



Corrosion Study of Mild Steel In 0.5M Trichloroacetic Acid By Potentiodynamic Method

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ABSTRACT

Four Schiff bases are studied as inhibitors for Mild steel in 0.5M trichloroacetic acid by potential measurement. The inhibition effect was studied at different concentrations of the inhibitors. The potential measurement was studied at dip time and up to 60 min for both uninhibited and inhibited at 35±0.1°C. Shift of potential in presence of different concentrations of inhibitors was calculated. Negative potential at dip time indicate cathode polarization and the potential shows a positive shift in presence of inhibitors. The positive shift in potential shows that the Schiff bases are efficient inhibitors for mild steel in 0.5M trichloroacetic acid. Potentiodynamic method can be used in screening the inhibitors as inhibitor.

Keywords: Mild Steel, Schiff bases, Trichloroacetic acid.

INTRODUCTION

Corrosion is an essential evil of metals and is the major industrial problem. So it becomes the important topic of research [1-6] in this era. The researchers are trying to minimize it by using various inhibitors. Mild Steel is used in various types of house-hold articles and comes in contact of acid and get corroded. The mild steel is widely used many applications like in the construction, industries, construction of tunnels, factory structures, transmission towers, bridges, ships. The other uses are in infrastructure projects, electrical wires, electrical plates, automobile industries, household utensils, automobile trims, chemical and food processing equipment, interior decoration, petrochemicals, nuclear and pharmaceutical equipment. Because of its large application its susceptibility to come in contact with acid, bases and salts is maximum, thus the ease to corrosion is also more.

Although a large number of organic natural products [7-14], synthesized organic as well as inorganic inhibitors were studied previously [15-23] and were found to effective inhibition powers. In this view it tried to find some inhibitors which can inhibit the rate of corrosion in acidic medium. The change in potential was studied with time and the shift of potential [24-25] was measured for mild steel in presence of four synthesized schiff bases of different concentrations in 0.5M trichloroacetic acid. The efficiencies of the inhibitors are studied by weight loss method at 35±0.1°C.

MATERIALS AND METHODS

Mild Steel was taken from ESSAR steel, India. Its material specifications are Cast number: B59747, Grade: SRGENP6, Steel Quality: IS 2062 E 250 (Fe 410 W) B: 2006. The thickness of the sheet was 2.0 mm with Carbon 0.160, Manganese 0.980, Sulphur 0.009, Phosphorous 0.013, Silicon 0.007, Aluminum 0.040 and Carbon equivalent 0.328 and remaining iron. The Yield strength is 292 MPa ($\text{Mpa} = 1\text{N/mm}^2 = 0.102\text{Kg/mm}^2$) and ultimate tensile strength is 448 Mpa.

All the chemicals used were of the A.R. grade and all the solutions were prepared in conductivity water. The test solution 0.5M trichloroacetic acid was standardized by sodium hydroxide solution [26-28]. For maintaining temperature High Precision water Bath Equitron 14LSS Model No. 8414.AJG106 with readability $\pm 0.1^\circ\text{C}$ was used.

The four Schiff bases were prepared by equimolar mixing of the aldehyde and amine ionized. The Schiff bases were prepared based on the methods reported earlier [29]. Schiff bases N^{\prime} -(3,4-dimethoxybenzylidene)pyridine-3-carbohydrazide (SB-I), N^{\prime} -[(*E*)-(4-hydroxyphenyl) methylidene]pyridine-3-carbohydrazide (SB-II), N^{\prime} -[(*E*)-phenylmethylidene]pyridine-3-carbohydrazide (SB-III) and N^{\prime} -[(*E*)-(4-methoxy phenyl) methylidene]pyridine-3-carbohydrazide (SB-IV) were prepared by mixing equimolar (1:1 molar) methanolic solutions of ionized and 3,4-dimethoxybenzaldehyde, benzaldehyde, 4-hydroxybenzaldehyde and 4-Methoxybenzaldehyde respectively. The Schiff bases prepared are characterized by IR, UV, Mass and NMR spectroscopy [30-34].

For potential measurements and weight loss measurements, the metal coupons were of circular design of diameter 2.8 cm with a handle 3 cm long and 0.5 cm wide. The only circular portion of the test coupon leaving other was covered with perspex act as working electrode and the other electrode used was platinum electrode of the same dimensions. For these measurements, single glass cell was used which has a built in capillary to make connection to the reference saturated calomel electrode. In cell compartment, the volume of corrosive media taken was 80mL. The electrochemical cell used for potential measurement studies was a two electrode system with working and reference. The reference electrode used is calomel electrode and the working electrode is the test coupon.

RESULTS AND DISCUSSION

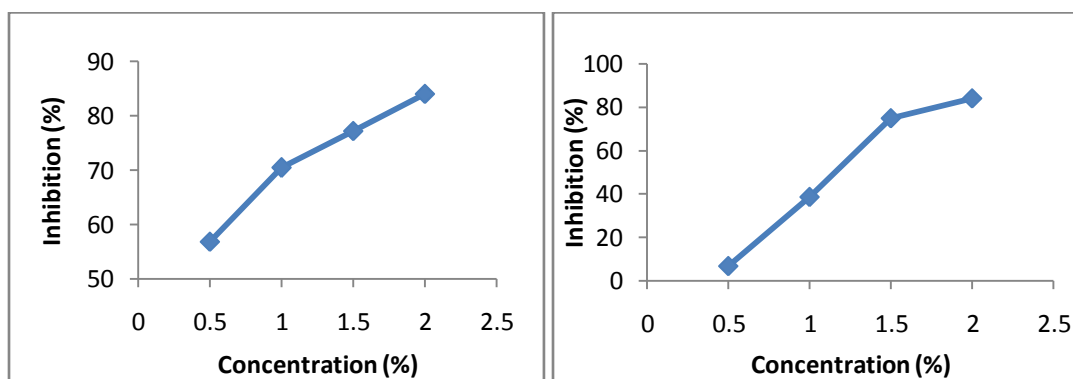
The corrosion of mild steel in 0.5M trichloroacetic acid at 35°C for one hour immersion period is 7.98 mg dm^{-3} . This showed that 0.5M trichloroacetic acid is very corrosive for mild steel. There is change in potential rapidly to the negative value in a short span of time and the shift in the negative direction may be due to attack of acid on the metal [35-39]. The initial dip potential is negative and shift is in negative direction which decreases later on and levels after approximately one to three minute. The dip potential in absence of inhibitor is -370mV which decreases further and decreases to -0.432mV in one minute as shown in fig. 2.0. The large negative dip potential means the 0.5M trichloroacetic acid is highly corrosive in nature. In presence of Schiff base inhibitors, the potential shifts in the positive direction, the change in potential with time for 0.5% concentration of the four Schiff bases (SB-I, SB-II, SB-III and SB-IV) is shown in figures from 3.0 to 6.0. It is observed that in the potential moves in negative direction rapidly in approximate one minute time from the initiation time and then it levels.

The weight loss data, the inhibition efficiencies, the dip potentials and shift in potentials are given in the table 1. It is found that as the shift of potential is more if the efficiency of inhibition is large. With 0.5% of the SB-I, the inhibition efficiency is found to be 57% in 0.5M trichloroacetic acid and on increasing the concentration of the inhibitor, the efficiency increases to 84% with 2.0% of SB-I was used. The shift of potential is found positive with respect to the absence of inhibitor for all concentration of the Schiff base.

In SB-II the potential shift observed is positive and with increase of concentration of the inhibitor and the weight loss efficiency increases from 7% in 0.5% SB-II to the 84% in 2.0% SB-II as shown in figures 1-6.

Table 1. Shift of Corrosion Potential of Mild Steel in 0.5M trichloroacetic in presence and absence of inhibitors

Name of Inhibitor	inhibitor concentration (in %)	Inhibitor Efficiency (%)	Potential (mV)	Shift in Potential (mV)
Nil	-----	-----	-0.370	-----
SB-I	0.5	57	-0.002	0.368
	1.0	70.5	-0.192	0.178
	1.5	77	-0.054	0.316
	2.0	84	-0.086	0.284
SB-II	0.5	7	-0.269	0.101
	1.0	39	-0.378	-0.008
	1.5	75	-0.232	0.138
	2.0	84	-0.162	0.208
SB-III	0.5	80	-0.007	0.363
	1.0	95	-0.198	0.172
	1.5	95	0.014	0.384
	2.0	89	-0.292	0.078
SB-IV	0.5	93	0.066	0.436
	1.0	95.5	-0.341	0.029
	1.5	98	-0.112	0.258
	2.0	98	-0.140	0.230



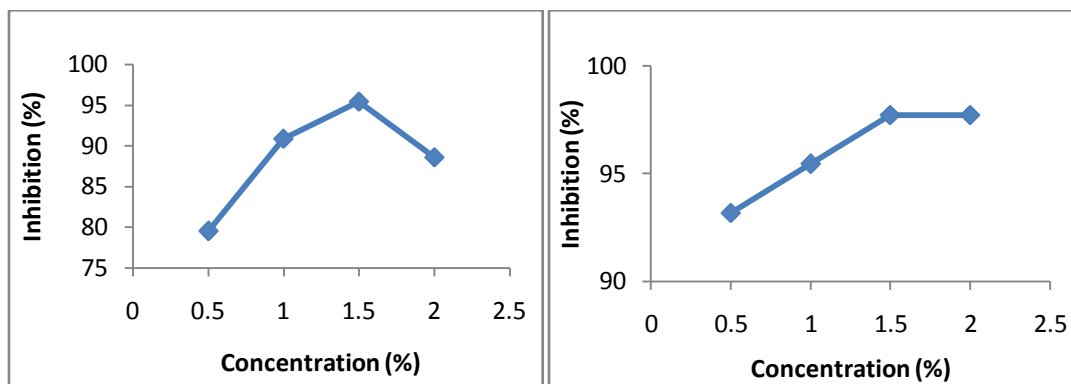


Fig.1. Effect of concentration on the inhibition efficiency of Mild Steel in 0.5M Trichloroacetic acid at 35 ± 1 °C and 1 hour period of immersion

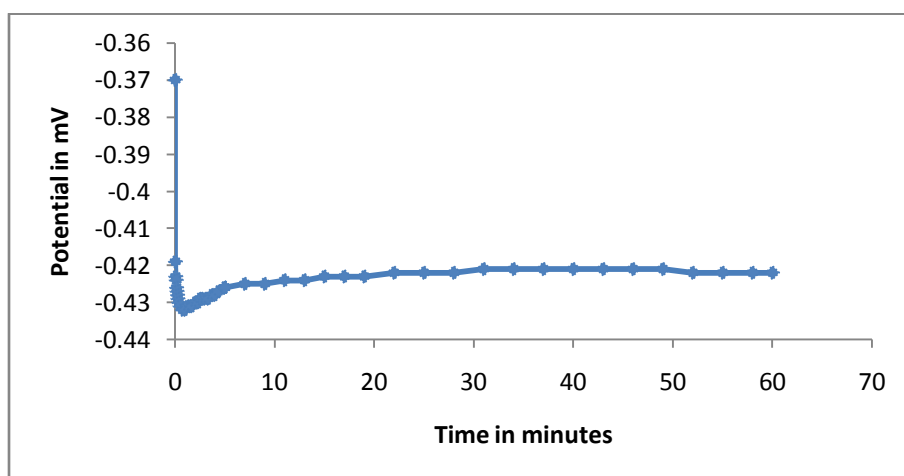


Fig.2.0. Change in Corrosion Potential of Mild Steel with Time in 0.5M trichloroacetic acid

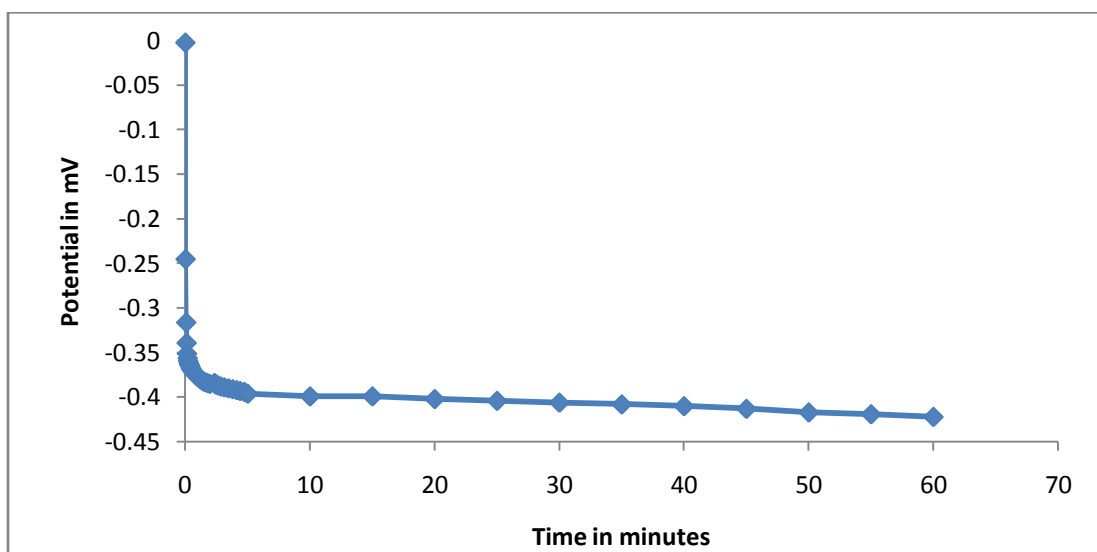


Fig.3.0. Change in Corrosion Potential of Mild Steel with Time in 0.5M trichloroacetic acid in 0.5% SB-I

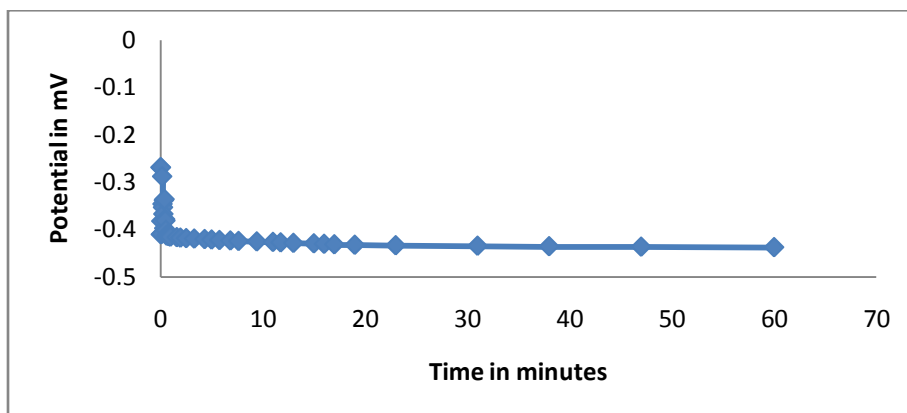


Fig.4.0. Change in Corrosion Potential of Mild Steel with Time in 0.5M trichloroacetic acid in 0.5% SB-II

Without inhibitor, the value of potential is more negative as compared to in presence of inhibitor. After adding inhibitor to 0.5M trichloroacetic acid the value of dip potential may be positive or negative but the shift of potential (i.e. difference of potential) is positive. This shows cathodic polarization has occurred [40]. The shift in the positive direction indicates that the immediate passivation of the metal surface takes place and the formation of the protective film due to adsorption at cathodic area. The negative potential means insufficient coating of the inhibitor on the surface and localized attack of the acid. Thus the Schiff bases form a protective layer by adsorption on the mild steel and show maximum efficiency at particular concentration of the inhibitor. Effect of concentration on Inhibitor efficiency of Mild steel in 0.5M trichloroacetic acid at temperature 35 ± 0.1 °C and period of immersion 1 hour (Table 1) shows that efficiency increases with increase in concentration. Moreover maximum positive potential shift is observed at concentration of maximum efficiency.

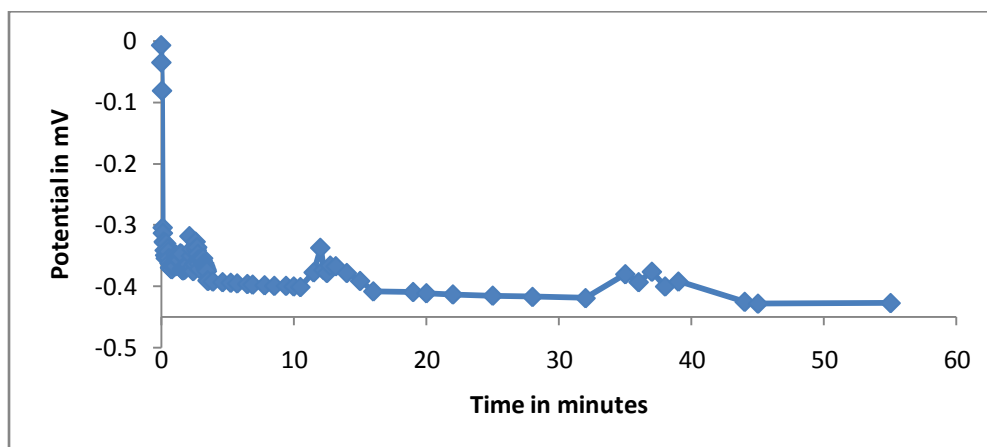


Fig.5.0. Change in Corrosion Potential of Mild Steel with Time in 0.5M trichloroacetic acid in 0.5% SB-III

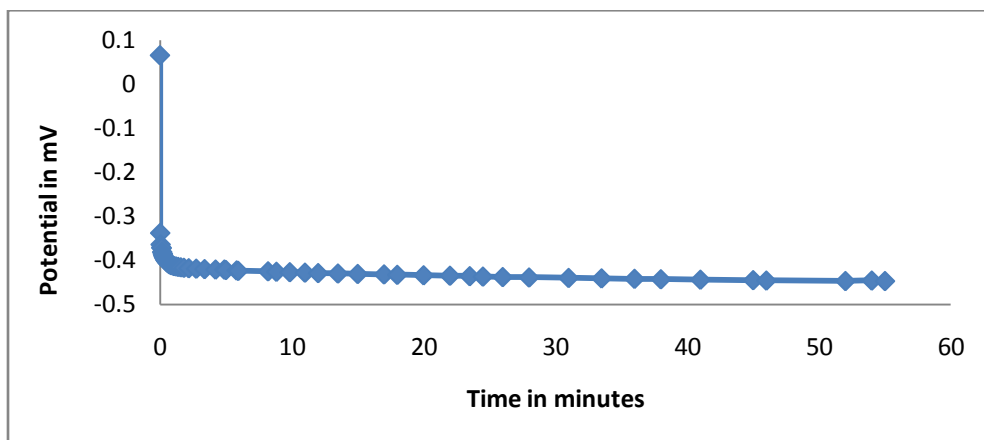


Fig.6.0. Change in Corrosion Potential of Mild Steel with Time in 0.5M trichloroacetic acid in 0.5% SB-IV

APPLICATIONS

The study is highly useful to screen the inhibitive properties of the selected Schiff bases by using potential measurement method. The N⁷-(3,4-dimethoxybenzylidene)pyridine-3-carbohydrazide (SB-I), N⁷-[(E)-(4-hydroxyphenyl) methylidene]pyridine-3-carbohydrazide (SB-II), N⁷-[(E)-phenylmethylidene] pyridine-3-carbohydrazide (SB-III) and N⁷-[(E)-(4-methoxy phenyl) methylidene]pyridine-3-carbohydrazide (SB-IV) Schiff bases are useful corrosion inhibitor for IS 2062 E 250 (Fe 410 W) B: 2006 mild steel in acidic environments.

CONCLUSIONS

From the present study, it is found that potentiodynamic method is only the screening method to evaluate the efficiency of the inhibitors and select compound as inhibitors. It is found that the shift in potential is more in positive direction more will the susceptibility of the inhibitor to inhibit the metal surface. The shift of potential is found maximum value in positive direction for the SB-IV and hence it exhibit maximum inhibition efficiency as predicted by weight loss method also. The inhibition increases on increasing the concentration of the inhibitor as revealed by both weight loss and potential measurement methods. Out of four Schiff bases used in the present study, the SB-IV is found to be more effective inhibitor for mild steel in 0.5M trichloroacetic acid.

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