Inhibitive Action of Aegle marmelos Extract on the Corrosion of Zinc in 0.5N H_2SO_4 Medium

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Abstract- The inhibitive action of the extract of the roots and fruits of *Aegle marmelos* was investigated as a green corrosion inhibitor for zinc in 0.5N H_2SO_4 employing weight loss, gasometric and thermometric methods. The results obtained revealed that the extract of the plant could be employed as an effective inhibitor for the corrosion of zinc in sulphuric acid medium.. The inhibition efficiency of the extract increased with increase in its concentration. The adsorption of the inhibitor molecules on the zinc metal surface obeyed Temkin adsorption isotherm.

Index Terms- *Aegle marmelos*, acidic solutions, zinc corrosion, weight loss, gasometry, thermometry.

I. Introduction

In the field of corrosion of metals, the inhibitors play a vital role in controlling the corrosion process. Organic compounds are widely used as corrosion inhibitors. The main disadvantage of these inhibitors is their toxic nature. The search for safe, eco friendly, biodegradable alternative sources as corrosion inhibitors lead to the development of natural products of plant origin as corrosion inhibitors[1-15].

In spite of the availability of numerous materials of plant origin, only a few were investigated and employed as corrosion inhibitors. *Aegle marmelos* is a tree found throughout Tamil Nadu, India and belongs to the family rutaceae. The extract of the roots and fruits of *aegle marmelos* is used to cure chronic diarrhoea and dysentry. The fruits exhibit antiviral activity against Ranikhet disease virus. The aim of the present work is to investigate the extract of the roots and fruits of *aegle marmelos* as a green corrosion inhibitor for zinc metal in 0.5N H_2SO_4 employing weight loss, gasometry and thermometry 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 3cm*1.5cm* 0.08cm were used in all the experiments. Zinc metal specimens were polished with a series of emery papers of various grades from 200- 1200, degreased with absolute ethanol and air dried. The corrosion medium employed was 0.5N H_2SO_4 prepared from A.R grade H_2SO_4 and deionised water.

The roots and fruits of the *aegle marmelos* tree were first shade dried and then dried in an oven for 2 hours at 100^0C and ground to get the powder form of the material. 500 ml of alcohol was then added to 10 gram of this powder and left standing for two days with occasional shaking. The solution was then filtered and the alcohol was evaporated to get a light brown sticky mass. 1 gram of this sticky mass was then dissolved in 1L of 0.5N H_2SO_4 to get the stock solution. From this stock solution, concentrations of 200, 400, 600, 800 mg/L of the extract were prepared by dilution. 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

Weight loss, gasometry and thermometric experiments were carried out at five different concentrations of the extract 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 experiments for the corrosion of zinc in 0.5N H_2SO_4 in the presence of different concentrations of the extract.

Method employed	Values of I.E(%) for different concentrations (mg/L) of the extract				
	200	400	600	800	1000
Weight loss	27.4	48.2	64.8	76.6	81.2
Gasometry	27.8	48.9	63.2	76.1	82.4
Thermometry	28.5	47.4	63.9	75.4	81.9

From the table it can be seen that all the techniques gave similar values of inhibition efficiencies. It can also be seen from the table that the inhibition efficiency of the *aegle marmelos* extract increases with increase in the concentration. The dependence of inhibition efficiency of the extract on the concentration is shown in figure-1

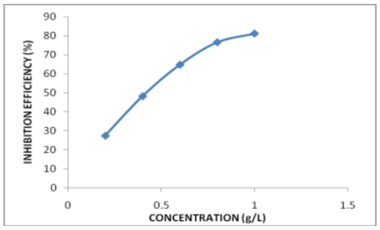


Figure 1 Variation of inhibition efficiency with concentration of the plant extract.

Table-2 presents the 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 extract

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

Values of corrosion rates (mm/y) for different concentrations (mg/L) of the extract				
200	400	600	800	1000
74.8	53.4	36.3	24.3	19.4

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 plant extract. The effect of extract concentration on the corrosion rates is shown in figure-2.

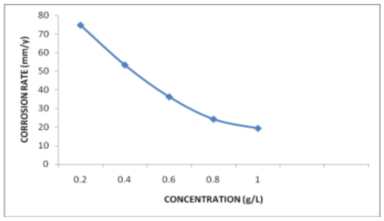
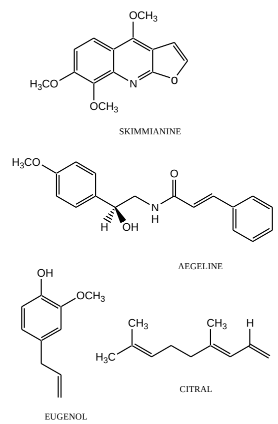


Figure 2 Variation of corrosion rates with concentration of the inhibitor.

The inhibitive action of *aegle marmelos* extract can be attributed to the presence of various organic compounds . These include skimmianine, scoparone, scopoletin, umbelliferone, marmesin, aegeline, marmelin, beta-sitisterol, citral, eugenol etc. The molecular structure of some of these compounds are shown below.



It can be seen from the structures of these compounds that many hetero atoms, multiple bonds and aromatic rings are present in the molecules. A survey of the literature clearly brings out the fact that organic compounds containing hetero atoms. multiple bonds and aromatic rings with π- electrons function as effective corrosion inhibitors for the corrosion of many metals in various aggressive solutions[21-25]. A*egle marmelos* extract contains many organic compounds with the above mentioned characteristics. No single compound can be credited with the corrosion inhibiting activity of the extract. The inhibitive activity of the extract is attributed to the combined action of all the compounds present in the extract.

IV. ADSORPTION ISOTHERMS

From the weight loss measurements the degree of surface coverage (θ) values were determined and plotted against log C of the extract which results in a straight line. This indicates that the adsorption of the inhibitor on the zinc metal surface follows Temkin adsorption isotherm. Figure 3 shows the Temkin adsorption isotherm.

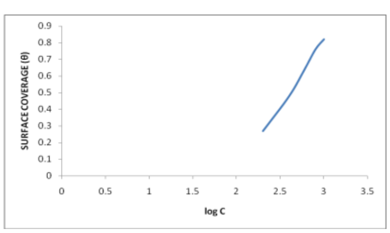


Figure 3 Temkin adsorption isotherm plot for zinc in 0.5N H_2SO_4 containing different concentrations of the extract.

V. CONCLUSIONS

The extract of the roots and fruits of *Aegle marmelos* used in this work exhibited good inhibition efficiency. The inhibition efficiency increases with increase in the concentration of the extract. The adsorption of the components of the extract on to the metal surface in 0.5N H_2SO_4 follows the Temkin adsorption isotherm.

REFERENCES

[1] S. Verma, G.N. Mehta, Trans. SAEST 32 (1997) 4.
[2] S. Martinez, I. Stern, J. Appl. Electrochem. 31 (2001) 973. [51]
[3] S. Verma, G.N. Mehta, Bull. Electrochem. 15 (1999) 67.
[4] A.Y. El-Etre, M. Abdallah, Corros. Sci. 42 (2000) 731. [28]
[5] B. Hammouti, S. Kertit, M. Mellhaoui, Bull. Electro chem.13(1997) 97.
[6] K. Srivatsava, P. Srivatsava, Br. Corros. J. 16 (1981) 221.
[7] G. Gunasekaran,L.R. Chauhan, Electrochimica Acta. 49 (2004) 4387.
[8] A. Bouyanzer, B. Hammouti, L. Majidi, Mater. Lett. 60 (2006) 2840.
[9] A.Y. El-Etre, Appl. Surf. Sci. 25 (2005) 8521.
[10] A.Y. El-Etre, Corros. Sci. 43 (2001) 1031.
[11] A. Bouyanzer, B. Hammouti, Pigm. Res. Technol. 33 (2004) 287.
[12] E.E.Oguzie, Pigm.res.Technol.34(2005)321.
[13] F. Zucchi, I.H. Omar, Surf. Tech. 24 (1985) 391.
[14] K.S. Parikh, K.J. Joshi, Trans. SAEST 39 (2004) 29.
[15] P. Kar, A. Hussein, G. Varkey, G. Singh, Trans. SAEST 28 (1997) 2801.
[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.
[21] E.H.El Ashry, A.El.Nemr, S.A.Essawy,S.Ragub, Prog.in. Org.Coat .61(2008)11.
[22] O.K.Abiola, Corros. and Mater.10(2007)10
[23] K.C.Emregul,M.Heyvali, Mater.Chem.Phys. 83(2004)209.
[24] S.Viswanatham, N.Haldar, Corros.Sci.50(2008)2999.
[25] S.V.Ramesh, A.V.Adhikari, Mater.Chem.Phys. 115(2009) 618.

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