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Glycylglycine as Corrosion Inhibitor for Zinc Metal in Acid Solutions

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Abstract- The effect of glycylglycine was evaluated as a corrosion inhibitor for zinc in 0.5N HCl by weight loss, gasometric and therometric methods. The inhibition efficiency was found to increase with increase in the inhibitor concentration. The adsorption of the inhibitor molecules on to the zinc metal surface obeyed Temkin adsorption isotherm.

Index Terms- Glycylglycine, acidic solutions, zinc corrosion, weight loss, gasometry, thermometry

I. Introduction

Though zinc metal stands at 23rd place in the relative abundance among the elements in the earth's crust, it stands at 4th place in terms of production and consumption worldwide. The first three being iron, aluminium and copper. Due to the numerous industrial applications, zinc metal protection against corrosion gained much attention among the researchers. One of the most efficient methods available for the metal protection is the use of inhibitors[1-9]. Inhibitors bring down the corrosion of metal dissolution by adsorption process. In the present work glycylglycine was evaluated as a corrosion inhibitor for zinc metal in 0.5N HCl using weight loss, gasometric and therometric techniques.

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 the present study. The metal specimens were polished , degreased with absolute ethanol and air dried. The inhibitor compound, glycylglycine was procured from Alfa Aesar chemicals of UK. The corrosion medium employed was 0.5N HCl prepared from A.R grade HCl and deionised water.

Weight loss , gasometry and thermometry studies

Weight loss , gasometry and thermometry studies were conducted as reported earlier[10-14].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 was 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 HCl in the presence of different concentrations of glycylglycine are presented in the table1 .

Table 1 Values of inhibition efficiency obtained from various experiments.

Method employed	Values of I.E(%) for different concentrations (mM) of glycylglycine				
	5	10	30	50	100
Weight loss	42.1	57.0	75.2	84.3	91.1
Gasometry	42.2	57.4	74.9	84.9	90.0
Thermometry	43.6	57.9	76.1	85.8	89.7

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

The relationship between the inhibition efficiency of the inhibitor and its concentration is shown in figure 1.

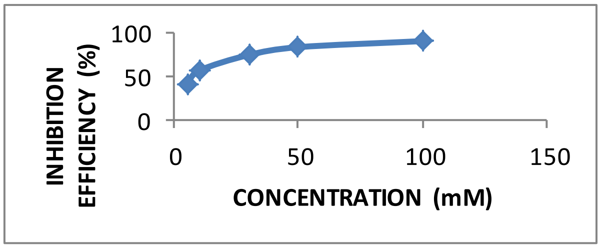

Figure- 1 Variation of inhibition efficiency with concentration of the glycylglycine for zinc in 0.5N HCl

Values of corrosion rates (mm/year) obtained from the weight loss experiments for the inhibition for the corrosion of zinc in 0.5N HCl in the presence of different concentrations of glycylglycine 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 glycylglycine				
5	10	30	50	100
81.2	60.2	35.0	22.4	12.6

From the table 2 it can be understood that the corrosion rates decreases with increasing concentration of the inhibitor. The effect of inhibitor concentration on the corrosion rates is shown in figure 2.

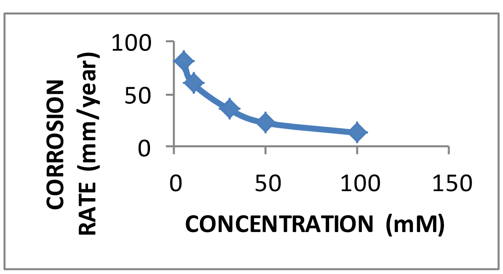

Figure- 2 Variation of corrosion rates with concentration of the glycylglycine inhibitor for zinc in 0.5N HCl.

The inhibitor molecule possess many heteroatoms in its molecular structure. These heteroatoms are potential adsorption centers, because they contain lone pairs of electrons. The inhibitor molecule gets adsorbed on to the zinc metal surface through these heteroatoms with lone pair of electrons. This adsorption of the inhibitor molecules on to the metal surface leads to the establishment of a thin film on the metal surface which offers protection to the metal from the acid attack. The inhibitor dipeptide, glycylglycine normally exists in the zwitter ionic form in solution. The chloride ions present in the acid medium adsorb specifically on the zinc metal surface due to its lesser degree of hydration resulting in the creation of excess negative charges on the metal surface. This increases the adsorption of the zwitter ionic form of the dipeptide on to the metal surface leading to enhanced protection of the metal.

IV. ADSORPTION ISOTHERMS

The degree of surface coverage (θ) for various concentration(C) of glycylglycine inhibitor was obtained from the weight loss measurements and plotted against log C. The plot resulted in a straight line indicating the adsorption of the inhibitor on to the zinc metal surface follows Temkin adsorption isotherm. Figure 3 shows the Temkin adsorption isotherm.

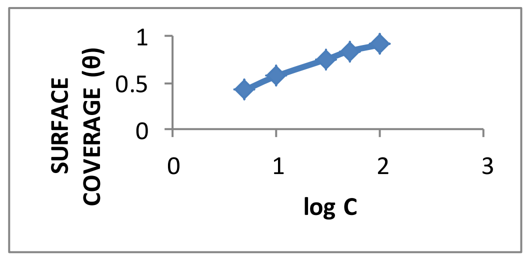

Figure-3 Temkin adsorption isotherm plot for corrosion of zinc in 0.5N HCl containing different concentrations of inhibitor.

V. CONCLUSIONS

The inhibitor, glycylglycine used in this work exhibited good inhibition efficiency. It gave 99.1% of inhibition efficiency at a concentration of 100 mM. Inhibition efficiency increased with increase in inhibitor concentration. The adsorption of the inhibitor molecules on to the metal surface obeys Temkin's adsorption isotherm.

REFERENCES

[1] Kawai,S., Kato,H., Hatoushika, Y., and Yasumasa,M., *Denki Kagaku*, 43, (1975) 127.

[2] Antropov, L.I., *Zasch. Metal*. **6**, (1970) 440.

[3] Biallazo, S., *Elektrokhimiya*, **1**, (19651137).

[4] Aziz, K., and Shams El din A.M., *Corros.Sci*, **5**, (1965)489.

[5] Ramamani, R., and Shanmuganadhan, S.P., *Current Science*, **37**, (1968)39.

[6] Machu, W., and Gouda, V.K., *Werkst.Korro*. **13**, (1962)745.

[7] Antropov, L.I., *Zasch. Metal*. **6**, (1970)440.

[8] Leroy, R.L., *Corrosion*, **34**, (1978)98.

ISSN 2250-3153

[9] Fouda, A.S., Madkour, L.H., Elshafei, A.A., and Elmaksoud, S.A.A., *Bull. Korean. chem.soc.*, **16**, (1995)454.

[10] S.Muralidharan, M.A.Quraishi and Venkatakrishna Iyer, Corros.Sci.,37(1995) 39

[11] S.Rengamani, S.Muralidharan and Venkatakrishna Iyer, Ind.Jour.Chem.Tech, 1 (1995) 168

[12] B.N.Oza and R.S.Sinha, Trans.SAEST, 17(1982) 281.

[13] R.K.Upadhyay and S.P.Mathur, E.J.Chem 4(2007)408.

[14] A.Y.El-Etre, Corros.Sci.43(2001)1031

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