Dibutyl Sulphide as Corrosion Inhibitor for Zinc Metal in Acid Solutions

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Abstract- The efficiency of dibutyl sulphide as zinc corrosion inhibitor in 0.5N HCl and 0.5N H_2SO_4 was studied by the conventional weight loss and gasometry methods. Results obtained from this study revealed that dibutyl sulphide exhibited good inhibiting action. The inhibition efficiency of dibutyl sulphide increased with the increase in inhibitor concentration. The inhibitor obeyed Temkin adsorption isotherm.

Index Terms- Dibutyl sulphide, acidic solutions, zinc corrosion, weight loss, gasometry.

I. Introduction

Corrosion inhibitors are compounds which are added in small quantities to the corrosive environment in order control or prevent the corrosion of metals and alloys[1-29]. The inhibitive action of the inhibitors is based on the adsorption of the inhibitor molecules on the metal surface .In the present work, dibutyl sulphide was evaluated as an inhibitor for zinc corrosion in 0.5N HCl and 0.5N H_2SO_4 using the conventional weight loss and gasometry 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 were used in these studies. Zinc metal specimens were abraded with a series of emery papers of various grades from 200- 1200, degreased with absolute ethanol and air dried. The inhibitor compound, dibutyl sulphide was an imported sigma Aldrich sample.. The corrosion medium was 0.5N HCl and 0.5N H_2SO_4 prepared from A.R grade HCl and H_2SO_4 and deionised water.

Weight loss and gasometry studies

Weight loss and gasometry studies were conducted as reported earlier[30-31]. 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 is 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.

III. RESULTS AND DISCUSSION

Values of inhibition efficiency obtained from the weight loss and gasometry experiments for the inhibitor for the corrosion of zinc in 0.5N HCl and 0.5N H_2SO_4 in the presence of different concentrations of dibutyl sulphide are presented in the tables 1and 2 respectively.

Table 1 Values of inhibition efficiency obtained from the weight loss experiments.

Corrosive medium	Values of I.E(%) for different concentrations (mM) of dibutyl sulphide				
	5	10	30	50	100
0.5N HCl	38.1	52.3	74.0	82.5	92.4
0.5N H_2SO_4	48.7	61.5	78.2	86.5	96.4

Table 2 Values of inhibition efficiency obtained from the gasometry experiments.

Corrosive medium	Values of I.E(%) for different concentrations (mM) of dibutyl sulphide				
	5	10	30	50	100
0.5N HCl	37.6	52.4	73.8	81.9	92.6
0.5N H_2SO_4	48.5	61.1	77.9	86.8	95.9

It can be seen from these tables that dibutyl sulphide performed better in 0.5N H_2SO_4 than in 0.5N HCl. A similar observation has already been made by several authors[32-37]. It can also be observed that the inhibition efficiencies increases with increase in the inhibitor concentration.

The inhibitor molecule possess a sulphur atom and two butyl groups. The sulphur atom with its two lone pairs of electrons gets adsorbed on the positively charged metal surface. This leads to the formation of a thin film on the metal surface offering protection to the metal. The inhibitor used in this study contains two bulky butyl groups in its molecular structure. Butyl groups are electron releasing in nature (+ I effect.). Due to this, the electron density on the sulphur atom increases resulting in more adsorption of the inhibitor molecule on to the metal surface leading to more protection hence more inhibition efficiency.

The sulphur atom in the inhibitor molecule in acid medium can get protonated to some extent to form the cationic form of the inhibitor. The chloride and sulphate ions in the corrosive medium with less degree of hydration gets specifically adsorbed on the positively charged metal surface leading to the creation of excess negative charges on the metal surface which fecilitates more adsorption of the protonated form of the inhibitor molecules and hence more protection of the metal.

The bulky nature of the butyl groups play an important role in the reduction of the corrosion rates. After getting adsorbed on the metal surface through the sulphur atom, the bulky butyl groups offers more surface coverage to the metal from the aggressive media, leading to more corrosion inhibition. Infrared spectrum confirm that a metal sulphur bond may exist between the sulphur atom of the inhibitor and the metal[38]. The variation of inhibition efficiency with the concentration of the inhibitor is shown in figure 1.

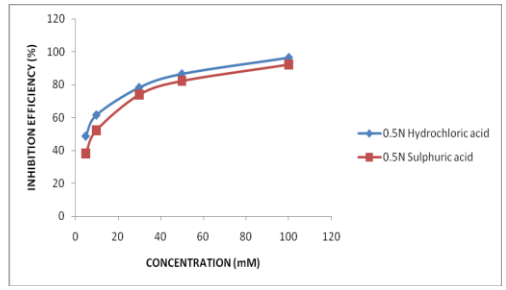

Figure- 1 Variation of inhibition efficiency with concentration of the dibutyl sulphide inhibitor for zinc in 0.5N HCl and 0.5N H_2SO_4

Values of corrosion rates(mm/year) obtained from the weight loss experiments for the inhibition for the corrosion of zinc in both the acids in the presence of different concentrations of the inhibitor are presented in the table 3.

Table 3 Values of corrosion rates(mm/year) from the weight loss measurements

Corrosive medium	Values of corrosion rates(mm/year) for different concentrations (mM) of dibutyl sulphide				
	5	10	30	50	100
0.5N HCl	86.6	66.8	36.4	24.5	10.6
0.5N H_2SO_4	52.8	39.7	22.5	13.9	03.7

From the table 3 it can be observed that the corrosion rates for the corrosion of zinc in both acids decreases with increasing concentration of the inhibitor. The effect of inhibitor concentration on the corrosion rates is shown in figure 2.

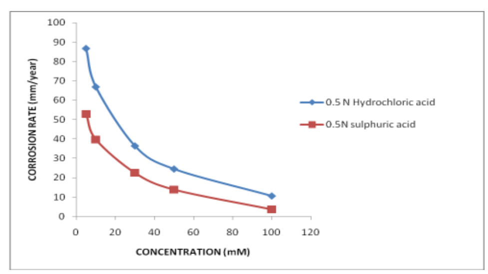

Figure- 2 Variation of corrosion rates with concentration of the dibutyl sulphide inhibitor for zinc in 0.5N HCl and 0.5N H_2SO_4

IV. ADSORPTION ISOTHERMS

From the weight loss experiments, the degree of surface coverage (θ) for various concentration of the inhibitor were determined and plotted against log C for different concentrations of the inhibitor. A straight line was obtained. This shows that Temkin adsorption isotherm was obeyed. Figure 3 shows the Temkin adsorption isotherm.

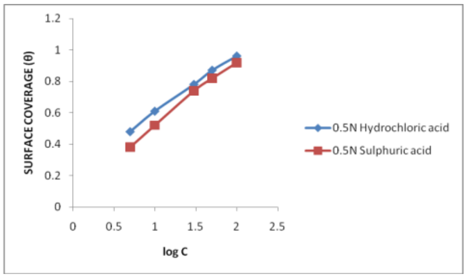

Figure-3 Temkin adsorption isotherm plot for corrosion of zinc in 0.5N HCl and 0.5N H_2SO_4 containing different concentrations of inhibitor.

V. CONCLUSIONS

The inhibitor dibutyl sulphide used in this work exhibited good inhibition efficiency.Inhibition efficiency increases with increase in inhibitor concentration. The inhibitor performed better in in 0.5N H_2SO_4 than in 0.5N HCl.The adsorptionof the inhibitor molecules on the metal surface obeyed Temkin's adsorption isotherm.

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