Inhibitive Action of *Allium Sativum* Extract on the Corrosion of Zinc in 0.5N H_2SO_4 Medium

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Abstract- In this work, the extract of *Allium Sativum* was examined as a green corrosion inhibitor for zinc in 0.5N H_2SO_4 by using weight loss, gasometric and thermometric methods. Results indicated that the extract of *Allium Sativum* performed as a very good corrosion inhibitor for the corrosion of zinc. The inhibition efficiency increases with the increase in the extract concentration. The adsorption of the inhibitor molecules on the zinc metal surface obeyed Temkin adsorption isotherm.

Index Terms- *Allium sativum*, acidic solution, zinc corrosion, weight loss, gasometry, thermometry.

I.INTRODUCTION

In order to remove the undesirable scale and rust on the metals, acid solutions are widely employed in many industries. To control the excess acid consumption and metal dissolution, inhibitors are used. Corrosion inhibitors are mostly synthetic organic compounds, used to bring down the rate of corrosion of metals and alloys in various aggressive environments. These compounds are expensive, non-biodegradable and hazardous to both the environment and human beings. This made the researchers to focus their attention on employing natural products as corrosion inhibitors, which are cheap, biodegradable and environment friendly for different metals and alloys in various aggressive environments[1-15].

Allium sativum is a medicinal plant, native to Central Asia and cultivated all over India, belongs to the family Liliaceae. It is widely used in the preparation of ayurvedic medicines to cure diseases such as, cardiac related problems, chronic fever, tumours, throat infection, cough, asthma, constipation and intestinal parasitic infections. In the present work we have examined the extract of *allium sativum* as a green corrosion inhibitor for zinc metal in 0.5N H_2SO_4 employing weight loss, gasometric and thermometric methods.

II.EXPERIMENTAL

The composition of the zinc metal specimens used in this work is given in table-1

Table-1 Composition of zinc metal specimens(Wt %)

Lead	Cadmium	Iron	Zinc
1.03	0.04	0.001	Remainder

The size of the zinc metal specimens used in this work is 3cm*1.5cm* 0.08cm. Zinc metal specimens were polished with a series of emery papers of various grades from 200- 1200, washed with distilled water ,degreased with acetone and dried. The corrosion medium employed was 0.5N H_2SO_4 prepared from A.R grade H_2SO_4 and deionised water.

Preparation of the extract

Allium sativum was obtained from the local market. The outer hard cover was removed and the inner soft bulb is dried 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 three days with occasional shaking. The solution was then filtered and the alcohol on evaporation results in a light yellow 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 these stock solution concentrations of 200, 400, 600, 800 mg/L were prepared by dilution.

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 was calculated by using the following equation.

$$I.E = \frac{Vo - Vi}{Vo} X\,100$$

Where V_o and V_i represent 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. Table-2 presents the values of inhibition efficiency obtained from these experiments.

Table 2 Values of inhibition efficiency (I.E(%) obtained from the weight loss, gasometry and thermometric experiments.

Method employed	Values of I.E(%) for different concentrations (mg/L) of the extract				
	200	400	600	800	1000
Weight loss	26.7	52.7	65.8	74.6	81.2
Gasometry	25.9	51.4	63.9	73.4	80.2
Thermometry	24.6	53.7	64.2	75.4	82.3

From the table it can be observed that there is very good agreement between the values of inhibition efficiency obtained from these three methods. It shows that the inhibition efficiency increases with increase in the extract concentration. The dependence of inhibition efficiency of the extract on the concentration is shown in figure-1

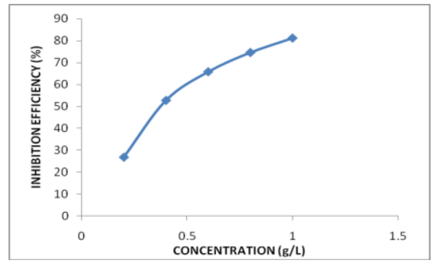


Figure 1 Variation of inhibition efficiency with concentration of the extract.

Table-3 presents the values of corrosion rates obtained from the weight loss experiments for the extract for the corrosion of zinc in 0.5N H_2SO_4 in the presence of different concentrations of the extract.

Table 3 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
75.5	48.7	35.2	26.2	19.4

From the table-3 it can be observed that the corrosion rates decreases with increasing concentration of the extract. The influence of extract concentration on the corrosion rates is shown in figure-2.

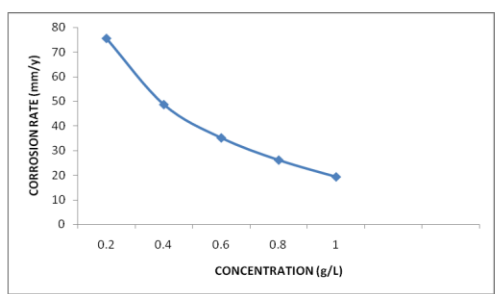
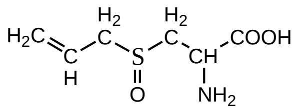
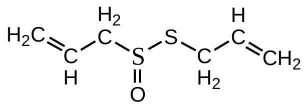


Figure 2 Variation of corrosion rates with concentration of the inhibitor.

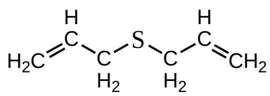
The inhibitive action of *allium sativum* can be attributed to the presence of various organic compounds in the extract. These include alliin, allicin, dially sulphide and ally methyl trisulphide.The molecular structures of these compounds are shown below.



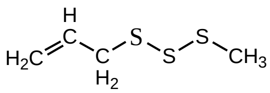
ALLIIN



ALLICIN



DIALLYL SULPHIDE



ALLY METHYL TRISULPHIDE

The molecular structures of these compounds shows the presence of many hetero atoms and double bonds, which are potential adsorption centres for adsorption on to the metal surface. Organic compounds containing π-electrons, hetero atoms and multiple bonds have been reported to function as effective inhibitors for the corrosion of many metals in various media[21-25]. Since the *allium sativum* extract contains many organic compounds, it is very difficult to attribute the inhibitive activity to any one of these compounds. The inhibitive activity of the extract is attributed to the combined action of all the compounds present in the extract.

IV.ADSORPTION ISOTHERMS

Inhibitors retard the corrosion of metals by adsorption on to the metal surface leading to the formation of a thin film which acts as a barrier between the metal and the aggressive media resulting in the inhibition of corrosion. To study the mechanism of corrosion inhibition, attempts were made to fit the data available to the various adsorption isotherms such as Langmuir, Temkin, Freundlich, Bockris-Swinkels and Flory-Huggins. From the weight loss values the degree of surface coverage (θ) for various concentration of extract were determined and plotted against log C of the extract which resulted in a straight line. This shows that the adsorption of the inhibitor on to the zinc metal surface follows Temkin adsorption isotherm. Figure 3 shows the Temkin adsorption isotherm.

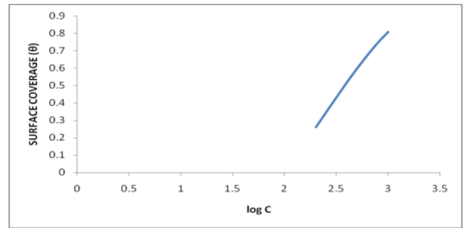


Figure 3 Temkin adsorption isotherm plot for zinc in 0.5N H_2SO_4 containing different concentrations of the extract.

V.CONCLUSIONS

The extract of *allium sativum* used in this work performed as a good corrosion inhibitor for the zinc metal corrosion in 0.5N H_2SO_4. The inhibition efficiency increased 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 obeys the Temkin adsorption isotherm.

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