

# Dipropyl Sulphide as Corrosion Inhibitor for Zinc in Sulphuric Acid Medium

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**Abstract-** In this work, dipropyl sulphide was evaluated as a corrosion inhibitor for zinc in 0.5N sulphuric acid by weight loss, gasometry and thermometry methods. Results obtained revealed that the inhibitor performed well in the acid solution. 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-** Dipropyl sulphide, zinc corrosion, weight loss, gasometry, thermometry and acid solutions.

## I. INTRODUCTION

Generally acids such as hydrochloric acid and sulphuric acid are employed to remove the millscale and rust formed on the surface of the metals before their use. Corrosion inhibitors are used in these processes to minimize the metal loss and acid consumption<sup>1-10</sup>. Corrosion inhibitors retard the corrosion of metals by getting adsorbed on the metal surface there by blocking active sites on the metal surface. In the present work, we have evaluated dipropyl sulphide as an inhibitor for the corrosion of zinc in 0.5N sulphuric acid using weight loss, gasometry and thermometry methods. Five different concentrations of the inhibitor are used to evaluate the inhibition efficiency of dipropyl sulphide.

## 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 H<sub>2</sub>SO<sub>4</sub> prepared from A.R grade H<sub>2</sub>SO<sub>4</sub> and deionised water.

Weight loss, gasometry and thermometric studies were carried out as reported earlier<sup>11-15</sup>. From the weight loss experiments the % inhibition efficiency (I.E) and the degree of surface coverage ( $\theta$ ) were calculated by using the following equations.

$$I.E = \frac{w_o - w_i}{w_o} \times 100$$

$$\theta = \frac{w_o - w_i}{w_o}$$

Where W<sub>o</sub> and W<sub>i</sub> 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<sup>2</sup>), t is the exposure time (h) and D is the density of the metal (g/cm<sup>3</sup>).

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

$$I.E = \frac{V_o - V_i}{V_o} \times 100$$

Where V<sub>o</sub> and V<sub>i</sub> 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

$$RN = \frac{T_m - T_i}{t}$$

Where T<sub>m</sub> is the maximum temperature, T<sub>i</sub> 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

$$I.E = \frac{RN_o - RN_i}{RN_o}$$

Where RN<sub>o</sub> is the reaction number in the absence of the inhibitor and RN<sub>i</sub> is the reaction number in the presence of various concentrations of the inhibitor.

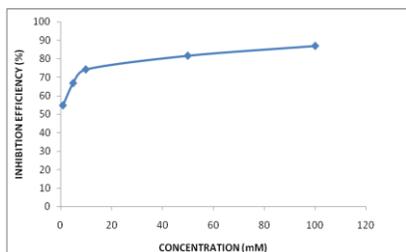
## III. RESULTS AND DISCUSSION

Values of inhibition efficiency obtained from the weight loss gasometry and thermometry experiments for the corrosion of zinc in 0.5N H<sub>2</sub>SO<sub>4</sub> in the presence of different concentrations of the inhibitor are presented in the table-1

**Table-1 Values of inhibition efficiency (I.E(%)) obtained from the weight loss and gasometry experiments for the corrosion of zinc in 0.5N H<sub>2</sub>SO<sub>4</sub> in the presence of different concentrations of the inhibitor.**

Method employed	Values of I.E(%) for different concentrations (mM) of dipropyl sulphide				
	1	5	10	50	100
Weight loss	54.8	66.8	72.2	81.6	86.9
Gasometry	55.2	66.1	73.8	80.9	86.4
Thermometry	56.1	67.2	73.5	81.2	86.0

It can be observed from the table 1 that there is very good agreement between the values of inhibition efficiency obtained from weight loss, gasometric and thermometric methods. The results also show that the inhibition efficiency increases with increase in the inhibitor concentration. The dependence of inhibition efficiency of the inhibitor on its concentration is shown in figure-1



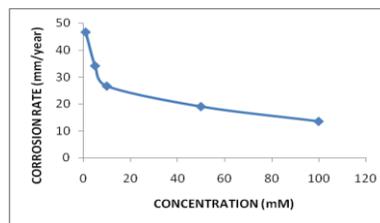
**Figure 1 Variation of inhibition efficiency with concentration of the inhibitor.**

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				
1	5	10	50	100
46.6	34.1	28.6	19.0	13.5

From table-2 it can be observed that the corrosion rate of zinc in 0.5N H<sub>2</sub>SO<sub>4</sub> decreases with increasing concentration of the inhibitor. The effect of inhibitor concentration on the corrosion rates is shown in figure-2.

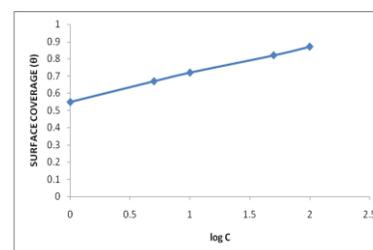


**Figure 2 Variation of corrosion rate with concentration of the inhibitor**

The inhibitor used in this study contains two propyl groups attached to a central sulphur atom. Adsorption of the inhibitor molecule on to the metal surface occurs through the two lone pairs of electrons present in the sulphur atom. The presence of two propyl groups facilitates the adsorption process due to the electron releasing nature of the propyl groups (+I effect). The two propyl groups release electrons towards the sulphur atom and makes it more electron rich, which results in enhanced adsorption. Due to adsorption of the inhibitor molecules on to the metal surface, a uniform and strongly adherent layer is formed on the metal surface which protects the metal from the aggressive acid environment. Apart from the electron releasing nature of the propyl groups, it offers higher surface coverage to the metal surface after getting adsorbed on to the metal surface because of their bulkier nature. This factor also contributes to the good inhibition efficiency exhibited by the inhibitor.

#### IV. ADSORPTION ISOTHERMS

Adsorption of inhibitor molecules on the metal surface is characterized by various adsorption isotherms such as Langmuir, Temkin, Freundlich etc., From the weight loss measurements, the degree of surface coverage ( $\theta$ ) for various concentrations of the inhibitor were evaluated. Langmuir's isotherm was tested by plotting  $C/\theta$  vs  $C$  for all concentrations which does not give a straight line indicating that the adsorption of the inhibitor on the surface of the zinc from 0.5N H<sub>2</sub>SO<sub>4</sub> does not obey Langmuir's adsorption isotherm. Temkin's adsorption isotherm was tested by plotting  $\log C$  vs  $\theta$  which resulted in a straight line thereby showing that the adsorption of the inhibitor on the surface of zinc from 0.5N H<sub>2</sub>SO<sub>4</sub> obeys Temkin's adsorption isotherm. Figure-3 shows the Temkin adsorption isotherm plot for zinc in 0.5N H<sub>2</sub>SO<sub>4</sub> containing different concentrations of the inhibitor.



**Figure 3 Temkin adsorption isotherm plot for zinc in 0.5N H<sub>2</sub>SO<sub>4</sub> containing different concentrations of the inhibitor**

## V. CONCLUSIONS

The dipropyl sulphide used as a corrosion inhibitor for zinc in 0.5N H<sub>2</sub>SO<sub>4</sub> performed well and gave high percentage of inhibition efficiency. It exhibited a maximum inhibition efficiency of 86.0 % at 100 mM concentration. The adsorption of the inhibitor on zinc surface obeyed Temkin adsorption isotherm.

## REFERENCES

- [1] M.S. Abdel-Aal, Z.A. Ahmed, M.S. Hassan, J. Appl. Electrochem. 22 (1992) 1104.
- [2] C.A. Witt, I. Drzisga, W. Kola, Metal. 39 (1985) 828.
- [3] I.A. Ahmed, S. Abdel-Hakim, Anti-Corrosio. 3 (1989) 4.
- [4] H. Mansour, G.A. Noubi, M.H. Abu-Elwaia, J. Electrochem. Soc. India. 34 (1985) 237.
- [5] M. Troquet, J. Pegeiti, Electrochim. Acta 27 (1982) 197.
- [6] L. Horner, E. Plicke, Werkstoffe und Korrosion. 37 (1986) 457.
- [7] C. Fiaud, S. Bensarsa, I. Demesy des Aulnios, M. Tzinmann, Br. Corros. J. 22 (1987) 109.
- [8] K. Wipperman, J.W. Shultze, R. Kessel, J. Penninger, Corros. Sci. 32 (1991) 205.
- [9] A.S. Fouda, A.H. Elasklary, L.H.M. Maadkeur, J. Indian Chem. Soc. 22 (1984) 425.
- [10] C.S. Venkatachalam, S.R. Rajagopalan, M.V.C. Sastry, Electrochim. Acta. 26 (1981) 1257.
- [11] S.Muralidharan, M.A.Quraishi and Venkata krishna Iyer, Corros.Sci.,37(1995) 39

- [12] S.Rengamani, S.Muralidharan and Venkata krishna Iyer, Ind.Jour.Chem.Tech, 1 (1995) 168
- [13] B.N.Oza and R.S.Sinha, Trans.SAEST, 17(1982) 281.
- [14] R.K.Upadhyay and S.P.Mathur, E.J.Chem 4(2007)408.
- [15] A.Y.El-Etre, Corros.Sci.43(2001)1031

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