

*Chapter- 6*  
*Effects of Surfactants on*  
*AMOD & HI*

Surfactants<sup>238-239</sup> are amphiphile molecule that consists of both hydrophobic tails (usually hydrocarbon chains) and hydrophilic molecular segments. The hydrophobic segment tends to aggregate together to have energetically less expensive state. The shape and size of aggregation depend upon the energetics of interaction between adjacent hydrophilic head groups as well as adjacent hydrophobic tails. They self associate at concentrations above the critical micellar concentration (cmc) to form association colloids, called micelles. Micelles have interfacial regions containing ionic or polar head groups. This polar or ionic head groups plays an important role in the adsorption<sup>240-241</sup> of surfactants onto the solid surfaces and thereby inhibit corrosion by blocking the surface of metal. Surfactant adsorption may occur due to electrostatic interaction, van der Waals interaction, hydrogen bonding and/ or solvation and desolvation of adsorbate and adsorbent species<sup>242</sup>. Studies in surfactant media have demonstrated a marked inhibiting effect on corrosion<sup>243-249</sup>. Depending upon the concentrations the adsorption may occur as individual molecules or as surfactant aggregates of various types.

Surfactant adsorption to the metallic surface is below monolayer level, below cmc and at concentrations above cmc adsorption can consists of multiple layers of physically adsorbed surfactant molecules<sup>250</sup>. Above the cmc, increasing surfactant concentration leads to the gradual formation of multilayer that further reduce the rate of corrosion beyond what can be achieved with monolayer coverage below the cmc. However, concentration changes above the cmc lead to smaller changes in inhibition, since the changes above the cmc result only in additional coverage beyond the monolayer level, which is already sufficient for significant corrosion inhibition.

In the present study the effect of anionic sodium dodecylsulfate (SDS), cationic cetyltrimethylammonium bromide (CTAB), and nonionic Triton-X-100 (TX-100) surfactants on the corrosion efficiency of 2-aminophenyl-5-mercapto-1-oxa-3,4-diazole (AMOD) and 2- Heptyl -1,3 imidazoline (HI) have been studied by weight loss measurements and potentiodynamic measurement studies.

## RESULTS AND DISCUSSION

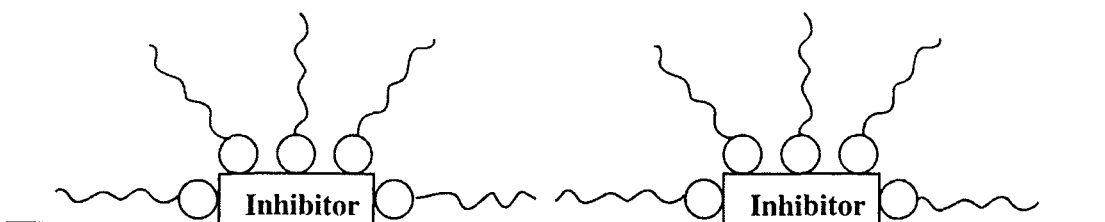
### 6.1. Weight loss measurements

The effect of variation [surfactants] on the inhibition efficiency (IE) of AMOD and HI were carried out by weight loss method. The concentrations of surfactants (cationic CTAB, anionic SDS and non-ionic TX-100) were varied in the range from  $1 \times 10^{-2} \text{ mol dm}^{-3}$  to  $5 \times 10^{-1} \text{ mol dm}^{-3}$  in the absence and presence of 500 ppm AMOD and HI at  $30^{\circ}\text{C}$ . The results are summarized in Tables 6.1-6.6 and Figures 6.1-6.2. The addition of surfactant enhanced the inhibition efficiency (IE) of AMOD and HI appreciably. The IE first increased with increase in [surfactant], giving maxima at concentrations  $0.2 \text{ mol dm}^{-3}$  and  $0.1 \text{ mol dm}^{-3}$  for AMOD and HI respectively. The further increase in [surfactant] decreased the inhibition efficiency. The dissolved surfactant helps inhibitor to adsorb onto the iron surface due to their hydrophilic property and leads to the strong bonding between the metal surface and inhibitor along with head group of surfactant. The hydrophobic surfactant tails prefer to adsorb together to form a coherent hydrophobic film that serves as a barrier to block the reaction between the iron surface and the external environment, thus the corrosion reaction between the metal and aqueous medium is inhibited<sup>251</sup>.

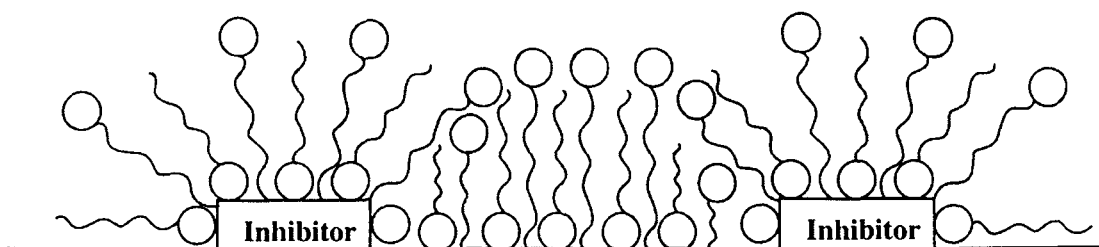
At the surfactant concentration below cmc, the surfactant molecules adsorb to the surface to form monolayer coverage on the interface and the surfactant tails are oriented parallel to adsorbent plane<sup>252</sup> as depicted below:



Thus, the surfactant and inhibitor molecules inhibit the dissolution of metal either by blocking the cathodic or the anodic reaction by occupying reactive sites, or by simply providing resistance to the supply of oxidant or the transport of the reaction products. Thus, corrosion is inhibited more effectively with increasing surfactant concentration. The monolayer coverage increases with the increase in surfactant concentration and may lead to the formation of hemimicelles<sup>253</sup>.



As the concentration of surfactant increases further, surfactant molecules form dimers, and multiple molecules aggregate. The bilayer aggregates are formed with hydrophobic hydrocarbon chains inside and polar head groups outside. A further increase of surfactant concentration, which is already sufficient for significant corrosion inhibition, causes an increase in ionic concentration in the surface region due to the incorporation of ions as counterions or coions. This leads to an increase in concentration of  $H^+$  in the vicinity of surface and therefore, the corrosion efficiency is decreased on increasing the [surfactant].



The variation of inhibition efficiency on the acid concentration was studied at  $[HCl]$  ( $1.0 - 5.0 \text{ mol dm}^{-3}$ ). The concentrations of inhibitor (AMOD and HI) was kept constant at 500 ppm at  $30^\circ\text{C}$  and the concentration of surfactant was  $0.2 \text{ mol dm}^{-3}$  for AMOD and  $0.1 \text{ mol dm}^{-3}$  for HI. The results are presented in Tables 6.7- 6.8 and in Figures 6.3- 6.4. Inhibition efficiency decreased with the increase in acid concentration due to the greater aggressiveness of acid solutions at higher concentration in AMOD. The variation in the acid concentration in presence of HI and surfactants did not cause any significant change in inhibition efficiency as the surface remains blocked by inhibitor and surfactant due to adsorption.

The variation in inhibition efficiency was studied at 500 ppm of inhibitors (AMOD and HI) at different temperature in the range from  $30^\circ\text{C}$  to  $60^\circ\text{C}$ . The results are presented in Tables 6.9- 6.10 and in Figures 6.5- 6.6. It demonstrates that the surfactants help inhibitor to adhere the surface upto  $60^\circ\text{C}$ . The decrease in inhibition efficiency with increase in temperature from  $30^\circ\text{C}$  to  $60^\circ\text{C}$  (Figure 6.6) in presence of HI and surfactant show desorption of HI and surfactants from metal surface occur at higher temperatures<sup>182</sup>.

The surface coverage ( $\theta$ ) at different concentrations of surfactant in the range from  $1 \times 10^{-2} \text{ mol dm}^{-3}$  to  $5 \times 10^{-1} \text{ mol dm}^{-3}$  in the presence of 500 ppm inhibitor (AMOD and HI) have been evaluated by weight loss method. The temperature was kept constant at  $30^\circ\text{C}$  and the immersion time was 3h in  $1.0 \text{ mol dm}^{-3} \text{ HCl}$ . The data was tested graphically by fitting to various

isotherms. A straight line plot was obtained for  $\log \theta / (1-\theta)$  versus  $\log C$  (Concentration of surfactants in  $\text{mol dm}^{-3}$ ) as shown in Figures 6.7- 6.8. These plots suggest that the adsorption of AMOD and HI in presence of surfactant on mild steel follows Langmuir's adsorption isotherm. The adsorption of inhibitors (AMOD and HI) on mild steel surface is enhanced in presence of the tested surfactants.

The values of the heat of adsorption ( $Q$ ) was calculated from the slope ( $-Q/2.303R$ ) of the plot of  $\log \theta/1-\theta$  versus  $1/T$  (Figures 6.9- 6.10) in presence of surfactant and inhibitor. The values are given in Tables 6.11- 6.12. The lower values of heat of adsorption for inhibitors ( AMOD / HI) and surfactant (SDS, CTAB and TX-100) show the physical nature of adsorption <sup>162</sup>.

Figures 6.11- 6.12 show plot of  $\log CR$  versus  $1/T$  for inhibitor (AMOD and HI) in presence of surfactants. The value of activation energy ( $E_a$ ) was obtained from the slope. It was observed that the values of  $E_a$  for AMOD in presence of surfactants is lower than that of uninhibited system. Values of  $E_a$  for HI in presence of surfactants are higher than those in the free acid solution except for TX-100 indicating that HI in presence of surfactants is more effective inhibitor at room temperature<sup>185</sup>.

Entropy and enthalpy changes for corrosion reaction was deduced from slope and intercept of plot of  $\log (C.R) / T$  versus  $1/T$  (Figures 6.13- 6.14). The values are listed in Tables 6.11- 6.12. The lower values of  $\Delta H$  in the presence of surfactants and AMOD indicates less energy barrier<sup>186</sup>. The higher values of  $\Delta H$  for HI in presence of surfactants suggest the high energy barrier for corrosion reaction. The entropy of activation  $\Delta S$  for AMOD and HI in presence of the surfactant is large and negative. This indicates that the

activated complex in the rate determining step in more ordered form and represents an association rather than a dissociation step. Decrease in disorderness takes place during transformation from reactants to the activated complex<sup>189</sup>.

The  $\Delta G_{ads}$  value calculated for AMOD and HI in presence of surfactant are presented in Tables 6.11- 6.12 respectively. The negative values of  $\Delta G_{ad}$  reveal the spontaneity nature of adsorption process<sup>190</sup>. Thus the adsorbed layer interacts strongly and is more stable on the steel surface<sup>191</sup>. Values of  $\Delta G_{ads}$  indicates that AMOD and HI in presence of surfactants are physically adsorbed on the metal surface<sup>192</sup>.

## 6.2. Potentiodynamic Polarization Studies

Various corrosion parameters such as  $E_{corr}$ ,  $I_{corr}$ , IE and CR were obtained by potentiodynamic polarization studies at 30°C in [surfactant] (= 0.20 mol dm<sup>-3</sup> for AMOD and 0.10 mol dm<sup>-3</sup> for HI), 500 ppm AMOD and HI after immersion for 3 hours. The results are given in Figures 6.15- 6.16 and the values of  $E_{corr}$ ,  $I_{corr}$ , IE and CR are given in Tables 6.13- 6.14. The presence of surfactants decreased  $I_{corr}$  values. Maximum decrease in  $I_{corr}$  was observed for TX-100 indicating that TX-100 is most effective surfactant.  $E_{corr}$  values do not change significantly in presence of these surfactants, suggesting that they are of mixed type inhibitors (i.e., they retard the corrosion reaction by blocking both anodic and cathodic sites of the metal<sup>194</sup>).

## 6.3. Mechanism of corrosion inhibition

The presence of surfactants increased the inhibition efficiency of AMOD and HI appreciably as indicated by Figures 6.1- 6.2. The ionic

surfactants (SDS) and CTAB tend to adsorb on the surface of mild steel through electrostatic forces between the head groups and the metal surface. The adsorption of non-ionic surfactants i.e. TX-100 involves hydrogen bonding between surface hydrogen atoms and proton acceptors in polar head group and the hydrophobic bonding between the surface and the hydrocarbon tails. At lower concentration, surfactant molecules are adsorbed along with inhibitor to the surface plane. The increase in [surfactant] leads to the association of the adsorbed surfactant into aggregates perpendicular to the surface. Thus the surfactants are effective even at their low concentrations.

At higher concentrations, tail - tail interactions may begin to cause association of the adsorbed surfactants into an additional coverage beyond the monolayer i.e. admicelles or bilayer formation. The addition of AMOD and HI to the surfactant solution further increases the inhibition efficiency as illustrated by Figures 6.1- 6.2. AMOD and HI are poorly soluble in water and exist in the protonated form in acidic solution and thereby reduces the aggressiveness of  $H^+$ . The non-ionic surfactants, TX-100 and anionic SDS bind with HI through electrostatic interaction and exist in the palisade layer of micelle<sup>254</sup>. Thus TX-100 and SDS help AMOD and HI to adsorb on the steel surface more firmly and, therefore, display higher IE. The IE in CTAB is higher as compared to blank AMOD and HI and lower than SDS and TX- 100. It may be due to the adsorption of AMOD and HI to the surface by binding with CTAB as coions or through hydrophobic interaction.



**Table 6.1-** Variation of corrosion parameters on [CTAB] for mild steel in the absence and presence of AMOD.

[CTAB] (mol dm <sup>-3</sup> )	In absence of AMOD			In presence of AMOD		
	Weight loss (mg)	IE (%)	CR (mmpy)	Weight loss (mg)	IE (%)	CR (mmpy)
0.0	62.4	-	23.20	11.3	81.85	4.21
0.01	31.0	50.09	11.62	9.1	85.43	3.38
0.05	28.8	54.17	10.69	8.6	86.12	3.20
0.075	29.7	54.89	11.03	7.4	88.14	2.74
0.10	24.7	60.16	9.20	5.2	91.66	1.93
0.20	23.9	61.57	8.91	4.1	93.43	1.52
0.30	24.7	60.31	9.20	6.2	90.05	2.30
0.50	26.0	58.24	9.68	10.9	82.49	4.06

[HCl]= 1.0 mol dm<sup>-3</sup>; [AMOD] =500 ppm; Temp= 30 °C; Time= 3 hours

**Table 6.2-** Variation of Corrosion parameters on [SDS] for mild steel in the absence and presence of AMOD.

[SDS] (mol dm <sup>-3</sup> )	In absence of AMOD			In presence of AMOD		
	Weight loss (mg)	IE (%)	CR (mmpy)	Weight loss (mg)	IE (%)	CR (mmpy)
0.0	62.4	-	23.20	11.3	81.85	4.21
0.01	29.8	52.07	11.08	8.8	85.87	3.27
0.05	27.9	55.14	10.37	7.1	88.66	2.63
0.075	26.3	57.64	9.79	6.8	89.11	2.52
0.10	23.8	61.62	8.87	4.3	91.03	2.08
0.20	22.2	64.31	8.25	2.5	95.99	0.92
0.30	23.3	62.47	8.67	4.5	92.74	1.67
0.50	24.6	60.49	9.13	9.6	84.61	3.57

[HCl]= 1.0 mol dm<sup>-3</sup>; [AMOD] =500 ppm; Temp= 30 °C; Time= 3 hours

**Table 6.3-** Variation of Corrosion parameters on [TX-100] for mild steel in the absence and presence of AMOD.

[TX-100] (mol dm <sup>-3</sup> )	In absence of AMOD			In presence of AMOD		
	Weight loss (mg)	IE (%)	CR (mmpy)	Weight loss (mg)	IE (%)	CR (mmpy)
0.0	62.4	-	23.20	11.3	81.85	4.21
0.01	23.9	61.45	8.91	7.2	88.47	2.67
0.05	22.3	63.48	8.91	6.1	90.15	2.28
0.075	20.4	67.52	8.44	5.8	90.65	2.16
0.10	16.0	73.12	7.50	2.6	95.67	1.04
0.20	15.0	75.82	6.21	1.4	97.63	0.54
0.30	15.8	74.54	5.59	1.7	97.27	0.63
0.50	17.7	71.43	6.60	4.8	92.15	1.82

[HCl]= 1.0 mol dm<sup>-3</sup>; [AMOD] =500 ppm; Temp= 30 °C; Time= 3 hours

**Table 6.4-** Variation of Corrosion parameters on [CTAB] for mild steel in the absence and presence of HI.

[CTAB] (mol dm <sup>-3</sup> )	In absence of HI			In presence of HI		
	Weight loss (mg)	IE (%)	CR (mmpy)	Weight loss (mg)	IE (%)	CR (mmpy)
0.0	62.4	-	23.20	9.6	85.80	3.29
0.01	31.0	50.09	11.62	8.2	87.96	3.04
0.05	28.8	54.17	10.69	7.5	88.98	2.78
0.075	29.7	54.89	11.03	5.4	92.06	2.00
0.10	24.7	60.16	9.20	2.2	96.64	0.85
0.20	23.9	61.57	8.91	3.3	95.02	1.26
0.30	24.7	60.31	9.20	3.9	94.23	1.46
0.50	26.0	58.24	9.68	8.3	87.70	3.11

[HCl]= 1.0 mol dm<sup>-3</sup>; [HI] =500 ppm; Temp= 30 °C; Time= 3 hours

**Table 6.5-** Variation of Corrosion parameters on [SDS] for mild steel in the absence and presence of HI.

[SDS] (mol dm <sup>-3</sup> )	In absence of HI			In presence of HI		
	Weight loss (mg)	IE (%)	CR (mmpy)	Weight loss (mg)	IE (%)	CR (mmpy)
0.0	62.4	-	23.20	9.6	85.80	3.29
0.01	29.8	52.07	11.08	7.2	89.66	2.61
0.05	27.9	55.14	10.37	6.1	95.02	2.27
0.075	26.3	57.64	9.79	4.7	92.96	1.78
0.10	23.8	61.62	8.87	1.6	97.53	0.62
0.20	22.2	64.31	8.25	2.6	96.16	0.97
0.30	23.3	62.47	8.67	2.8	95.76	1.07
0.50	24.6	60.49	9.13	6.7	90.02	2.52

[HCl]= 1.0 mol dm<sup>-3</sup>; [HI] =500 ppm; Temp= 30 °C; Time= 3 hours

**Table 6.6-Variation of Corrosion parameters on [TX-100] for mild steel in the absence and presence of HI.**

[TX-100] (mol dm <sup>-3</sup> )	In absence of HI			In presence of HI		
	Weight loss (mg)	IE (%)	CR (mmpy)	Weight loss (mg)	IE (%)	CR (mmpy)
0.0	62.4	-	23.20	9.6	85.80	3.29
0.01	23.9	61.45	8.91	6.7	90.06	2.51
0.05	22.3	63.48	8.91	3.1	95.39	1.16
0.075	20.4	67.52	8.44	1.7	97.35	0.66
0.10	16.0	73.12	7.50	1.5	95.67	0.58
0.20	15.0	75.82	6.21	1.4	97.63	0.55
0.30	15.8	74.54	5.59	1.7	97.27	0.11
0.50	17.7	71.43	6.60	6.0	91.07	2.26

[HCl]= 1.0 mol dm<sup>-3</sup>; [HI] =500 ppm; Temp= 30 °C; Time= 3 hours

**THESIS**

**Table 6.7.** Variation of acid concentration on Inhibition efficiency for AMOD on mild steel in the presence of surfactants at 30 °C for 3 h.

[Acid] (mol dm <sup>-3</sup> )	IE (%)		
	CTAB	SDS	TX-100
1.0	93.43	95.99	97.63
3.0	87.34	93.59	94.77
5.0	82.97	89.76	91.67

[HCl] = 1.0 mol dm<sup>-3</sup>; [AMOD] = 500 ppm

**Table 6.8.** Variation of acid concentration on Inhibition efficiency for HI in mild steel in the presence of surfactants at 30 °C for 3 h

[Acid] (mol dm <sup>-3</sup> )	IE (%)		
	CTAB	SDS	TX-100
1.0	96.23	97.21	99.34
3.0	96.84	97.59	98.21
5.0	97.12	98.16	97.87

[HCl] = 1.0 mol dm<sup>-3</sup> [HI] = 500 ppm

**Table 6.9.** Variation of Inhibition efficiency on temperature for AMOD in mild steel in the presence of surfactants.

IE (%)	Inhibition efficiency Temperature (°C)			
	30	40	50	60
CTAB	93.43	94.38	95.18	96.51
SDS	87.34	96.27	96.83	97.95
TX-100	82.97	97.90	98.03	98.18

[AMOD] = 500 ppm; [HCl] = 1.0 mol dm<sup>-3</sup>; Time = 3 hours

**Table 6.10.** Variation of Inhibition efficiency on temperature for HI in mild steel in the presence of surfactants

IE (%)	Inhibition efficiency Temperature (°C)			
	30	40	50	60
CTAB	97.43	95.85	95.38	95.20
SDS	96.64	97.31	96.98	96.73
TX-100	97.79	98.21	98.84	98.53

[HI] = 500 ppm; [HCl] = 1.0 mol dm<sup>-3</sup>; Time = 3 hours



**Table 6.11-** The thermodynamic activation parameters for the corrosion of mild steel in the absence and presence of surfactants and AMOD.

[Inhibitor] (ppm)	[Surfactant] (mol dm <sup>-3</sup> )	E <sub>a</sub> (kJmol <sup>-1</sup> )	ΔH (kJmol <sup>-1</sup> )	-ΔS (JK <sup>-1</sup> mol <sup>-1</sup> )	-ΔG <sub>ads</sub> (kJ mol <sup>-1</sup> )	-Q (kJmol <sup>-1</sup> )
0.0	0.0	50.07	47.41	205.24	-	-
500	0.0	51.12	101.41	215.98	30.24	18.02
500	0.2 (CTAB)	32.51	29.90	231.86	34.90	30.43
500	0.2 (SDS)	31.75	29.16	234.16	33.71	23.36
500	0.2(TX-100)	48.08	40.74	238.18	29.30	14.35

[HCl] = 1.0 mol dm<sup>-3</sup>; Time= 3 hours

**Table 6.12-** The thermodynamic activation parameters for the corrosion of mild steel in the absence and presence of surfactants and HI.

[Inhibitor] (ppm)	[Surfactant] (mol dm <sup>-3</sup> )	E <sub>a</sub> (kJmol <sup>-1</sup> )	ΔH (kJmol <sup>-1</sup> )	-ΔS (JK <sup>-1</sup> mol <sup>-1</sup> )	-ΔG <sub>ads</sub> (kJ mol <sup>-1</sup> )	-Q (kJmol <sup>-1</sup> )
0.0	0.0	50.07	47.41	205.24	-	-
500	0.0	30.73	47.14	188.88	26.54	27.24
500	0.2 (CTAB)	57.50	46.91	227.97	27.56	10.72
500	0.2 (SDS)	55.52	60.31	229.00	26.01	17.36
500	0.2(TX-100)	26.76	79.14	231.30	25.08	33.09

[HCl] = 1.0 mol dm<sup>-3</sup>; Time= 3 hours

**Table 6.13-** Values of  $E_{\text{corr}}$ ,  $I_{\text{corr}}$  and IE for the corrosion of mild steel under varying conditions of solution composition at 30 °C.

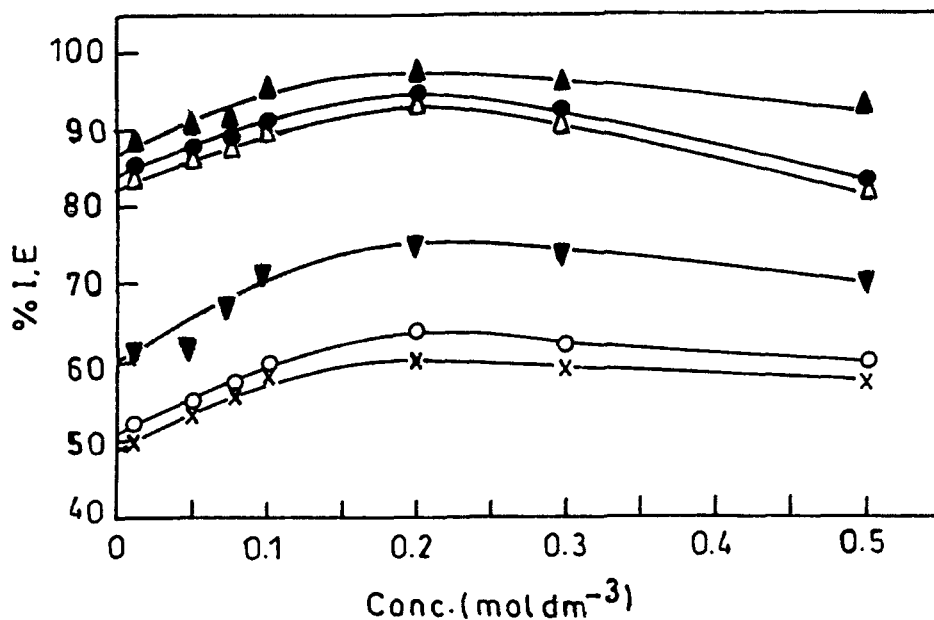
Solution composition	$E_{\text{corr}}$ (mV)	$I_{\text{corr}}$ (mA cm <sup>-2</sup> )	IE (%)
HCl	507	0.360	-
HCl + AMOD	526	0.036	89.85
HCl + AMOD + CTAB	521	0.032	90.87
HCl + AMOD + SDS	519	0.021	94.12
HCl + AMOD + TX-100	514	0.012	96.53

[AMOD] = 500 ppm; [HCl] = 1.0 mol dm<sup>-3</sup>; Time= 3 hours

**Table 6.14-** Values of  $E_{\text{corr}}$ ,  $I_{\text{corr}}$  and IE for the corrosion of mild steel under varying conditions of solution composition at 30°C.

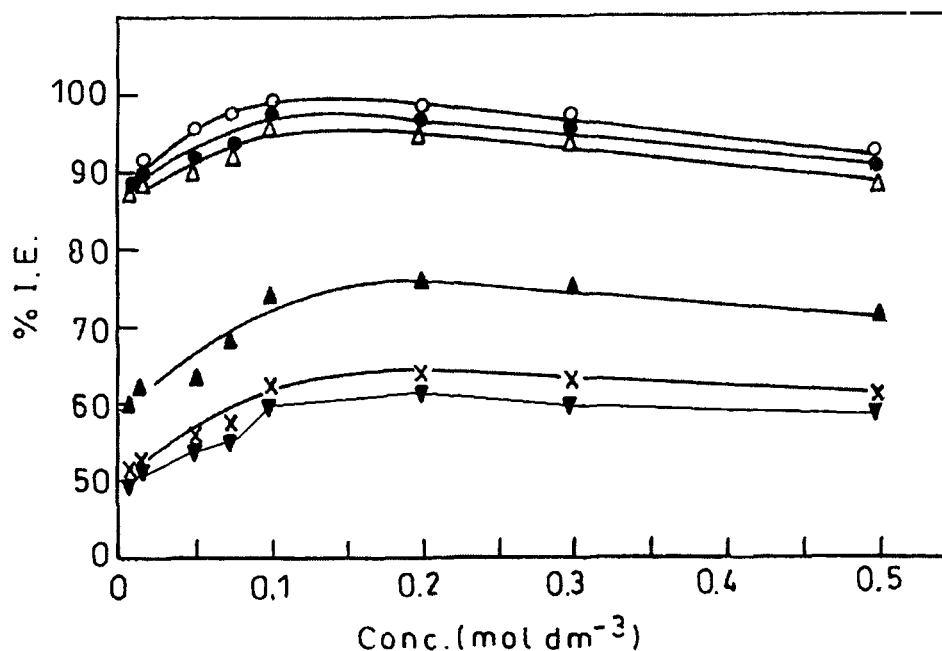
Solution composition	$E_{\text{corr}}$ (mV)	$I_{\text{corr}}$ (mA cm <sup>-2</sup> )	IE (%)
HCl	507	0.360	-
HCl + HI	473	0.150	58.33
HCl + HI + CTAB	431	0.032	90.87
HCl + HI + SDS	459	0.021	94.12
HCl + HI + TX-100	484	0.012	96.53

[HI] = 500 ppm; [HCl] = 1.0 mol dm<sup>-3</sup>; Time= 3 hours



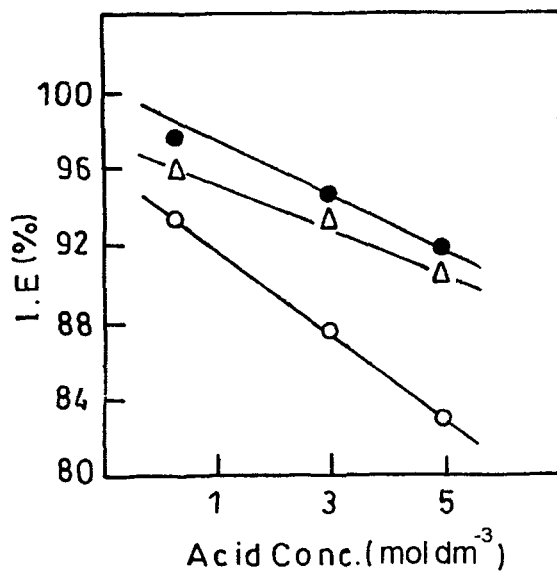
**Fig 6.1.** Plot of inhibition efficiency on [surfactant] in absence & presence of AMOD ( x,CTAB; o,SDS; ▼,TX-100; ▲,CTAB+AMOD; ●,SDS +AMOD; ▲,TX-100+AMOD).

Reaction conditions [HCl] = 1.0 mol dm<sup>-3</sup>, Temp = 30°C, Time = 3 hours.

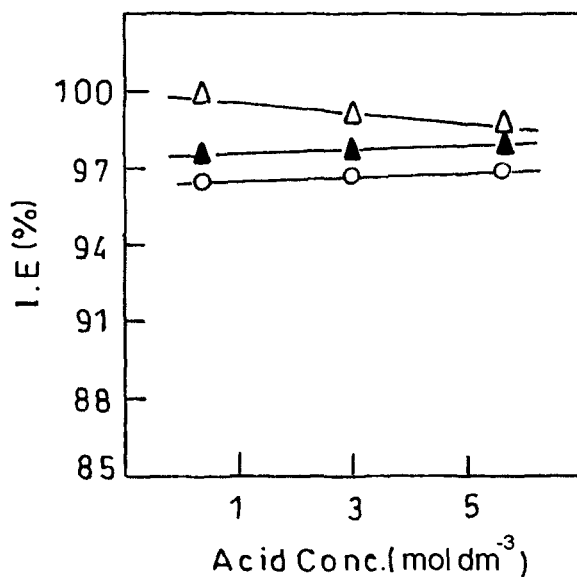


**Fig 6.2.** Plot of inhibition efficiency on [surfactant] in absence & presence of HI ( ▼,CTAB; x,SDS; ▲,TX-100; ▲,CTAB+HI; ●,SDS +AMOD;○,TX-100 +HI)

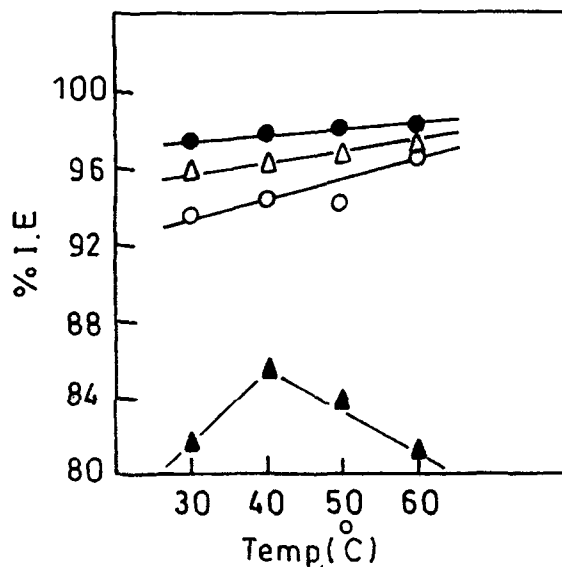
Reaction conditions [HCl] = 1.0 mol dm<sup>-3</sup>, Temp = 30°C, Time = 3 hours.



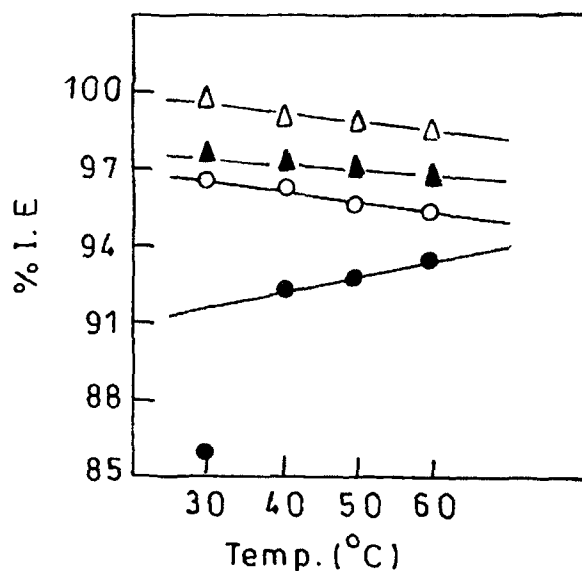
**Fig.6.3.** Plot of inhibition efficiency on [hydrochloric acid] (●,TX-100+AMOD; Δ,SDS+AMOD; ○,CTAB+AMOD).  
 Reaction conditions [inhibitor]=500 ppm, Temp =30°C, Time =3 hours.



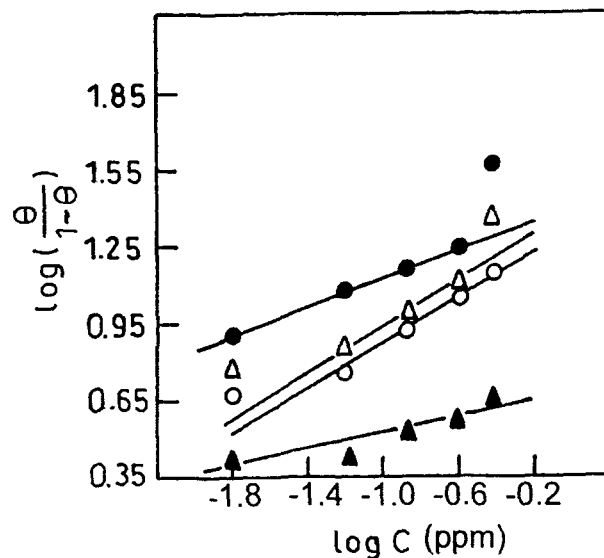
**Fig. 6.4.** Plot of inhibition efficiency on [hydrochloric acid] (●,TX-100+ HI; Δ,SDS+ HI; ○,CTAB+ HI).  
 Reaction conditions [inhibitor]=500 ppm, Temp =30°C, Time =3 hours.



**Fig 6.5.** Variation of inhibition efficiency on temperature in 1 mol dm<sup>-3</sup> HCl (●,TX-100+AMOD; Δ,SDS+AMOD; ○,CTAB+AMOD; ▲, AMOD)  
Reaction conditions [HCl] =1.0 mol dm<sup>-3</sup>, Time =3 hours, [inhibitor]=500 ppm.

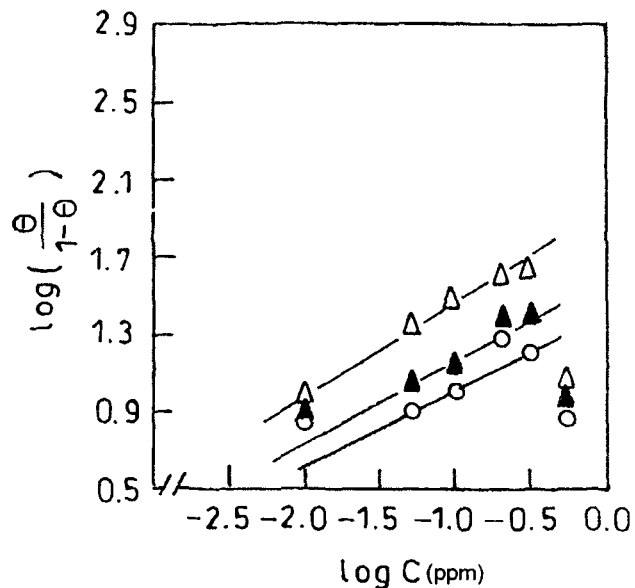


**Fig 6.6.** Variation of inhibition efficiency on temperature in 1 mol dm<sup>-3</sup> HCl (Δ, TX-100+HI; ▲, SDS+HI; ○, CTAB+HI; ●, AMOD).  
Reaction conditions [HCl] =1.0 mol dm<sup>-3</sup>, Time =3 hours, [inhibitor]=500 ppm.



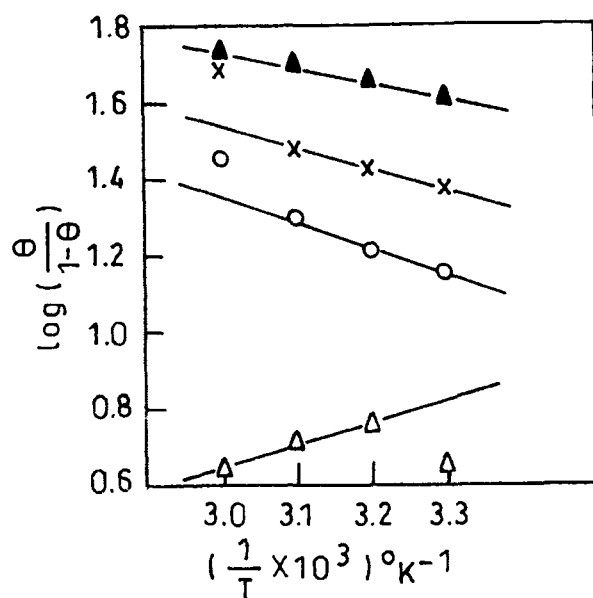
**Fig.6.7.** Langmuir's isotherm plots for the adsorption of surfactants in presence of AMOD in  $1 \text{ mol dm}^{-3}$  HCl on mild steel (●, TX-100+AMOD; ▲, SDS+AMOD; ○, CTAB+AMOD; ▲, AMOD).

Reaction conditions  $[\text{HCl}] = 1.0 \text{ mol dm}^{-3}$ , Temp =  $30^\circ\text{C}$ , Time = 3 hours.

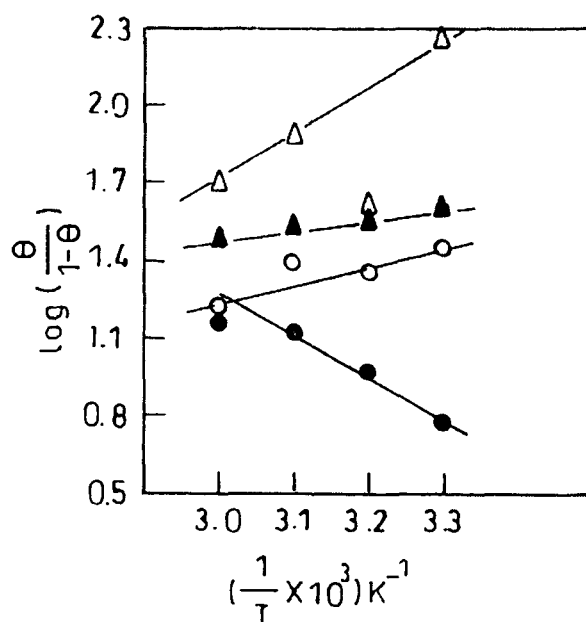


**Fig.6.8.** Langmuir's isotherm plots for the adsorption of surfactants in presence of HI in  $1 \text{ mol dm}^{-3}$  HCl on mild steel (●, TX-100+HI; ▲, SDS+HI; ○, CTAB+HI; ▲, HI).

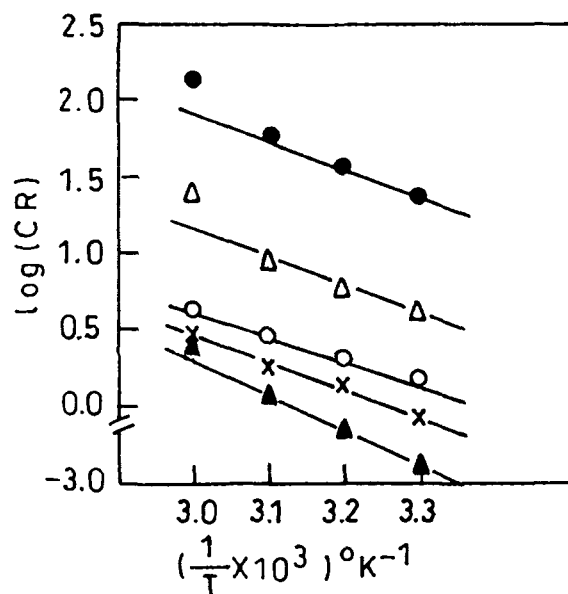
Reaction conditions  $[\text{HCl}] = 1.0 \text{ mol dm}^{-3}$ , Temp =  $30^\circ\text{C}$ , Time = 3 hours.



**Fig. 6.9.** Arrhenius plot for  $\log (\theta / 1-\theta)$  versus  $1/T$  (▲, TX-100+AMOD; x, SDS+AMOD; o, CTAB+AMOD; Δ, AMOD).  
 Reaction conditions  $[\text{HCl}] = 1.0 \text{ mol dm}^{-3}$ , Time = 3 hours, [inhibitor]=500 ppm.

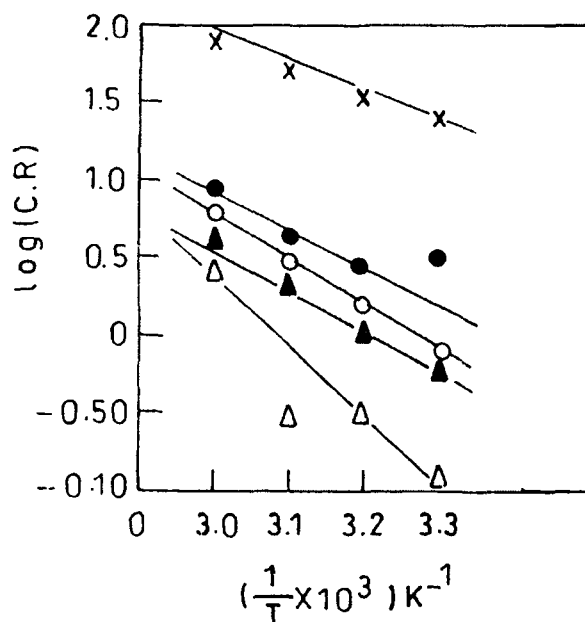


**Fig.6.10** Arrhenius plot for  $\log (\theta / 1-\theta)$  versus  $1/T$  (Δ, TX-100+ HI; ▲, SDS+HI; o, CTAB+ HI; ●, HI )  
 Reaction conditions  $[\text{HCl}] = 1.0 \text{ mol dm}^{-3}$ , Time = 3 hours, [inhibitor]=500 ppm.



**Fig. 6.11.** Arrhenius plot for log (CR) versus 1/T (▲, TX-100+AMOD; x, SDS+AMOD; ○, CTAB+AMOD; Δ, AMOD; ●, Blank).

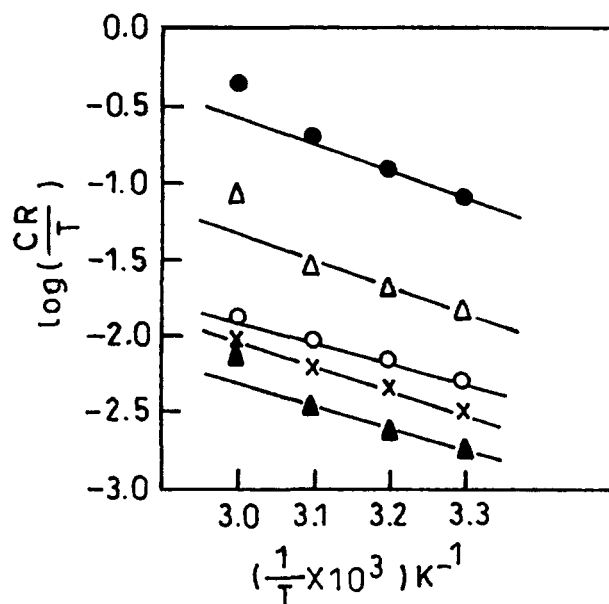
Reaction conditions [HCl] = 1.0 mol dm<sup>-3</sup>, Time = 3 hours, [inhibitor] = 500 ppm.



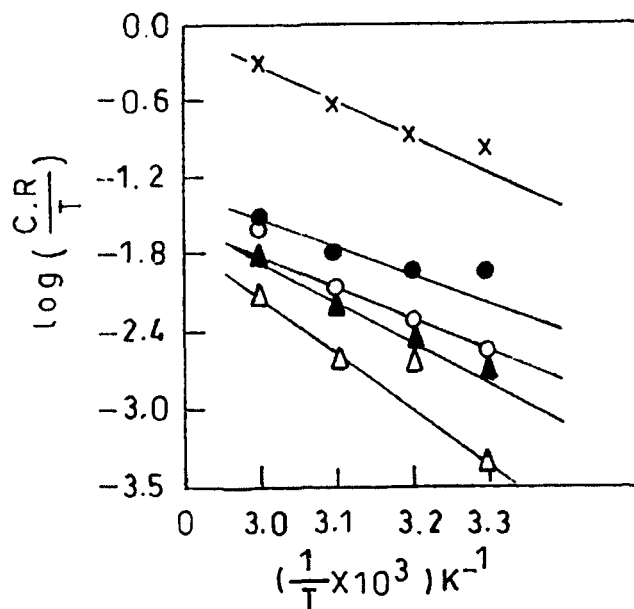
**Fig 6.12.** Arrhenius plot for log (CR) versus 1/T (Δ, TX-100+HI; ▲, SDS+ HI; ○, CTAB+ HI; ●, HI; x, Blank).

Reaction conditions [HCl] = 1.0 mol dm<sup>-3</sup>, Time = 3 hours, [inhibitor] = 500 ppm.

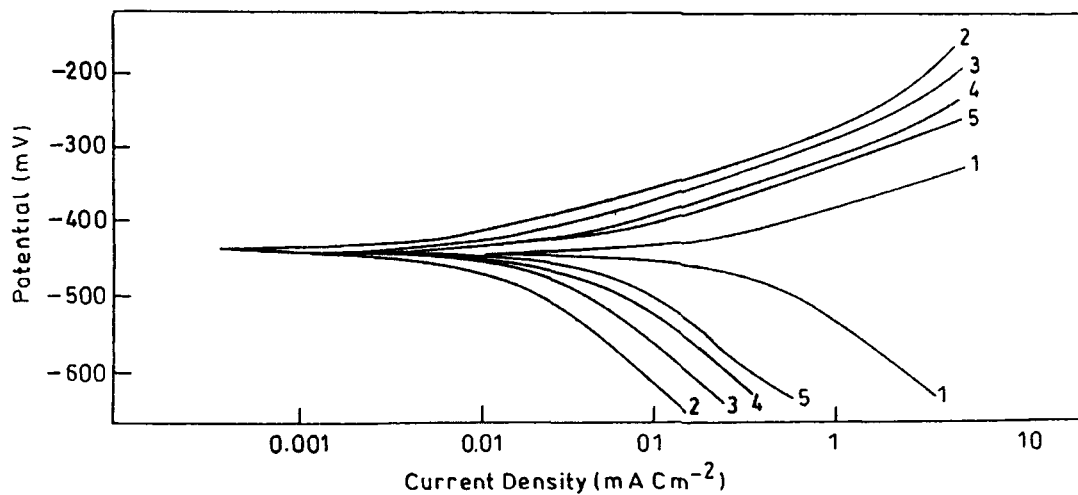




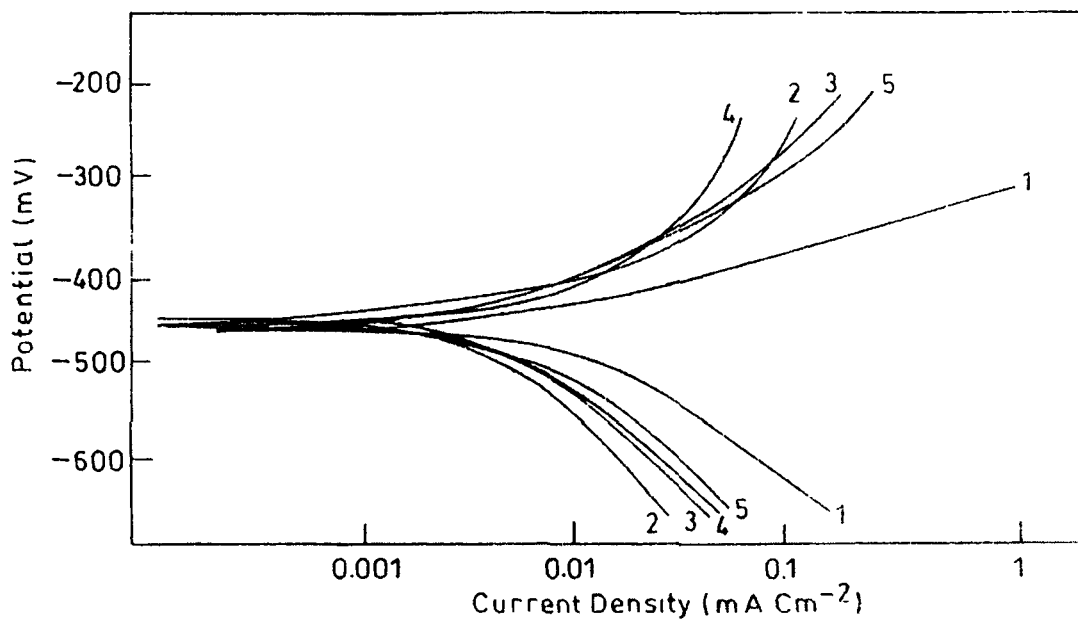
**Fig. 6.13.** Arrhenius plot for  $\log (CR/T)$  versus  $1/T$  ( $\blacktriangle$ , TX-100+AMOD;  $\times$ , SDS+AMOD;  $\circ$ , CTAB+AMOD;  $\triangle$ , AMOD;  $\bullet$ , Blank).  
 Reaction conditions  $[HCl] = 1.0 \text{ mol dm}^{-3}$ , Time = 3 hours, [inhibitor]=500 ppm.



**Fig. 6.14.** Arrhenius plot for  $\log (CR/T)$  versus  $1/T$  ( $\triangle$ , TX-100+HI;  $\blacktriangle$ , SDS+HI;  $\circ$ , CTAB+HI;  $\bullet$ , HI;  $\times$ , Blank).  
 Reaction conditions  $[HCl] = 1.0 \text{ mol dm}^{-3}$ , Time = 3 hours, [inhibitor]=500 ppm.



**Fig 6.15.** Potentiodynamic polarization curves of AMOD on mild steel (1) Blank (2) TX-100+AMOD (3) SDS+AMOD (4) CTAB+AMOD (5) AMOD Reaction conditions  $[HCl] = 1.0 \text{ mol dm}^{-3}$ , Temp =  $30^\circ\text{C}$ .



**Fig 6.16.** Potentiodynamic polarization curves of HI on mild steel (1) Blank (2) TX-100+HI (3) SDS+HI (4) CTAB+ (5) HI. Reaction conditions  $[HCl] = 1.0 \text{ mol dm}^{-3}$ , Temp =  $30^\circ\text{C}$ .