Ethyl Phenyl Sulphide as Corrosion Inhibitor for Zinc Metal in Acid Solutions

A.Pasupathy[1], S.Nirmala[1], G.Abirami[1], A.Satish[2] and R.Paul Milton[3]

[1]P.G and Research Department of Chemistry, Urumu Dhanalakshmi College, Tiruchirappalli, Tamil Nadu, India.
[2]Department of Chemistry, M.A.R college of Engineering and Technology, Viralimalai, Anna University, Tamil Nadu.
[3]Department of Chemistry, Kongunadu college of Engineering and Technology, Thottiam, Anna University, Tamil Nadu.

Abstract- In this work, ethyl phenyl sulphide was evaluated as a corrosion inhibitor for zinc in 0.5N H_2SO_4 by weight loss, gasometric and therometric methods. Results obtained reveals the fact that ethyl phenyl sulphide exhibited high inhibition efficiencies. The inhibition efficiency increased with increase in the inhibitor concentration. The adsorption of the inhibitor molecules on to the zinc metal surface obeyed Temkin adsorption isotherm.

Index Terms- Ethyl phenyl sulphide, acidic solutions, zinc corrosion, weight loss, gasometry, thermometry

I. Introduction

In order to remove the undesirable scale and rust formed on the surface of the metals acid solutions are widely used. Among the various acids, sulphuric acid is used often. During this process, unexpected metal dissolution and excess consumption of the acid occurs. To avoid these, inhibitors are generally used[1-12]. Inhibitors bring down the corrosion of metal dissolution by adsorption process whereby the inhibitor molecules are adsorbed on the metal surface and block the active sites. In the present work we have investigated ethyl phenyl sulphide as a corrosion inhibitor for zinc metal corrosion in 0.5N H_2SO_4 using weight loss, gasometric and therometric methods.

II. EXPERIMENTAL

The zinc metal specimens of composition: lead 1.03%, cadmium 0.04%, iron 0.001% and the remainder being zinc and size of 4cm*2cm* 0.08cm with a small hole of approximately 3mm near the end of the specimen were used in the present study. Zinc metal specimens were polished with a series of emery papers of various grades from 400- 1200, degreased with absolute ethanol and air dried. The inhibitor compound, ethyl phenyl sulphide was imported from the Sigma Aldrich chemicals of the USA. The corrosion medium was 0.5N H_2SO_4 prepared from A.R grade H_2SO_4 and deionised water.

Weight loss , gasometry and thermometry studies

Weight loss , gasometry and thermometry studies were conducted as reported earlier[13,17].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 the metal in the absence and presence of the inhibitor respectively.

The corrosion rate (C.R) of the metal 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 metal (mg), A is the surface area of the metal specimen(cm^2), t is the exposure time (h) and D is the density of the metal (g/cm^3).

From the gasometry experiments the inhibition efficiency was calculated by using the following equation.

$$I.E = \frac{Vo-Vi}{Vo} X\,100$$

Where V_o and V_i are the volume of hydrogen gas evolved in the absence and presence of the inhibitor respectively.

From the thermometric studies the reaction number was first calculated by using the equation

$$RN = \frac{Tm-Ti}{t}$$

Where Tm is the maximum temperature , Ti is the initial temperature and t is the time taken to attain the maximum temperature.

The inhibition efficiency is calculated by using the following equation

$$I.E = \frac{RNo-RNi}{RNo}$$

Where RN_o is the reaction number in the absence of the inhibitor and RN_i is the reaction number in the presence of various concentrations of the inhibitor.

III. RESULTS AND DISCUSSION

Values of inhibition efficiency obtained from the weight loss , gasometry and thermometry studies for the corrosion of zinc in 0.5N H_2SO_4 in the presence of different concentrations of ethyl phenyl sulphide are presented in the table1

ISSN 2250-3153

Table 1 Values of inhibition efficiency obtained from various experiments.

Method employed	Values of I.E(%) for different concentrations (mM) of ethyl phenyl sulphide				
	5	10	30	50	100
Weight loss	46.1	59.4	73.5	80.6	88.4
Gasometry	45.2	58.4	72.9	80.9	87.5
Thermometry	44.6	58.1	73.1	79.8	88.1

The results presented in the table1 shows that the inhibition efficiencies increase with increase in the inhibitor concentration.

The dependence of inhibition efficiency of the inhibitor on its concentration is shown in figure 1.

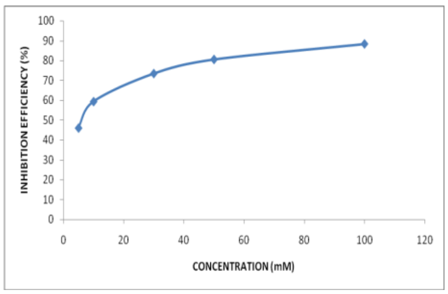

Figure- 1 Variation of inhibition efficiency with concentration of the ethyl phenyl sulphide for zinc in 0.5N H_2SO_4

Values of corrosion rates(mm/year) obtained from the weight loss experiments for the inhibition for the corrosion of zinc in 0.5N H_2SO_4 in the presence of different concentrations of ethyl phenyl sulphide is presented in the table 2.

Table 2 Values of corrosion rates(mm/year) from the weight loss measurements

Values of corrosion rates (mm/y) for different concentrations (mM) of ethyl phenyl sulphide				
5	10	30	50	100
55.5	42.8	27.3	19.9	11.9

From the table 2 it can be observed that the corrosion rates for the corrosion of zinc in 0.5N H_2SO_4 decreases with increasing concentration of the inhibitor. The effect of inhibitor concentration on the corrosion rates is shown in figure 2.

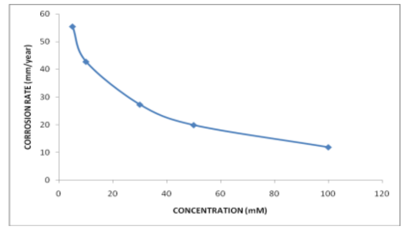

Figure- 2 Variation of corrosion rates with concentration of the ethyl phenyl sulphide inhibitor for zinc in 0.5N H_2SO_4.

The inhibitor molecule contains one phenyl group and one ethyl group attached to a central sulphur atom. The sulphur atom with its two lone pairs of electrons can get adsorbed on the metal surface leading to the formation of a thin film, which protects the metal from the acid solution. The ethyl group being electron releasing in nature (+Ieffect) releases electrons towards the sulphur atom making it more electron rich and facilitating the adsorption process resulting in more protection to the metal. The phenyl group which is also attached to the sulphur atom is a rich source of π-electrons. The adsorption of the inhibitor molecules can also take place via the π-electrons of the aromatic ring leading to enhanced protection to the metal. As both the phenyl group and the ethyl group are bulkier in nature, they offer more surface coverage to the metal resulting in enhanced protection to the metal against the corrosive attack of the acid solution.

IV. ADSORPTION ISOTHERMS

From the weight loss values the degree of surface coverage (θ) for various concentration of ethyl phenyl sulphide inhibitor were determined and plotted against log C for different concentrations of the inhibitor. A straight line was obtained indicating that the adsorption of the inhibitor on the zinc metal surface follows Temkin adsorption isotherm. Figure 3 shows the Temkin adsorption isotherm.

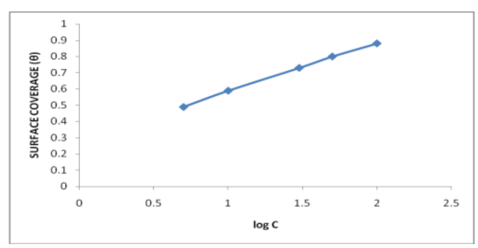

Figure-3 Temkin adsorption isotherm plot for corrosion of zinc in 0.5N H_2SO_4 containing different concentrations of inhibitor.

V. CONCLUSIONS

The inhibitor, ethyl phenyl sulphide used in this work exhibited good inhibition efficiency. It gave 88% of inhibition efficiency at a concentration of 100 mM. Inhibition efficiency increased with increase in inhibitor concentration. The adsorption of the inhibitor molecules on the metal surface obeys Temkin's adsorption isotherm.

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AUTHORS

First Author – A.Pasupathy, P.G and Research Department of Chemistry, Urumu Dhanalakshmi College, Tiruchirappalli, Tamil Nadu, India., Tel.: +919003427375, E-mail address: pasupathyudc@gmail.com(A.Pasupathy)
Second Author – S.Nirmala, P.G and Research Department of Chemistry, Urumu Dhanalakshmi College, Tiruchirappalli, Tamil Nadu, India.
Third Author –G.Abirami, P.G and Research Department of Chemistry, Urumu Dhanalakshmi College, Tiruchirappalli, Tamil Nadu, India.
Fourth Author – A .Satish, Department of Chemistry, M.A.R college of Engineering and Technology, Viralimalai, Anna University, Tamil Nadu.
Fifth Author – R.Paul Milton, Department of Chemistry, Kongunadu college of Engineering and Technology, Thottiam, Anna University, Tamil Nadu.