



A COMPARATIVE STUDY OF CORROSION INHIBITIVE EFFECTS OF SOME SCHIFF BASES ON METAL IN ACIDIC MEDIUM

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ABSTRACT

Mass loss techniques have been employed to study the corrosion inhibition of some newly synthesized Schiff bases viz. N-(2-Methoxy bezalidine)-2- Amino pyrimidine (SB1), N(3-Methoxy benzalidine)-2- Amino pyrazine(SB2) for copper metal in HCl solutions. Results of inhibition efficiencies from the mass loss technique show that Schiff bases are good inhibitors in acidic solution. Inhibition efficiency increases with the increase in the concentration of acid as well as those of inhibitors. Maximum inhibition efficiency is shown at highest concentration of Schiff bases at the highest concentration of acid.

KEYWORDS : Schiff bases, Corrosion, Inhibition efficiency, Corrosion rate, Surface coverage, Iron Metal.

Introduction

Copper is an important metal regarding to its wide applications in industry in various mechanical and structural purposes. It is widely used in engineering fabrications like bridgework, buildings, steam engine parts and automobiles etc. It is much prone to corrosion while in use by different corrosion agents of which acids like HCl and H₂SO₄ are most common and dangerous. HCl and H₂SO₄ have been used for drilling operations, picking baths and in decaling processes¹.

Corrosion of Iron and its alloys in different acid media has been extensively studied^{2,5}.

Corrosion rate of Iron is affected by pH of solution, metal dissolved oxygen and temperature.

It is adversely affected in the pH range 4 to 10 but fairly resistant to attack by alkali. The effects of certain organic compounds bearing hetero atoms have been studied as corrosion inhibitors for Iron. Many investigators have studied the effect of some, nitrogen containing compounds on corrosion of Iron in different acid media. Extracts of some naturally occurring Plants containing some alkaloids have also been found effective corrosion inhibitors in Hydrochloric acid for iron.

Generally the heterogeneous organic compounds having higher basicity and electron density on the hetero atoms like O, N, S have tendency to resist corrosion. Nitrogen and sulphur are the active centers for the process of adsorption on the metal surface.⁶⁻¹²

Experimental

A Rectangular specimens Iron of dimension 2.0 cm x 2.0 cm x 0.05 cm containing a small hole of about 2 mm diameter near the upper edge were taken. Specimens were cut from the centre of a sheet and were thoroughly cleaned, buffed, rubbed with emery paper to obtain mirror like spotless surface. The specimens were finally degreased by using acetone. All chemicals used for the synthesis of Schiff's bases were of analytical reagent grade and solutions of hydrochloric acid were prepared in double distilled water.

All the Schiff bases were prepared by conventional method i.e. by refluxing equimolar quantities of respective aldehydes and amines. Each specimen was suspended by a V-shaped glass hook made by fine capillary glass tubes and immersed in a glass beaker containing 50ml of test solutions at room temperature. After the test, specimens were cleaned with running water and dried with hot air drier and then weighed again. The percentage inhibition efficiency (%) was calculated as¹³⁻¹⁶

$$\eta\% = (\Delta M_u - \Delta M_i / \Delta M_u) \times 100$$

where ΔM_u is the weight loss in uninhibited solution and ΔM_i is the weight loss in inhibited solution.

Corrosion rate can be determined from the loss in mass as follows¹⁷.

$$CR (mm/py) = \frac{87.6 \times \Delta M}{A \times D \times T}$$

Where ΔM is the loss in mass in mg, A is the exposed area of the specimen in cm², D is the density in gm/cm³ and T is time of exposure in hours. Surface coverage (θ) of metal specimen by inhibitor was calculated as¹⁸⁻²²

$$\text{Surface coverage } (\theta) = \Delta M_u - \Delta M_i / \Delta M_u$$

Where ΔM_u is the mass loss in uninhibited acid, ΔM_i is the mass loss in inhibited acid.

Results and Discussion

Mass loss (ΔM) and percentage inhibition efficiencies ($\eta\%$) for different concentrations of HCl and inhibitors are shown in Table 1. It is observed that percentage inhibition efficiency ($\eta\%$) increases with increase in the concentration of the acids and also with the increase in the concentration of inhibitors.

A comparative study of Inhibitive effects of Some Schiff Bases

Table 1. Mass loss and inhibition efficiency ($\eta\%$) for iron metal in HCl solution with given inhibitor additions; Temperature :- 30±0.1°C

Inhibitor Concentration	0.1N HCl	72 hrs	0.5 N HCl	48 hrs	1 N HCl	24hrs	2N HCl	4 hrs
%	ΔM , mg	$\eta\%$	ΔM , mg	$\eta\%$	ΔM , mg	$\eta\%$	ΔM , mg	$\eta\%$
Uninhibited	21.3	-	30.5	-	42.5	-	47.5	-
Sb₁								
0.5	13.4	37.08	13.3	56.39	13.1	69.17	13.9	70.73
1.0	12.4	41.78	12.9	57.48	12.3	71.05	11.9	74.94
2.0	10.6	50.23	10.0	66.91	11.7	72.47	10.3	713.31
5.0	8.9	58.21	9.2	69.67	10.2	76.00	9.8	79.36
SB₂								
0.5	13.7	35.68	14.2	53.44	16.2	61.88	16.4	65.47
1.0	12.9	39.43	12.6	58.68	13.9	67.29	14.5	69.47
2.0	11.6	45.53	12.1	60.32	13.4	68.47	13.9	70.73
5.0	10.9	48.82	11.5	62.29	12.9	69.64	12.8	73.05

The two new Schiff bases show maximum inhibition efficiency at the highest concentration of the acid 2N at their highest

concentration i.e. 5.0%.

Corresponding corrosion rate and surface coverage () for HCl solutions are depicted in Table 2. It is observed from table that corrosion rate iron metal decreases with the increase in the concentration of inhibitors whereas corrosion rate increases with the increase in the strength of HCl solutions.

Surface coverage (θ) of metal specimen by inhibitors increases with the increase in the acid strength as well as with the increase in the concentration of inhibitors. Maximum surface coverage is observed at the highest concentration of acid (2N) at maximum concentration (5.0).

Surface coverage (θ) and $\log [\theta/(1-\theta)]$ values of Iron metal in HCl solutions are depicted in Table 3. It is observed from the table that as surface coverage increases, the value of $\log [\theta/(1-\theta)]$ also increases.

Table 2. Corrosion rate (mm/yr) and surface coverage () for Iron metal in HCl solution with given inhibitor additions; Temperature- $30 \pm 0.1^\circ\text{C}$. Effective area of specimen: 4 cm^2 .

Inhibitor	0.1N HCl		0.5N HCl		1 N HCl		2 N HCl	
Concentration %	72 hrs		48 hrs		24 hrs.		4 hrs	
	C. R.	Surface	C. R.	Surface	C. R.	Surface	C. R.	Surface
	mm/yr	Coverage	mm/yr	Coverage	mm/yr	Coverage	mm/yr	Coverage
Uninhibited	0.45	-	0.82	-	9.50	-	10.40	-
Sb₁								
0.5	0.20	0.37	0.35	0.56	3.50	0.69	4.40	0.70
1.0	0.18	0.41	0.23	0.57	2.70	0.70	3.10	0.74
2.0	0.13	0.50	0.19	0.66	2.10	0.72	2.90	0.78
5.0	0.08	0.58	0.13	0.69	1.30	0.76	1.80	0.79
Sb₂								
0.5	0.27	0.35	0.40	0.53	3.90	0.61	5.12	0.65
1.0	0.19	0.39	0.27	0.58	2.98	0.67	4.14	0.69
2.0	0.17	0.45	0.21	0.60	2.42	0.68	3.15	0.70
5.0	0.10	0.48	0.18	0.62	1.62	0.69	2.18	0.73

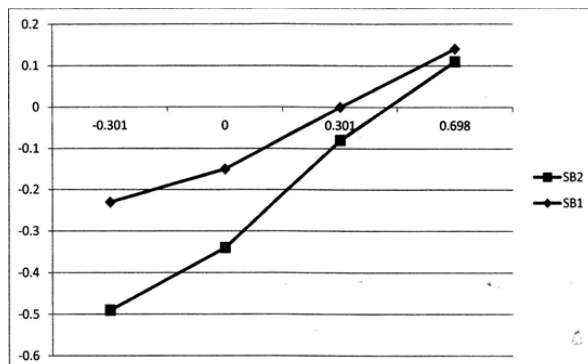
Table 3. Surface Coverage (θ) and $\log [\theta/(1-\theta)]$ for Iron metal in HCl solutions with given inhibitor additions. Effective area of specimen: 4 cm^2

Inhibitor	0.1N HCl 72 h		0.5 N HCl 48h		1N HCl 24 h		2N HCl 4 h	
Concentration %	Surface	log	Surface	log	Surface	log	Surface	log
	Coverage	$[\theta/(1-\theta)]$	Coverage	$[\theta/(1-\theta)]$	Coverage	$[\theta/(1-\theta)]$	Coverage	$[\theta/(1-\theta)]$
Uninhibited								
Sb₁								
0.5	0.37	-0.23	0.56	0.10	0.69	0.34	0.70	0.36
1.0	0.41	-0.15	0.57	0.12	0.70	0.36	0.74	0.45
2.0	0.50	0	0.66	0.28	0.72	0.41	0.78	0.54
5.0	0.58	0.14	0.69	0.34	0.75	0.47	0.79	0.57
Sb₂								
0.5	0.35	-0.26	0.53	0.05	0.61	0.19	0.65	0.26
1.0	0.39	-0.19	0.58	0.14	0.67	0.30	0.69	0.34
2.0	0.45	-0.08	0.60	0.17	0.68	0.32	0.70	0.36
5.0	0.48	-0.03	0.62	0.21	0.69	0.34	0.72	0.41

Generally the organic molecules containing heteroatom like oxygen. Sulphur and nitrogen cause blockage of active sites on the metallic surface, thus resulting in the decrease in the corrosion rate. Nitrogen atom present in the Schiff bases has lone pair of electrons and thus Schiff base form a monolayer on the metallic surface. The presence of $-\text{OCH}_3$ group in Schiff base further increases the inhibition efficiency of inhibitors. It has been observed that inhibition efficiency is higher in higher concentration of acids. This may be due to the fact that in strong acidic conditions ionization of

Schiff bases increases which favours the adsorption strongly and thus further reduces the exposed area of metal which results further increase in inhibition efficiency.

Langmuir adsorption isotherm plot (graph between $\log C$ and $\log [\theta/(1-\theta)]$) for copper metal in 0.1 N HCl containing the inhibitors as Schiff bases are shown in Figure 1.



$\log [\theta/(1-\theta)]$

$\log C, \text{mol/L}$

Figure 1. Langmuir adsorption isotherms for Iron metal in 0.1 N HCl

Conclusion:

A study of two synthesized Schiff Bases has shown effective. Corrosion inhibitors for Iron metal in HCl acid solutions. Mass loss method has shown that efficiency of inhibitors increase with increasing strength of acid from 0.1 N HCl to 2 N HCl and with increasing concentration of inhibitors in the range from 0.5 % to 2.0 %.

It has been observed that inhibiting effect has deviation from ideal Langmuir adsorption isotherm. This is due to the fact that molecules of adsorbed species interact with each other on the anodic and cathodic sites on the metallic surface.

Acknowledgement

The authors thanks to University Grant Commission, Bhopal to grant Minor Research Project and the Principal, Govt. Lohia PG College, Churu provided of research laboratory and facility.

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