1,4-Diaminobutane as Corrosion Inhibitor for Zinc in Hydrochloric Acid Medium

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Abstract- 1,4-diaminobutane was examined as a corrosion inhibitor for zinc in 0.5N hydrochloric acid by weight loss, gasometry and thermometry methods. Results obtained showed that the inhibition efficiency increased with increase in the concentration of the inhibitor. The adsorption of the inhibitor molecules on the zinc metal surface obeyed Temkin adsorption isotherm.

Index Terms- 1,4-diaminobutane, zinc corrosion, weight loss, gasometry, thermometry and acid solutions.

I. Introduction

Interaction of a metal with its environment leads to its deterioration, commonly referred to as corrosion. Organic compounds containing hetero atoms are widely used as corrosion inhibitors in various aggressive environments[1-8]. Corrosion inhibitors bring down the corrosion of metals by adsorption on the metal surface leading to the blockage of active sites on the metal surface. In the present work, we have examined 1,4-diaminobutane as an inhibitor for the corrosion of zinc in 0.5N hydrochloric acid employing weight loss, gasometry and thermometry methods. Five different concentrations of the inhibitor are used to evaluate the inhibition efficiency of 1,4-diaminobutane.

II. EXPERIMENTAL

The zinc metal specimens used in this work has the following composition: lead 1.03%, cadmium 0.04%, iron 0.001% and the remainder being zinc. Zinc metal specimens of size 4cm*2cm* 0.08cm were polished with a series of emery papers of various grades from 400-1200, degreased with absolute ethanol and air dried. The corrosion medium used was 0.5N HCl prepared from A.R grade HCl and deionised water.

Weight loss, gasometry and thermometric studies were carried out as reported earlier[9-13]. 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.

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 experiments for the corrosion of zinc in 0.5N HCl in the presence of different concentrations of the inhibitor are presented in the table-1

Table-1 Values of inhibition efficiency obtained from the weight loss, gasometry and thermometry experiments

Method employed	Values of I.E(%) for different concentrations (mM) of 1,4-diaminobutane				
	10	20	30	40	50
Weight loss	44.8	58.7	67.4	73.8	79.1
Gasometry	44.3	58.1	66.8	74.2	78.8
Thermometry	43.9	59.2	67.9	73.2	78.3

The inhibition efficiency values obtained from weight loss, gasometric and thermometric methods agree very well. With increase in the concentration of the inhibitor , the inhibition efficiency values also increases. The dependence of inhibition efficiency of the inhibitor on its concentration is shown in figure-1

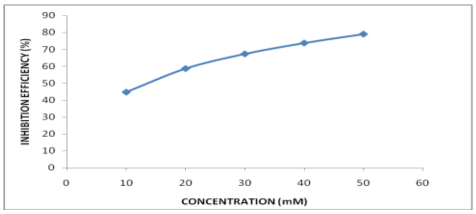

Figure 1 Variation of inhibition efficiency with concentration of the inhibitor.

Values of corrosion rates obtained from the weight loss experiments are presented in the table-2

Table 2 Values of corrosion rates obtained from the weight loss measurements.

Corrosion rate (mm/y) for different concentrations (mM) of inhibitor				
10	20	30	40	50
77.3	57.8	45.6	36.7	29.3

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

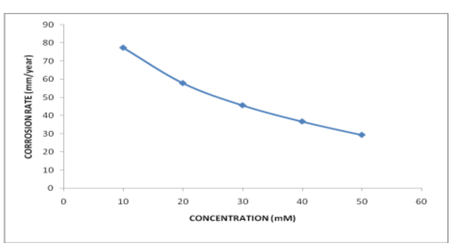

Figure 2 Variation of corrosion rate with concentration of the inhibitor

The inhibitor molecule contains two primary amino groups, in its molecular structure which are potential adsorption centres, through which the inhibitor molecule can get adsorbed on the zinc surface leading to the formation of a layer on the zinc metal surface. This layer acts as a barrier between the zinc metal and the corrosive media giving protection to the zinc metal. In addition to these, in acid medium, the two primary amino groups present in the molecule can be easily protonated to form the cationic form of the inhibitor. The chloride ions present in the acid medium gets adsorbed specifically on the positively charged zinc metal surface due to its lesser degree of hydration leading to the creation of excess negative charges on the zinc surface which favours the adsorption of these cationic form of the inhibitor molecules on the zinc metal surface resulting in the enhanced protection of zinc metal.

IV. ADSORPTION ISOTHERMS

From the weight loss measurements, the degree of surface coverage (θ) for various concentrations of the inhibitor were evaluated. Temkin's adsorption isotherm was tested by plotting logC vs θ which resulted in a straight line thereby showing that the adsorption of the inhibitor on the surface of zinc from 0.5N HCl obeys Temkin's adsorption isotherm. Figure-3 shows the Temkin adsorption isotherm plot for zinc in 0.5N HCl containing different concentrations of the inhibitor.

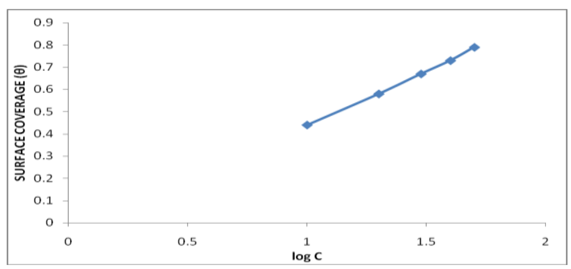

Figure 3 Temkin adsorption isotherm plot for zinc in 0.5N HCl containing different concentrations of the inhibitor

V. CONCLUSIONS

1,4-diaminobutane used as a corrosion inhibitor for zinc in 0.5N HCl performed well. It exhibited a maximum inhibition efficiency of 79.1 % at 50 mM concentration. The adsorption of the inhibitor on zinc surface obeyed Temkin adsorption isotherm.

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