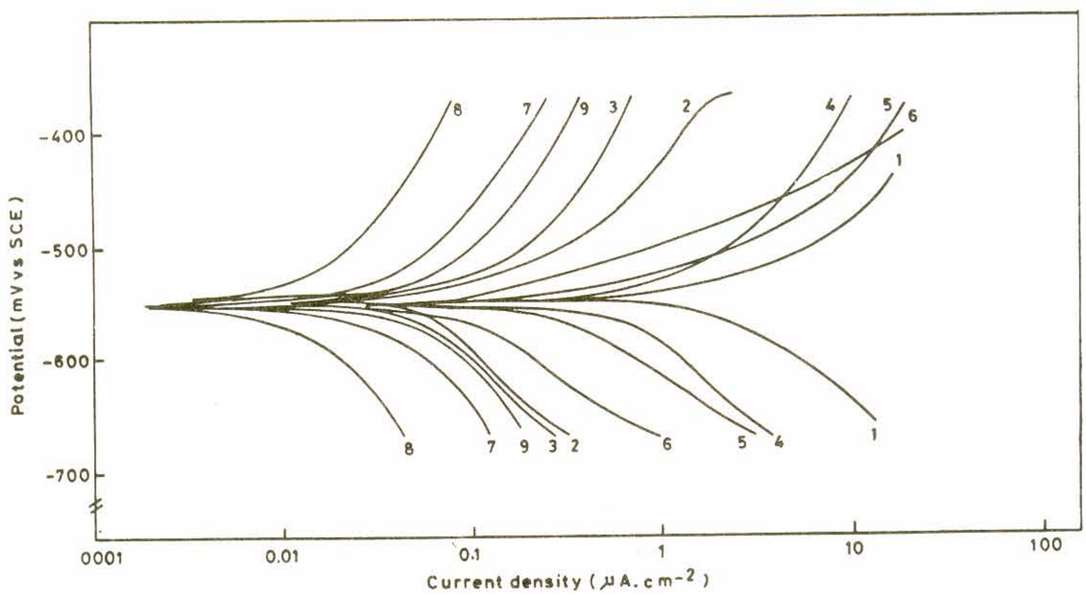

Fig. 1: Potentiodynamic polarisation curves for mild steel in 15% HCl in the absence and presence of various concentrations of inhibitors 1. 15% HCl (Blank) 2. 250 ppm PA 3. 500 ppm PA 4. 250 ppm ACLBT 5. 500 ppm ACLBT 6. 250 ppm PA + 250 ppm ACLBT 7. 250 ppm PA + 500 ppm ACLBT 8. 500 ppm PA + 250 ppm ACLBT 9. 500 ppm PA + 500 ppm ACLBT

TABLE II: Potentiodynamic polarisation parameters for mild steel in 15% HCl at room temperature in absence and presence of inhibitors

Inhibitor concn (ppm)	E_{corr} mV vs SCE	i_{corr} $\mu A\ cm^{-2}$	I.E %
15% HCl	-542	3500	—
PA			
250	-516	50	98.29
500	-522	60	98.29
ACLBT			
250	-522	1000	71.43
500	-522	400	88.57
PA + ACLBT			
250 + 250	-526	100	97.14
250 + 500	-524	40	98.86
500 + 250	-524	10	99.71
500 + 500	-526	50	98.57

that the I_{corr} values decreases significantly in presence of the inhibitors. At optimum concentrations ACLBT and PA give inhibition efficiency of 88.57% and 98.29% respectively. The best synergistic combination comprises 500 ppm of PA and 250 ppm of ACLBT which provides the maximum protection (99.71%) to mild steel in 15% HCl solution. The E_{corr} values are almost unchanged in the presence of inhibitors suggesting that these inhibitors inhibit the corrosion of mild steel in 15% HCl by controlling both the anodic and cathodic reactions. Inhibitors of this type are known as mixed type inhibitors.

The plausible mechanism of the inhibition of corrosion of mild steel in 15% HCl by PA and ACLBT may be explained on the basis of adsorption of inhibitor molecules on the metal surface. It is reported in the literature that PA inhibits corrosion by forming a polymeric film in the metal surface [13,14] ACIBT can adsorb on the metal surface either as protonated species or through π electrons of the heterocyclic ring [15]. Thus the inhibition mechanism of mild steel in HCl in presence of a combination of PA-ACIBT may be attributed to both polymerisation and adsorption mechanism.

CONCLUSION

The mixture of ACLBT and PA may be used as a less toxic alternative for PA during acidizing process.

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