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Tartrazine Dye as a Novel Corrosion Inhibitor for Zinc Metal in Acid Solutions

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Abstract- Weight loss and gasometry methods were employed to evaluate the inhibition efficiency of tartrazine dye as zinc corrosion inhibitor in 0.5 N H_2SO_4 . The results showed that the tartrazine dye is a very good inhibitor in 0.5N H_2SO_4. The dye exhibited more than 85% inhibition efficiency at a concentration of 30mM. The inhibition efficiency of the dye increased with the increase in the concentration of the dye. The adsorption of the dye obeyed Temkin adsorption isotherm.

Index Terms- Tartrazine dye, sulphuric acid, weight loss , gasometry.

I. Introduction

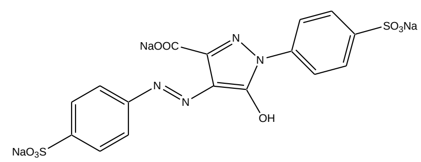
Among the various methods available for the protection of metals and alloys against corrosion in various aggressive media, the use of inhibitors occupies an importance place in the field of metallic corrosion. Many organic compounds containing hetero atoms such as nitrogen, sulphur and oxygen were employed as inhibitors for the protection of zinc metal corrosion in different aggressive media[1-19]. The presence of hetero atoms, multiple bonds and aromatic rings in the inhibitor molecules make them efficient corrosion inhibitors as these are regarded as good adsorption centers, through which adsorption of these molecules on the metal surface occurs, leading to the formation of a protective film.

Synthetic organic dyes are a class of compounds which possess most of the above mentioned characteristics, which makes them a prospective candidate to be employed as corrosion inhibitors. A review of the literature reveals the fact that many synthetic organic dyes have been used as corrosion inhibitors for various metals in different acidic media [20-27.]

In the present work, we have examined tartrazine dye as a corrosion inhibitor for zinc metal in 0.5 N H_2SO_4 using the conventional weight loss and gasometry methods.

II. EXPERIMENTAL

Weight loss and gasometry experiments were performed on zinc metal specimens of the following composition (wt %): lead 1.03, cadmium 0.04, iron 0.001 and the remainder being zinc and dimension 4cm * 2cm * 0.08cm. 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, tartrazine dye was obtained from the Loba chemicals, India. The corrosion medium employed was 0.5N H_2SO_4 prepared from A.R grade H_2SO_4 and deionised water. The following figure shows the molecular structure of the tartrazine dye.



Weight loss and gasometry studies

Weight loss and gasometry studies were carried out as reported earlier[28,29]. 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

Weight loss and gasometry studies were carried out at six different concentrations of the inhibitor and the inhibition efficiency(IE) values were calculated. Values of inhibition efficiency obtained from these experiments are presented in the table-1

Table- 1 Values of inhibition efficiency(I.E(%) obtained from the weight loss and gasometry experiments.

Method employed	Values of I.E(%) for different concentrations (mM) of tartrazine dye inhibitor					
	5	10	15	20	25	30
Weight loss	23.2	40.3	55.6	68.2	79.6	88.4
Gasometry	22.8	41.6	54.7	67.4	80.4	89.3

The results 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

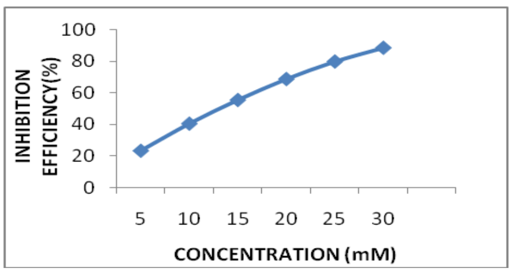


Figure-1 Variation of inhibition efficiency with concentration of the inhibitor.

The inhibitor molecule contains many hetero atoms namely sulphur, oxygen and nitrogen ,all of them possess lone pair of electrons. Through these lone pair of electrons they get adsorbed on the metal surface leading to the formation of a layer on the metal surface. This layer acts as a barrier between the metal and the corrosive media giving protection to the metal. The inhibitor also contains aromatic rings with lot of π electrons through which also adsorption of the inhibitor molecules on the metal surface can take place leading to enhanced protection. Another important factor responsible for the higher inhibition efficiency of the inhibitor is the large surface area of the inhibitor molecules which provides higher surface coverage to the metal after getting adsorbed on the metal surface.

Values of corrosion rates obtained from the weight loss 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-2

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

Values of corrosion rates(mm/y) for different concentrations (mM) of tartrazine dye inhibitor					
5	10	15	20	25	30
79.0	61.5	45.7	32.8	21.0	11.9

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.

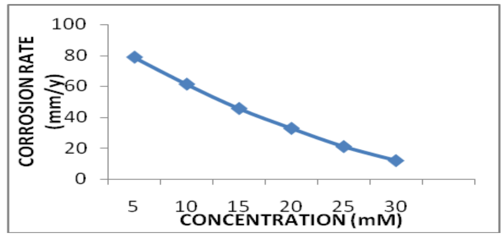


Figure 2 Variation of corrosion rates with concentration of the inhibitor.

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 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.

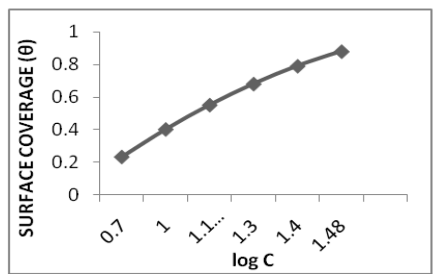


Figure 3 Temkin adsorption isotherm plot for zinc in 0.5N H_2SO_4 with different concentrations of the inhibitor

V. CONCLUSIONS

The tartrazine dye used as a corrosion inhibitor for zinc in 0.5N H_2SO_4 performed well and gave high percentage of inhibition efficiency. It exhibited a maximum inhibition efficiency of 89.3 % at 30mM concentration. The inhibition efficiency of the inhibitor increases with the increase in the concentration of the inhibitor. The adsorption of the inhibitor on zinc surface obeyed Temkin adsorption isotherm.

REFERENCES

[1] S.Kawai, H.Kato, Y.Hatoushika, and M.Yasumasa, Denki Kagaku, 43, (1975) 127.
[2] L.Cavallaro, L.Felloni, and G.Trabanelli, 1st Euro.Symp.Corro. Inhibition, University of Ferrara, Ferrara, Italy, (1960) p 129.
[3] L.I.Antropov, Zasch. Metal. 6, (1970) 440.
[4] S.Biallazo, Elektrokhimiya, 1, (1965)1137.
[5] K.Aziz, and A.M.Shams El din, Corros.Sci, 5, (1965)489.
[6] R.Ramamani and S.P.Shanmuganadhan, Current Science, 37, (1968)39.
[7] B.L.Jain and Gaur, J.N., J.Electrochem. Soc of India, 37, (1978)165.

[8] K.Balakrishnan, K.Ramakrishnaiah,M. Raghavan, B.Sathianadhan and N.Palaniswamy, Proc.8th Intl.Cong. Met. corros., Germany, (19811193).
[9] K.Ramakrishnaiah,Bull.Electrochem, 3, (1987) 97.
[10] M.Y.Mourad, S.A.Saliman and Elmetaal, Bull . Soc. Chim, France, 6, (1991)832.
[11] Y.K.Agarwal,J.D.Talati,M.D.Shah,M.N.Desai and N.K.Shah, Corros.Soc, 46, (2003)633.
[12] W.Machu and V.K.Gouda, Werkst. Korro. 13, (1962)745.
[13] L.I.Antropov, Zasch. Metal. 6, (1970)440.
[14] R.L.Leroy, Corrosion, 34, (1978)98.
[15] B.Elkhar Abo, K.M.Mostafa, I.A.Kamal and K.Abdel Hamid, Ind.J.Chem, 15A, 0 (1977)1010.
[16] M.S.Abdel Aal, A.A.Abdel Wahab and A.El Saeed, A., Corrosion, 37, (1981)557.
[17] E.Stupnisek Lisac, S.Podbrscek and T.Soric, J. Appl. Electrochem, 24, (1994)779.
[18] E.Stupnisek Lisac, D.Kasumic and Varkapic – Furae, Corrosion, 51, (1997)767.
[19] A.S.Fouda, L.H.Madkour, A.A.Elshafei andS.A.A.Elmaksoud, Bull. Korean. chem.soc., 16, (1995)454.
[20] E.E.Oguzie, C.Unaegbu ,C.N.Ogukwea B.N.Okolue andA.I. Onuchuku. Mater. Chem. Phys. 84(2004)364
[21] E.E.Ebenso and E.E.Oguzie Mater.Lett. 59 (2005)2163,.
[22] E.E. Oguzie , Mater.Lett.59(2005)1076.
[23] E.E.Oguzie ,C. Akalezi. and C.Enenebeaku. Pigm.Res. Technol.38(2009)359
[24] R.Q.Liu,L.Xiang, X.G.Zhang and X.Xia. Corros .Prot.22 (2001)98.
[25] J.Sathiyabama,S. Rajendran, J.O.Selvi and A.J.Amalraj,Indian J.Chem.Technol.15(2008)462.
[26] R.A.Prabu, T.V.Venkatesha and A.V. Shabhag ,J.Iran.Chem.Soc.6(2009)353.
[27] X.H.Li,S.D.Deng, H.Fu and T.H.Li, Corros.Sci. 52(2010)3413.
[28] S.Muralidharan, M.A.Quraishi and Venkatakrishna Iyer, Corros.Sci.,37(1995) 1739.
[29] S.Rengamani, S.Muralidharan and Venkatakrishna Iyer, Ind.Jour.Chem.Tech, 1 (1995) 168 .

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