International Journal of Scientific and Research Publications, Volume 4, Issue 3, March 2014 1
ISSN 2250-3153

Cystein as a Corrosion Inhibitor for Zinc in Acidic Solutions

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Abstract- The amino acid, cystein was examined as an inhibitor for zinc in 0.5N HCl was using weight loss and potentiodynamic polarization studies. Corrosion parameters such as inhibition efficiency, corrosion rates, corrosion potential and corrosion current were evaluated. The inhibition efficiency was found to increase with increase in the inhibitor concentration. The adsorption of the inhibitor on the zinc surface followed Temkin adsorption isotherm.

Index Terms- cystein , acidic solutions, zinc corrosion, weight loss , potentiodynamic polarization.

I. Introduction

Zinc metal corrosion attracted the attention of many researchers because of its use in many fields. One of the efficient and effective method of controlling corrosion is the use of inhibitors. Inhibitors are usually organic compounds with hetero atoms and multiple bonds. These compounds inhibit the corrosion of metals by adsorption process. A review of literature revealed that many organic compounds were employed as inhibitors for the corrosion of zinc in various aggressive environments[1-15]. In this work, the influence of cysteine as a corrosion inhibitor for zinc in 0.5N HCl acid solution was examined by weight loss and potentiodynamic polarization studies.

II. EXPERIMENTAL

The zinc specimens (≈ 98% purity) of size 5cm*2cm* 0.025cm were used for weight loss studies. Zinc specimens were polished with a series of emery papers of various grades from 400-1200, degreased with absolute ethanol and air dried. For polarization studie, zinc rod of the same composition, embedded in araldite, with an exposed area of 0.283 cm^2 was used. The inhibitor compound, cystein was obtained from the Loba chemicals, India. The corrosion medium was 0.5N HCl prepared from A.R grade HCl and deionised water.

Weight loss studies were carried out as reported earlier[16].From the weight loss experiments the % inhibition efficiency (I.E) and the degree of surface coverage (θ) were calculated by using the following equations.

$$I.E = \frac{Wo - Wi}{Wo} \; X\,100$$

$$\theta = \frac{Wo - Wi}{wo}$$

Where W_o and W_i are the weight loss of zinc in the absence and presence of the inhibitor respectively.

The corrosion rate (C.R) of the zinc was calculated by using the following equation.

$$C.R(mmy) = \frac{87.6\,W}{A\;t\;D}$$

Where W is the weight loss of the zinc (mg), A is the surface area of the zinc specimen(cm^2), t is the exposure time (h) and D is the density of the zinc metal (g/cm^3).

III. RESULTS AND DISCUSSION

The inhibition efficiency values and corrosion rates for the corrosion of zinc in 0.5N HCl in the presence of different concentrations of the inhibitor are presented in table-1.

Table 1Values of inhibition efficiency (%) and corrosion rates(mm/y) for the corrosion of zinc in 0.5N HCl.

Parameter	Cystein concentration (mM)				
	10	20	30	40	50
Inhibition efficiency	40.1	60.4	72.1	81.2	88.2
Corrosion rates	83.8	55.4	39.1	25.5	12.8

The results show that the inhibition efficiency increases and corrosion rates decreases with increase in the inhibitor concentration. The dependence of inhibition efficiency and corrosion rates on the concentration of the inhibitor is shown in figures-1and 2.

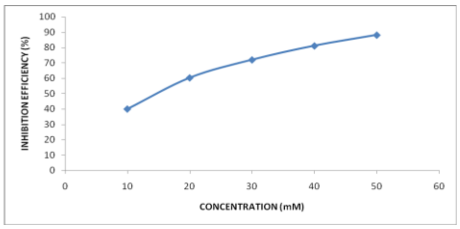

Figure 1 Variation of inhibition efficiency with concentration of the inhibitor.

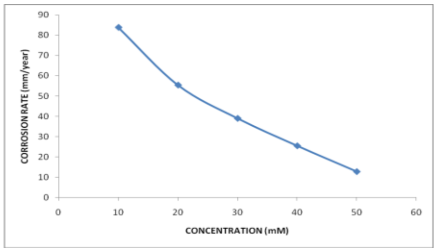

Figure 2 Variation of corrosion rates with concentration of the inhibitor.

Table-2 gives the various corrosion kinetic parameters such as corrosion potential (E_{corr}), corrosion current(I_{corr}) and anodic and cathodic Tafel slopes (b_a and b_c) obtained from the potentiodynamic polarization studies.

Table-2 The corrosion kinetic parameters obtained from polarization studies.

Inhibitor conc. (mM)	E_{corr} mV	Tafel slopes mV dec^{-1}		I_{corr} mA cm^{-1}	I.E (%)
		bc	ba		
Blank	-996	128	48	2.90	-
10	-960	134	52	1.71	40.9
20	-948	138	56	1.13	60.8
30	-941	144	59	0.78	73.1
40	-934	151	63	0.52	81.9
50	-929	158	68	0.35	87.5

From the table it can be observed that with the increase in the concentraton of the inhibitor, the values of E_{corr} for zinc becomes less negative indicating the strong adsorption of the inhibitor molecules on the metal surface leading to the reduction in corrosion of the metal. The values of I_{corr} decreases with the increase in the concentration of the inhibitor. This also indicates the reduction in the corrosion of the zinc in the presence of the inhibitor. The values of both ba and bc increases with increase in the concentration of the inhibitor .Both the values increase almost equally which indicates that the corrosion inhibition of zinc in 0.5N HCl is under mixed control. The values of inhibition efficiency obtained from the weight loss and polarization studies agree very well.

Cystein molecule possess sulphur, nitrogen and oxygen atoms which are potential adsorption centers due to the presence of lone pair of electrons on these atoms. With these electron pairs, these atoms can easily get attached with the metal surface by adsorption. This leads to the formation of strong, uniform layer of the inhibitor molecules on the metal surface. This layer acts as a barrier between the metal and the aggressive media, thus the metal gets protected.

IV. ADSORPTION ISOTHERMS

From the weight loss measurements the degree of surface coverage (θ) for various concentrations of the inhibitor were evaluated. Langmuir's isotherm was tested by plotting C/ θ vs C and no straight line was obtained which indicated that the adsorption of the inhibitor on the surface of the zinc from in 0.5N HCl does not obey Langmuir's adsorption isotherm. Then Temkin adsorption isotherm was tested by plotting log C Vs θ and a straight line was obtained, this shows that Temkin isotherm was followed. Figure -3 shows the Temkin adsorption isotherm plot for zinc in in 0.5N HCl.

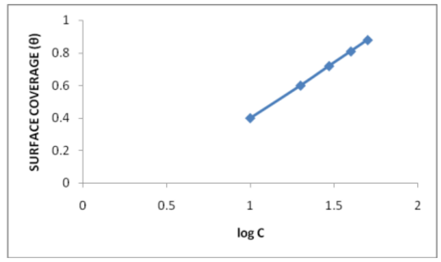

Figure 3 Temkin adsorption isotherm plot for zinc in 0.5 N HCl containing different concentrations of the inhibitor

V. CONCLUSIONS

The main conclusions drawn from this study are.
1.The inhibitor , cystein performed well in 0.5 N HCl and exhibited 88% of inhibition efficiency at 50 mM concentration of the inhibitor.
2. The inhibitor affects both the anodic and cathodic processes and hence the inhibitor is of mixed type.
3. The adsorption of the inhibitor on zinc metal surface from 0.5N HCl obeyed Temkin adsorption isotherm.

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