CORROSION INHIBITORY EFFECTS OF SOME SCHIFF'S BASES ON MILD STEEL IN ACID MEDIA

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ABSTRACT

Weight loss and thermometric methods have been used to study the corrosion inhibition of mild steel in acidic solution (HCl and H₂SO₄) by Schiff's bases viz. N-(4-N,N-dimethylaminobenzal)-p-anisidine (SB₁), N-(4-N,N-dimethylaminobenzal)-p-toluidine (SB₂) and N-(4-N,N-dimethylaminobenzal)-2,4-dinitroaniline (SB₃). The efficiencies have been compared with those of parent amines from which Schiff's bases have been derived. Results of inhibition efficiencies observed from these two methods are in good agreement and have been found to be dependent on the concentrations of inhibitors as well as those of acids. Inhibition efficiency of all inhibitors increases with increasing concentration of inhibitors. Efficiency also increases with increasing concentration of acids. Inhibition efficiency is more in case of HCl rather than in H₂SO₄. Inhibition efficiency was found maximum up to 95.55% for mild steel in HCl solution. Inhibition efficiencies of synthesised Schiff's bases have been found much more than their parent amines. It was observed that inhibition efficiency of all amines increases with increasing concentration of amines but decreases with increasing concentration of HCl and H₂SO₄.

Keywords: Corrosion, Inhibition, Weight loss method, Thermometric method, Surface coverage, Corrosion rate.

INTRODUCTION

Mild steel finds a variety of applications industrially, in mechanical and structural purposes, like bridge work, building, boiler plates, steam engine parts and automobiles. It finds various uses in most of the chemical industries due to its low cost and easy availability for fabrication of various reaction vessels, tanks, pipes etc. Since it suffers from severe corrosion in aggressive environment, it has to be protected. Acids like HCl and H₂SO₄ have been used for drilling operations, pickling baths and in descaling processes¹.

Corrosion commonly occurs at metal surfaces in the presence of oxygen and moisture, involving two electrochemical reactions. Oxidation takes place at anodic site and reduction occurs at cathodic site. In acidic medium hydrogen evolution reaction predominates. Corrosion inhibitors reduce or prevent these reactions. They are adsorbed on metal surface and form a barrier to oxygen and moisture by complexing with metal ions or by removing corrodants from the environment. Some of the inhibitors facilitate formation of passivating film on the metal surface.

Generally the organic compounds containing hetero atoms like O, N, S and in some cases Se and P are found to have function as very effective corrosion inhibitors²⁻¹¹. The efficiency of these compounds depends upon electron density present around the hetero atoms¹². Inhibition efficiency also depends upon the number of adsorption active centres in the molecule, their charge density, molecular size, mode of adsorption and formation of metallic complexes. Hetero atoms such as N, O, S and in some cases Se and P are capable of forming coordinate-covalent bond with metal owing to their free electron pairs. Compounds with π -bonds also generally exhibit good inhibitive properties due to interaction of π -orbital with metal surface. Schiff's bases with $-C=N$ linkage have both the above features combined with their structure which make them effective potential corrosion inhibitors¹³.

Corrosion of mild steel and its alloys in different acid media has been extensively studied¹⁴⁻¹⁶. The effect of various nitrogen containing ligands synthesised from aliphatic and aromatic monoamines, diamines and various aldehydes has been screened on the dissolution of mild steel in HCl and H₂SO₄ solutions.

In the present investigation the inhibition efficiencies of three Schiff's bases viz. N-(4-N,N-dimethylaminobenzal)-p-anisidine (SB₁), N-(4-N,N-dimethylaminobenzal)-p-toluidine (SB₂) and N-(4-N,N-dimethylaminobenzal)-2,4-dinitroaniline (SB₃) have been evaluated in different concentrations of HCl and H₂SO₄ with different concentrations of synthesised Schiff's bases. Inhibition efficiencies of synthesised Schiff's bases have been compared with their parent amines.

EXPERIMENTAL

Rectangular specimens of mild steel of dimension 2.0 × 2.0 × 0.03 cm containing a small hole of about 2 mm diameter near the upper edge were taken. The chemical composition of the specimen was 99.3% Fe, 0.2% C, 0.3% Mg, 0.14% Si and 0.04% S. Specimens were cut out from a steel sheet and were cleaned by buffing to produce a spotless finish and then degreased. Different solutions of HCl and H₂SO₄ were prepared using double distilled water. All

chemicals used were of analytical reagent grade. Different Schiff's bases were synthesised by conventional methods¹⁷⁻¹⁸.

Each specimen was suspended by a V-shaped glass hook made by capillary tubes and immersed in a glass beaker containing 50cc of the test solution at room temperature. After a definite time of exposure, the specimens were taken out, washed thoroughly with benzene and then dried with hot air dryer and then the final weight of each specimen was taken. The loss in weight was calculated. The percentage inhibition efficiency ($\eta\%$) of inhibitors were calculated using the following formula¹⁹:

$$\eta\% = \frac{100(\Delta M_u - \Delta M_i)}{\Delta M_u}$$

Where ΔM_u and ΔM_i are the weight loss of the metal in uninhibited and in inhibited solution, respectively.

The corrosion rates in mmpy (milli meter per year) is expressed as ²⁰:

$$\text{Corrosion rate (mmpy)} = \frac{\Delta M \times 87.6}{A \times T \times d}$$

Where ΔM is the weight loss of specimen in mg, A is the area of exposure of specimen in square cm, T is the time in hours and d is the density of specimen in gm/cm³.

The degree of surface coverage (θ) can be calculated as:

$$\theta = \frac{(\Delta M_u - \Delta M_i)}{\Delta M_u}$$

Where ΔM_u and ΔM_i are the weight loss of the metal in uninhibited and in inhibited solution, respectively.

Inhibition efficiencies were also calculated using thermometric method. This involves the immersion of single specimen of measurement 2.0 × 2.0 × 0.03 cm in an insulating reaction chamber having 50cc of solution at an initial room temperature. Temperature changes were measured at regular intervals using a thermometer with a precision of 0.1 °C. Initially the increase in temperature was slow, then rapid, attaining a maximum value and then decreased. The maximum temperature was noted. Percentage inhibition efficiency ($\eta\%$) was calculated as ²¹:

$$\eta\% = \frac{100(RN_f - RN_i)}{RN_f}$$

Where RN_f = Reaction Number in the free solution.
 RN_i = Reaction Number in the inhibited solution.
 Reaction Number, RN ($Kmin^{-1}$) is given as:

$$RN = \frac{(T_m - T_i)}{t}$$

Where T_m = Maximum temperature of solution.
 T_i = Initial temperature of solution.
 t = time required (in minutes) to attain maximum temperature.

RESULTS AND DISCUSSION

Weight Loss Method

Weight loss, percentage inhibition efficiencies, corrosion rate and surface coverage for different concentrations of HCl and inhibitors are given in Table-1 and for different concentrations of H_2SO_4 and inhibitors are given in Table-2. It can be seen from both the tables that inhibition efficiency of inhibitor increases with increasing concentration of inhibitor. Inhibition efficiency also increases with increasing concentration of acid and all the inhibitors show maximum inhibition efficiency at the highest concentration of acids used i.e. 2.0N HCl

and 2.0N H_2SO_4 . The maximum inhibition efficiency was obtained for N-(4-N,N-dimethylaminobenzal)-p-anisidine (SB_1) at an inhibitor concentration of 0.7% in 2.0N HCl and in 2.0N H_2SO_4 i.e. 95.55% and 90.93%, respectively. These results show that Schiff's bases show more inhibition efficiency in HCl than in H_2SO_4 . The variation of percentage inhibition efficiency with inhibitor concentrations are depicted graphically in Fig.1 for HCl and in Fig.2 for H_2SO_4 . Figures show a linear curve of percentage inhibition efficiency with the concentration of inhibitor, indicating that the inhibition efficiency increases with increasing inhibitor concentration.

Table - 1
Weight loss and percentage inhibition efficiency ($\eta\%$) for mild steel in HCl solution with given inhibitor additions.

Inhibitor addition	0.1N HCl (48 Hrs.)				0.5N HCl (48 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	38	-	1.73		146	-	6.66	
SB_1								
0.1%	12	68.42	0.55	0.68	40	72.60	1.82	0.73
0.3%	11	71.05	0.50	0.71	33	77.40	1.50	0.77
0.5%	9	76.32	0.41	0.76	29	80.14	1.32	0.80
0.7%	7	81.57	0.32	0.82	22	84.93	1.00	0.85
SB_2								
0.1%	14	63.16	0.64	0.63	53	63.70	2.42	0.64
0.3%	13	65.79	0.59	0.66	50	65.75	2.28	0.66
0.5%	11	71.05	0.50	0.71	35	76.02	1.60	0.76
0.7%	9	76.32	0.41	0.76	30	79.45	1.37	0.79
SB_3								
0.1%	18	52.63	0.82	0.53	56	61.64	2.56	0.62
0.3%	14	63.16	0.64	0.63	51	65.07	2.33	0.65
0.5%	13	65.79	0.59	0.66	45	69.18	2.05	0.69
0.7%	11	71.05	0.50	0.71	35	76.03	1.60	0.76
Inhibitor addition	1.0 N HCl (24 Hrs.)				2.0 N HCl (12 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	76	-	6.93		90	-	16.42	
SB_1								
0.1%	22	71.05	2.01	0.71	16	82.22	2.92	0.82
0.3%	17	77.63	1.55	0.78	12	86.66	2.19	0.87
0.5%	13	82.89	1.18	0.83	7	92.22	1.28	0.92
0.7%	10	86.84	0.91	0.87	4	95.55	0.73	0.96
SB_2								
0.1%	23	69.74	2.09	0.70	20	77.77	3.65	0.78
0.3%	18	76.32	1.64	0.76	15	83.33	2.73	0.83
0.5%	15	80.26	1.37	0.80	11	87.77	2.00	0.88
0.7%	12	84.21	1.09	0.84	9	90.00	1.64	0.90
SB_3								
0.1%	30	60.53	2.74	0.60	25	72.22	4.56	0.72
0.3%	22	71.05	2.00	0.71	21	76.66	3.83	0.77
0.5%	18	76.32	1.64	0.76	16	82.22	2.92	0.82
0.7%	15	80.26	1.37	0.80	13	85.55	2.37	0.86

Table - 2

Weight loss and percentage inhibition efficiency ($\eta\%$) for mild steel in H_2SO_4 solution with given inhibitor additions.

Inhibitor addition	0.1N H_2SO_4 (72 Hrs.)				0.5N H_2SO_4 (48 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	99	-	3.01		311	-	14.19	
SB ₁								
0.1%	39	60.60	1.19	0.61	112	63.99	5.11	0.64
0.3%	32	67.67	0.97	0.68	107	65.59	4.88	0.66
0.5%	26	73.73	0.79	0.74	72	76.85	3.28	0.77
0.7%	24	75.75	0.73	0.76	62	80.06	2.82	0.80
SB ₂								
0.1%	42	57.57	1.28	0.58	120	61.41	5.47	0.61
0.3%	38	61.61	1.16	0.62	109	64.95	4.97	0.65
0.5%	29	70.70	0.88	0.71	80	74.28	3.65	0.74
0.7%	27	72.72	0.82	0.73	65	79.10	2.96	0.79
SB ₃								
0.1%	52	47.47	1.58	0.47	136	56.27	6.20	0.56
0.3%	50	49.49	1.52	0.49	120	61.41	5.48	0.61
0.5%	45	54.54	1.37	0.54	95	69.45	4.33	0.69
0.7%	40	59.59	1.22	0.60	75	75.88	3.42	0.76
Inhibitor addition	1.0 N H_2SO_4 (24 Hrs.)				2.0 N H_2SO_4 (12 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage(θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	412	-	37.59		342	-	62.41	
SB ₁								
0.1%	102	75.24	9.31	0.75	80	76.60	14.60	0.77
0.3%	94	77.18	8.58	0.77	61	82.16	11.13	0.82
0.5%	90	78.16	8.21	0.78	47	86.25	8.58	0.86
0.7%	85	79.37	7.76	0.79	31	90.93	5.65	0.91
SB ₂								
0.1%	128	68.93	11.68	0.69	89	73.97	16.24	0.74
0.3%	108	73.79	9.86	0.74	83	75.73	15.15	0.76
0.5%	99	75.97	9.03	0.76	46	86.54	8.39	0.86
0.7%	88	78.64	8.03	0.79	42	87.71	7.66	0.88
SB ₃								
0.1%	172	58.25	15.69	0.58	100	70.76	18.25	0.71
0.3%	130	68.44	11.86	0.68	96	71.92	17.52	0.72
0.5%	115	72.08	10.49	0.72	72	78.94	13.14	0.79
0.7%	94	77.18	8.58	0.77	68	80.11	12.41	0.80

Fig. 1:- Variation of percentage inhibition efficiency ($\eta\%$) with inhibitor concentration (C) for mild steel in 2N HCl.

Fig. 2:- Variation of percentage inhibition efficiency ($\eta\%$) with inhibitor concentration (C) for mild steel in 2N H_2SO_4

uSB₁: N-(4-N, N-dimethylaminobenzal)- p- anisidine
 nSB₂: N-(4-N, N-dimethylaminobenzal)- p- toluidine
 ▲ SB₃: N-(4-N, N-dimethylaminobenzal)- 2, 4-dinitroaniline

Thermometric Method

Inhibition efficiencies were also determined using the thermometric method. Temperature changes for mild steel in 1.0N, 2.0N, 3.0N HCl and 1.0N, 2.0N, 3.0N H₂SO₄ were recorded both in presence and in absence of the different concentrations of inhibitors. However, no significant temperature changes were recorded in 0.1N and 0.5N concentrations of both the acids. Results summarised in Table-3 for HCl and in Table-4 for H₂SO₄ show a good agreement with the results obtained by weight loss method. The maximum inhibition efficiency was obtained with the highest concentration (0.7%) of inhibitor and with highest concentration of HCl (3.0N) and H₂SO₄ (3.0N). The variation of reaction number (RN) with inhibitor concentration is depicted graphically in Fig.3 for HCl and in Fig.4 for H₂SO₄. Figures show a linear deviation of reaction number with the concentration of inhibitor which indicates that the reaction number decreases with increasing inhibitor concentration.

Generally, organic molecules containing hetero atoms such as N, O, S and in some cases Se and P, adsorb on the metallic surface and inhibit the surface corrosion²⁻⁵. In the case of Schiff's bases nitrogen atom is responsible for adsorption. Nitrogen atom of Schiff's bases form a monolayer on the metallic surface, thus causes a decrease in corrosion rate. Presence of -OCH₃ group in N-(4-N,N-dimethylaminobenzal)-p-anisidine (SB₁) shows maximum inhibition efficiency among all the three Schiff's bases. The -OCH₃ group present in p-anisidine exerts a positive mesomeric effect (+M>-I) which increases the electron density at the nitrogen atom. It has also been observed that the efficiency is higher in higher concentration of HCl and H₂SO₄. This may be because of the fact that the inhibitor ionises more readily under more acid strength and is adsorbed more easily on the surface of metal. The acids which have more dissociation constant that is higher values of k_a or lower values of pK_a like HCl and H₂SO₄ enhance the ionisation of Schiff's bases thus causes more adsorption of Schiff's bases on metal surface. Therefore, they act as better inhibitors at higher concentrations. Adsorption plays an important role in the inhibition of metallic corrosion by organic inhibitors. The efficiencies of inhibitors expressed as the relative reduction in corrosion rate can be qualitatively 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 inhibitors species, whereas, the corrosion reaction occurs normally on the surface at inhibitors free area. The inhibition efficiency is thus, directly proportional to the fraction of the surface covered with adsorbed inhibitors. The higher ionisation of Schiff's bases in HCl than in H₂SO₄ may be the reason of these compounds exhibiting higher inhibition efficiencies in HCl as compared in H₂SO₄ since increased ionisation of inhibitor molecule will facilitate the adsorption of inhibitor on the mild steel surface.

$$\log \left[\frac{\theta}{(1-\theta)} \right] = \log A + \log C - (Q/2.3RT)$$

Many investigators have used the Langmuir adsorption isotherm to study inhibitor characteristics. Hoar and Holliday²² exhibited that the Langmuir isotherm, should give a straight line of unit gradient for the plot of $\log[\theta/(1-\theta)]$ versus $\log C$, A is a temperature independent constant, C is the bulk concentration of inhibitor and Q is the heat liberated in electrochemical reaction.

Fig. 3:- Variation of Reaction Number (RN) with inhibitor concentration (C) for mild steel in 3N HCl

Fig. 4:- Variation of Reaction Number (RN) with inhibitor concentration (C) for mild steel in 3N H₂SO₄

uSB₁: N-(4-N, N-dimethylaminobenzal)- p- anisidine
 nSB₂: N-(4-N, N-dimethylaminobenzal)- p- toluidine
 SB₃: N-(4-N, N-dimethylaminobenzal)- 2, 4-dinitroaniline

The corresponding plots shown in Fig.5 for HCl and Fig.6 for H₂SO₄ are linear but the gradients are not equal to unity as would be expected for the ideal Langmuir adsorption isotherm equation. This deviation from unity may be explained on the basis of interaction among the adsorbed species on the metal surface. It has been postulated in the derivation of the Langmuir isotherm equation that the adsorbed molecule do not interact with one another, but it is not true in the case of organic molecules having polar atoms or group which are adsorbed on the cathodic and anodic sites of the metal surface. Such adsorbed species may interact by mutual repulsion or attraction. This is also possible for inhibitor molecules those are adsorbed on anodic and cathodic sites, giving deviation from unit gradient.

Table - 3.- Reaction Number (RN) and percentage inhibition efficiency ($\eta\%$) for mild steel in HCl solution with given inhibitor additions.

Inhibitor addition	1.0N HCl		2.0N HCl		3.0N HCl	
	RN (kmin^{-1})	I.E. ($\eta\%$)	RN (kmin^{-1})	I.E. ($\eta\%$)	RN (kmin^{-1})	I.E. ($\eta\%$)
Uninhibited	0.0100	-	0.0416	-	0.1000	-
SB ₁						
0.1%	0.0046	54.00	0.0150	63.94	0.0300	70.00
0.3%	0.0033	67.00	0.0116	72.11	0.0266	73.40
0.5%	0.0023	77.00	0.0075	81.97	0.0150	85.00
0.7%	0.0010	90.00	0.0041	90.14	0.0083	91.70
SB ₂						
0.1%	0.0060	40.00	0.0175	57.93	0.0433	56.70
0.3%	0.0043	57.00	0.0141	66.10	0.0350	65.00
0.5%	0.0030	70.00	0.0133	68.03	0.0266	73.40
0.7%	0.0023	77.00	0.0091	78.12	0.0183	81.70
SB ₃						
0.1%	0.0056	44.00	0.0208	50.00	0.0450	55.00
0.3%	0.0046	54.00	0.0166	60.09	0.0400	60.00
0.5%	0.0036	64.00	0.0141	66.10	0.0333	66.70
0.7%	0.0033	67.00	0.0108	74.04	0.0200	80.00

Table - 4.- Reaction Number (RN) and percentage inhibition efficiency ($\eta\%$) for mild steel in H₂SO₄ solution with given inhibitor additions.

Inhibitor addition	1.0N H ₂ SO ₄		2.0N H ₂ SO ₄		3.0N H ₂ SO ₄	
	RN (kmin^{-1})	I.E. ($\eta\%$)	RN (kmin^{-1})	I.E. ($\eta\%$)	RN (kmin^{-1})	I.E. ($\eta\%$)
Uninhibited	0.0222	-	0.0458	-	0.1400	-
SB ₁						
0.1%	0.0094	57.66	0.0200	56.33	0.0440	68.57
0.3%	0.0072	67.57	0.0150	67.25	0.0340	75.71
0.5%	0.0055	75.22	0.0100	78.16	0.0260	81.43
0.7%	0.0038	82.88	0.0066	85.59	0.0200	85.71
SB ₂						
0.1%	0.0100	54.95	0.0216	52.84	0.0620	55.71
0.3%	0.0094	57.66	0.0175	61.79	0.0540	61.43
0.5%	0.0066	70.27	0.0150	67.25	0.0460	67.14
0.7%	0.0055	75.22	0.0108	76.42	0.0280	80.00
SB ₃						
0.1%	0.0122	45.04	0.0250	45.41	0.0700	50.00
0.3%	0.0105	52.70	0.0208	54.58	0.0640	54.28
0.5%	0.0088	60.36	0.0183	60.04	0.0500	64.28
0.7%	0.0072	67.57	0.0150	67.25	0.0400	71.43

Fig. 5:- Langmuir adsorption isotherms for mild steel in 2N HCl with inhibitor additions. **Fig. 6:-** Langmuir adsorption isotherms for mild steel in 2N H₂SO₄ with inhibitor additions.uSB₁: N-(4-N, N-dimethylaminobenzal)- p- anisidinenSB₂: N-(4-N, N-dimethylaminobenzal)- p- toluidine▲ SB₃: N-(4-N, N-dimethylaminobenzal)- 2, 4-dinitroaniline

Table - 5.- Weight loss and percentage inhibition efficiency ($\eta\%$) for mild steel in HCl solution with given inhibitor additions.

Inhibitor addition	0.1N HCl (48 Hrs.)				0.5N HCl (48 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	38	-	1.73		146	-	6.66	
p-anisidine								
0.1%	28	26.31	1.28	0.26	106	27.39	4.84	0.27
0.3%	22	42.10	1.00	0.42	100	31.50	4.56	0.32
0.5%	20	47.36	0.91	0.47	83	43.15	3.79	0.43
0.7%	18	52.63	0.82	0.53	73	50.00	3.33	0.50
p-toluidine								
0.1%	29	23.68	1.32	0.24	111	23.97	5.06	0.24
0.3%	24	36.84	1.09	0.37	102	30.13	4.65	0.30
0.5%	21	44.74	0.96	0.45	92	36.98	4.19	0.36
0.7%	19	50.00	0.87	0.50	83	43.15	3.79	0.43
2,4-dinitroaniline								
0.1%		30				115		
0.3%		28				106		
0.5%		22				101		
0.7%		20				87		
Inhibitor addition		21.05				21.23		
		26.31				27.40		
		42.10				30.82		
		47.37				40.41		
		1.37				5.25		
		1.28				4.83		
		1.00				4.61		
		0.91				3.97		
		0.21				0.21		
		0.26				0.27		
		0.42				0.31		
		0.47				0.40		
	1.0 N HCl (24 Hrs.)				2.0 N HCl (12 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	76	-	6.93		90	-	16.42	
p-anisidine								
0.1%	59	22.37	5.38	0.22	74	17.77	13.50	0.18
0.3%	52	31.58	4.74	0.32	68	24.44	12.41	0.24
0.5%	45	40.79	4.11	0.41	60	33.33	10.95	0.33
0.7%	39	48.68	3.56	0.49	54	40.00	9.86	0.40
p-toluidine								
0.1%	61	19.74	5.57	0.20	76	15.55	13.87	0.16
0.3%	55	27.63	5.02	0.28	70	22.22	12.78	0.22
0.5%	47	38.16	4.29	0.38	64	28.88	11.68	0.29
0.7%	44	42.10	4.02	0.42	56	37.77	10.22	0.38
2,4-dinitroaniline								
0.1%	65	14.47	5.93	0.14	77	14.44	14.05	0.14
0.3%	58	23.68	5.29	0.23	72	20.00	13.14	0.20
0.5%	52	31.58	4.74	0.31	67	25.55	12.22	0.26
0.7%	46	39.47	4.19	0.39	60	33.33	10.95	0.33

Table - 6
Weight loss and percentage inhibition efficiency ($\eta\%$) for mild steel in H_2SO_4 solution with given inhibitor additions.

Inhibitor addition	0.1N H_2SO_4 (72 Hrs.)				0.5N H_2SO_4 (48 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	99	-	3.01		311	-	14.18	
p-anisidine 0.1%	65	34.34	1.98	0.34	220	29.26	10.04	0.29
0.3%	61	38.38	1.86	0.38	200	35.69	9.12	0.36
0.5%	58	41.41	1.76	0.41	180	42.12	8.21	0.42
0.7%	54	45.45	1.64	0.45	172	44.69	7.85	0.45
p-toluidine 0.1%	69	30.30	2.09	0.30	230	26.04	10.49	0.26
0.3%	66	33.33	2.01	0.33	219	29.58	9.99	0.30
0.5%	62	37.37	1.88	0.37	211	32.15	9.63	0.32
0.7%	59	40.40	1.79	0.40	204	34.40	9.31	0.34
2,4-dinitroaniline 0.1%	76	23.23	2.31	0.23	238	23.47	10.86	0.23
0.3%	74	25.25	2.25	0.25	228	26.69	10.40	0.27
0.5%	67	32.32	2.04	0.32	218	29.90	9.95	0.30
0.7%	65	34.34	1.98	0.34	210	32.47	9.58	0.32
Inhibitor addition	1.0 N H_2SO_4 (24 Hrs.)				2.0 N H_2SO_4 (12 Hrs.)			
	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)	ΔM (mg)	I.E. ($\eta\%$)	Corrosion rate(mmpy)	Surface Coverage (θ)
Uninhibited	412	-	37.59		342	-	62.41	
p-anisidine 0.1%	312	24.27	28.47	0.24	242	29.24	44.16	0.29
0.3%	289	29.85	26.37	0.30	233	31.87	42.52	0.32
0.5%	259	37.13	23.63	0.37	222	35.09	40.51	0.35
0.7%	243	41.01	22.17	0.41	207	39.47	37.78	0.39
p-toluidine 0.1%	325	21.11	29.66	0.21	264	22.81	48.18	0.23
0.3%	303	26.46	27.65	0.26	250	26.90	45.62	0.27
0.5%	293	28.88	26.74	0.29	248	27.48	45.26	0.27
0.7%	276	33.01	25.18	0.33	240	29.82	43.80	0.30
2,4-dinitroaniline 0.1%	342	16.99	31.21	0.17	290	15.20	52.92	0.15
0.3%	332	19.42	30.29	0.19	282	17.54	51.46	0.18
0.5%	326	20.87	29.75	0.21	267	21.93	48.73	0.22
0.7%	318	22.82	29.02	0.23	262	23.39	47.81	0.23

A comparison was made between the synthesised Schiff's bases and their parent amines i.e. p-anisidine, p-toluidine and 2,4-dinitroaniline. The results for the parent amines have been summarised in Table-5 for HCl and Table-6 for H₂SO₄. It has been observed from both the tables that maximum inhibition efficiency is 52.63% in 0.1N HCl and 45.45% in 0.1N H₂SO₄. It has also been observed that inhibition efficiency of amines decreases with increasing concentration of acids.

CONCLUSIONS

A study of three synthesized Schiff's bases viz. N-(4-N,N-dimethylaminobenzal)-p-anisidine (SB₁), N-(4-N,N-dimethylaminobenzal)-p-toluidine (SB₂) and N-(4-N,N-dimethylaminobenzal)-2,4-dinitroaniline (SB₃) has shown them to be effective inhibitors for the corrosion of mild steel in HCl and in H₂SO₄ solutions. Both weight loss and thermometric methods have shown that the inhibition efficiency of Schiff's bases increases with increasing inhibitor concentrations over the range 0.1- 0.7% and with increasing acid concentrations i.e. 0.1-2.0N for HCl and H₂SO₄. Synthesized Schiff's bases are more effective inhibitors in HCl than in H₂SO₄.

It has been also observed that Langmuir adsorption isotherms deviate somewhat from their ideal behavior. This is attributed to the fact that adsorbed molecules interact with each other causing deviation in the behavior of Langmuir adsorption isotherm.

Compounds under investigation displayed highest inhibition efficiency (up to 95.55% in 2.0N HCl) by N-(4-N,N-dimethylaminobenzal)-p-anisidine (SB₁) at a concentration of 0.7%. A comparison between the inhibition efficiency of synthesized Schiff's bases and their parent amines has shown that synthesized Schiff's bases are better corrosion inhibitors than their parent amines.

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