# Ethyl Methyl Sulphide as a Corrosion Inhibitor for Zinc Metal in Acidic 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-*** Ethyl methyl sulphide was investigated as a corrosion inhibitor for zinc in 0.5N $H_2SO_4$ by weight loss, gasometric and thermometric methods. The inhibition efficiency was found to increase with increase in the inhibitor concentration. The adsorption of the inhibitor molecules on the zinc metal surface obeyed Temkin adsorption isotherm.

***Index Terms*-** Ethyl methyl sulphide, acidic solutions, zinc corrosion, weight loss, gasometry, thermometry.

## I. Introduction

Zinc metal finds wide applications such as electrode material in batteries, sacrificial anodes and metallic coatings. Therefore it is very important to find ways to protect zinc metal from aggressive environments. In industries various acids are widely used for the cleaning of metals and alloys. In this process metal loss occurs due to the dissolution of the metals in acids. In order to avoid metal loss and for reducing acid consumption many organic compounds are used as corrosion inhibitors. The presence of hetero atoms such as sulphur, oxygen and nitrogen, multiple bonds, aromatic rings in the molecular structure makes these compounds effective corrosion inhibitors. Literature survey shows that many organic compounds were used as corrosion inhibitors for zinc metal in various environments[1-15]. In the present work we have examined ethyl methyl sulphide as a corrosion inhibitor for zinc metal in 0.5N $H_2SO_4$ by weight loss, gasometry and thermometric 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 for weight loss gasometry and thermometry studies.. Zinc metal specimens were abraded with a series of emery papers of various grades from 400-1200, degreased with absolute ethanol and air dried. The inhibitor compound, ethyl methyl sulphide was obtained from the sigma aldrich chemicals of United States.. The corrosion medium was 0.5N $H_2SO_4$ prepared from A.R grade $H_2SO_4$ and deionised water.

**Weight loss, gasometry and thermometric studies** :

Weight loss, gasometry and thermometric studies were carried out as reported earlier[16-20]. 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 $T_m$ is the maximum temperature , $T_i$ 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 weight loss, gasometry and thermometry experiments for the corrosion of zinc in 0.5N $H_2SO_4$ 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, gasometry and thermometric experiments for the corrosion of zinc in 0.5N $H_2SO_4$ in the presence of different concentrations of the inhibitor.**

| Method employed | Values of Inhibition .Efficiency(%) | | | | |
|---|---|---|---|---|---|
| | 5 | 10 | 30 | 50 | 100 |
| Weight loss | 44.2 | 54.0 | 65.2 | 72.1 | 76.8 |
| Gasometry | 43.8 | 54.9 | 64.8 | 71.5 | 75.6 |
| Thermometry | 44.4 | 53.4 | 65.7 | 72.8 | 75.2 |

It can be seen from the table 1 that there is very good agreement between the values of inhibition efficiency obtained from these three 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 the concentration is shown in figure-1

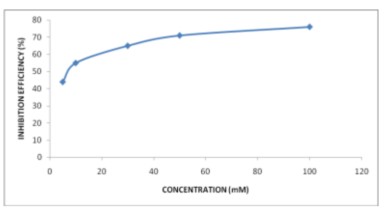


**Figure 1 Variation of inhibition efficiency with concentration of the inhibitor.**

Values of corrosion rates obtained from the weight loss experiments for the inhibitor for the corrosion of zinc in 0.5N $H_2SO_4$ in the presence of different concentrations of the inhibitor are presented in the table-2

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

| Values of corrosion rates (mm/y) | | | | |
|---|---|---|---|---|
| 5 | 10 | 30 | 50 | 100 |
| 57.5 | 47.3 | 35.8 | 28.7 | 23.8 |

From the table-2 it can be seen 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.

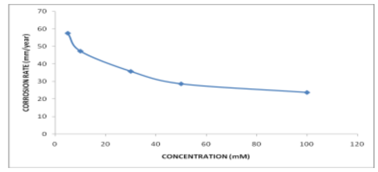


**Figure 2 Variation of corrosion rates with concentration of the inhibitor.**

The inhibitor used in this study contains one ethyl and one methyl 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 alkyl groups facilitates the adsorption process due to the electron releasing nature of the alkyl groups (+Ieffect). The two alkyl 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 alkyl 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

Basic information regarding the interaction between the metal surface and the inhibitor molecules can be obtained from the adsorption isotherms. Adsorption of inhibitor molecules on the metal surface is characterized by various adsorption isotherms such as Langmuir, Temkin, Freundlisch etc., From the weight loss measurements the degree of surface coverage ($\theta$) for various concentrations of the inhibitor were evaluated. Temkin's adsorption isotherm was tested by plotting logC vs $\theta$ which resulted in a straight line thereby showing that the adsorption of the inhibitor on the surface of zinc from 0.5N $H_2SO_4$ obeys Temkin's adsorption isotherm. Figure -3 shows the Temkin adsorption isotherm plot for zinc in 0.5N $H_2SO_4$ containing different concentrations of the inhibitor.

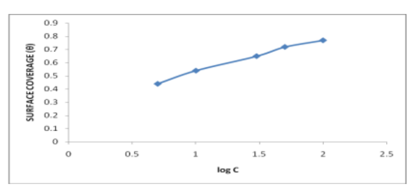


**Figure 3 Temkin adsorption isotherm plot for zinc in 0.5N $H_2SO_4$ containing different concentrations of the inhibitor**

## V. CONCLUSIONS

Ethyl methyl sulphide used as a corrosion inhibitor for zinc in 0.5N $H_2SO_4$ performed well and gave high percentage of inhibition efficiency. The inhibition efficiency of the inhibitor increases with the increase in its concentration. The adsorption of the inhibitor molecules on zinc surface obeyed Temkin adsorption isotherm.

## REFERENCES

[1] Kawai,S., Kato,H., Hatoushika, Y., and Yasumasa,M., Denki Kagaku, 43, (1975) 127.
[2] Cavallaro, L., Felloni, L., and Trabanelli, G., 1st Euro.Symp.Corro. Inhibition, University of Ferrara, Ferrara, Italy, (1960) p 129.
[3] Antropov, L.I., Zasch. Metal. 6, (1970) 440.
[4] Biallazo, S., Elektrokhimiya, 1, (19651137).
[5] Aziz, K., and Shams El din A.M., Corros.Sci, 5, (1965)489.
[6] Ramamani, R., and Shanmuganadhan, S.P., Current Science, 37, (1968)39.
[7] Machu, W., and Gouda, V.K., Werkst.Korro. 13, (1962)745.
[8] Antropov, L.I., Zasch. Metal. 6, (1970)440.
[9] Elkhar Abo, B., Mostafa, K.M., Kamal,I.A., and Abdel Hamid, K., Ind.J.Chem, 15A, 0 (1977)1010.
[10] Abdel Aal, M.S., Abdel Wahab, A.A., and El Saeed, A., Corrosion, 37, (1981)557.
[11] Stupnisek – Lisac, E., Podbrscek, S., and Soric, T., J. Appl. Electrochem, 24, (1994)779.
[12] Stupnisek – Lisac, E., Kasumic, D., and Varkapic – Furae, Corrosion, 51, (1997)767.
[13] Mourad, M.Y., Saliman, S.A., and Elmetaal, Bull . Soc. Chim, France, 6, (1991)832.
[14] Mani, N., Venkatakrishna Iyer, S., and Lal Bahadur, Trans. SAEST, 38, (2003)67.
[15] Agarwal, Y.K., Talati, J.D., Shah, M.D., Desai, M.N., and Shah, N.K., Corros.Soc, 46, (2003)633.
[16] S.Muralidharan, M.A.Quraishi and Venkatakrishna Iyer, Corros.Sci.,37(1995) 1739.
[17] S.Rengamani, S.Muralidharan and Venkatakrishna Iyer, Ind.Jour.Chem.Tech, 1 (1995) 168
[18] B.N.Oza and R.S.Sinha, Trans.SAEST, 17(1982) 281.
[19] R.K.Upadhyay and S.P.Mathur, E.J.Chem 4(2007)408.
[20] A.Y.El-Etre, Corros.Sci.43(2001)1031

## 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.