ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 11,November 2017

Comparative studies of Corrosion Inhibitive Properties of Benzofuran-2-carboxylic acid & Amla Leaves Extract On Mild Steel in Acid Media

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***Abstract:-* The effects of Benzofuran-2-carboxylic acid (BF) & Amla (Emblica officinal is) leaves aqueous extract as a corrosion inhibitor, behaviour of mild steel has been investigated in hydrochloric acid solutions containing Experiments were performed by weight loss method for different time intervals and at room temperature. The inhibition efficiency of Benzofuran-2-carboxylic acid was found to increase with inhibitor concentration and also in the presence of sodium bromide and sodium iodide. Inhibition efficiency was found to increase with increasing concentration of inhibitor (0.2 g /l to 10 g/l) for 6 hours at room temperature. The maximum inhibition efficiency of Emblica officinal is leaving 87 % in 1 N Hydrochloric acid. From the comparative studies, it was investigated that the corrosion inhibition efficiency of Emblica officinal is leaving as aqueous extract is approximately equal to that of Benzofuran-2-carboxylic acid in hydrochloric acid. This may be due to the presence of wide variety of compounds like tannins, alkaloids and phenols in Emblica officinal is a plant. The adsorption process was found to obey the Langmuir adsorption isotherm.**

***Keywords*- Benzofuran-2-carboxylic acid; Sodium bromide; Sodium iodide; 1.0M H2S04, Emblica officinalis leaves.**

INTRODUCTION

The research in field of corrosion inhibition has been addressed towards the goal of using cheap, effective biomasses at low environmental impact. Keeping these factors in mind, several naturally occurring compounds have been selected as corrosion Inhibitors in the different corrosive medium The selected inhibitor is non toxic utilized in food, cheap easily available and effective also. This paper describes the investigation of low toxic easily biodegradable plant Emblica officinalis antibacterial activity and corrosion inhibition efficiencies Emblica officinalis belongs to the family Euphorbiaceae possesses anti-viral, antibacterial, anti-cancer, anti-allergy, and anti-mutagenic properties. Amla is one of the most extensively studied plants and it contains tannins, alkaloids, and phenolic compounds. Amla is a rich source of vitamin C contents more than the levels of oranges, tangerines, or lemons1. The fruit also contains gallic acid, ellagic acid, chebulinic acid, chebulagic acid, emblicanin A, emblicanin B, punigluconin, pedunculagin, citric acid, ellagotannin, trigallayl glucose, pectin, 1-O- galloyl-b-D-glucose, 3,6-di-O-galloyl-D-glucose, chebulagic acid, corilagin, 1,6-di-O-galloyl-b-D-glucose, 3 ethylgallic acid (3 ethoxy 4,5 dihydroxy benzoic acid), and isostrictiniin2. It also contains flavonoids such as quercetin, kaempferol 3 O-a-L (600 methyl) rhamnopyrano- side and kaempferol 3 O-a-L (600 ethyl) rhamnopyranoside9,10. A huge amount of H2SO4 is used in the chemical industry for removal of undesired scales and rust .The addition ofcorrosion inhibitors effectively secures the metal against an acid attack. Many studies in this regard using organic inhibitors have been reported. Most of the inhibitors are organic compounds with N, S, and O hetero-atoms having higher electron density, making them the reaction centres. These compounds are adsorbed on the metallic surface and block the active corrosion sites, and most of them are highly toxic to both human beings and the environment. Corrosion is cancer of metals and alloys. There are direct as well as indirect losses due to corrosion. The cost of direct loss due to corrosion has been reported to be huge in developed countries. The development of corrosion inhibitors based on organic compounds has much scope in several industries because of their practical use. The molecular structure of organic compounds used as inhibitors has been found to exert a major influence on the extent of inhibition of corrosion. Inhibitors are used in industrial process to minimize both the metal loss and acid consumption. Moreover, many N-heterocyclic compounds have been proved to be effective inhibitors for

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ISSN (Online) 2456-1290

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EXPERIMENTAL:-

Mild steel metal(the percentage elemental composition was found to be, C(0.048%), Mn (0.335%), Si (0.029%), P(0.041%) ,S (0.025%), Cr (0.050%), Mo (0.016%), Ni(0.019%) and Fe (99.437%) having a surface area of 5x1cm2 were cut from a large sheet. The specimens were polished successively with emery sheets, degreased and dried. Distilled water and AR grade H_2SO_4 were used for preparing solutions. The specimens in triplicate were immersed in 1 M acid solutions containing various concentrations of the inhibitor for five hours at 303 k. The specimens were removed washed with water and dried. The mass of the specimens before and after immersion was determined using an electronic digital balance.

The metal surface was dipped in 1M H_2SO_4 solution, stirred without and with various concentrations of benzofuran-2-carboxylic acid for desired interval of time (5 hrs). Mild steel crystal plane was dissolved under stirred and unstirred conditions in aerated 1MH_2SO_4 without and with various concentrations (0.5M to 5.0M) of benzofuran-2-carboxylic acid at 303 k. The dissolution rates (mpy) were calculated by estimating the amount of mild steel surface dissolved in corrosive medium. The average mass loss of the three replicate measurements was calculated8-10. Very significant inhibitory effect of inhibitor on the dissolution rate of mild steel was seen. Decrease in the corrosion rate of mild steel was found to be a function of crystallographic orientation and concentration of inhibitors in the presence of halides Inhibitor efficiency (I.E.).

Aqueous extracts was prepared by mixing 10 gram of E. officinalis leaves powder in 100 ml of distilled water, filtered. The filtrate was sterilized at 120 0C for 20 minutes and preserved until further use. Bacterial strains were maintained on tryptophone soy agar (TSA). The antimicrobial assay was performed by agar well diffusion method. A well was prepared in the plates with the help of a cork- borer (0.85 cm). 100 µl of the test compound was introduced in to the well. The inoculated plates were incubated at 35-37 ºC for 24 hours and zone inhibition was measured to the nearest millimeter (mm). The bacteria selected for study were common human pathogens like Escherichia. Coli ATCC 632, Salmonella typhi ATCC 13311, Pseudomonas aeruginosa ATCC 13525, Bacillus cereus ATCC 128263 and Bacillus subtilis ATCC 12826311. Emblica officinalis leaves were washed with distilled water and dried in sunlight. Then it is powered with the help of a mixer. The resulting fine powder was stored in a sample bottle. Eight different concentrations (0.2, 0.4, 0.8, 1.6, 3.2, 6.0, 8.0 and 10.0 g/dm3) of the extract were prepared with 1N hydrochloric acid and 1 N sulphuric acid solutions and was used for all measurement

The metal surface was dipped in 1N acids solution, stirred without and with various concentrations of the inhibitor with various concentrations (0.2g/l to 10 g/l) for desired interval of time (6 hrs) at 30 0C. The dissolution rates (mpy) were calculated by estimating the amount of mild steel surface dissolved in corrosive medium. The average mass loss of the three replicate measurements was calculated. Inhibitor efficiency (I.E.), corrosion rate and surface coverage (θ) were calculated from the weight losses of the specimens in the absence and presence of the inhibitor using the equations5,6. Corrosion rate and surface coverage(θ) were calculated from the weight losses of the specimens in the absence and presence of the inhibitor using the equations .

The corrosion rate for both room temperature and high temperature studies (308,313,318 K) with various concentrations of inhibitor and various concentrations of anions was obtained from the following formula,

C.R. (mpy) = 436.095 x 1000 x W / A x T

Where, W = Weight loss in grams, A = Area of specimen in cm^2
T = Exposure time in hours. The unit of the corrosion rate is in mills per year (mpy)

$$\text{IE\%} = \frac{(\text{Weight loss without inhibitor} - \text{Weight loss with Inhibitor}) \times 100}{\text{Weight loss without inhibitor}}$$

$$\text{Surface Coverage} = \frac{(\text{Weight loss without inhibitor}) - (\text{Weight loss with inhibitor})}{\text{Weight loss without inhibitor}}$$

RESULTS AND DISCUSSION:-

The effect of Benzofuran-2-carboxylic acid dosage on the corrosion of mild steel in 1.0 M sulphuric acid has been investigated and the optimum concentration at which maximum inhibitor effi ciency was determined. The results given in Table-I reveal that as the concentration of the inhibitor increased, the inhibition efficiency also increased. Maximum inhibitor effect at 5.0 M at 5 h period of immersion was found to be 87%. It may be due to increase in surface area of the inhibitor molecules on the metal surface.

Table-I: Effect of benzofuran-2-carboxylic acid on the corrosion inhibition of mild steel in 1.0 M H2SO4 in 5 h of immersion at 303K:-

Inhibitor	**Concentration (M)**	**Weight loss (g)**	**I.E(%)**	**Surface Coverage(ɵ)**	**Corrosion Rate(mpy)**	**C/(ɵ)**
Benzofuran-2-carboxylic acid	Blank	0.4874	-	-	8502.11	-
	0.5	0.2348	51.83	0.52	4095.80	0.96
	1.0	0.1156	76.28	0.76	2016.50	1.31
	2.0	0.09876	79.74	0.80	1722.75	2.51
	3.0	0.0734	82.94	0.85	1280.37	3.53
	4.0	0.0678	84.09	0.86	1182.69	4.65
	5.0	0.0623	87.22	0.87	1086.75	5.73

The results of weight loss experiments of corrosion of mild steel in 1 N Sulphuric acid in the presence of Emblica officinalis leaves extract at 30 0C temperature are shown in table-2. The I.E increases at the given temperature for all concentrations. The inhibition of corrosion may be due to the formation and maintenance of a protective film on the metal surface.

Table-2: Corrosion Rate for mild steel in the given concentration of inhibitor with 1N H2SO4 solution for the period of 6 hours immersion:-

Inhibitor concentration (g/l)	**weight loss (g) H2SO4**	**CR(mpy)**	**Surface coverage (θ)**	**Inhibition Efficiency (%)**	**C/(θ)**
Blank	0.204	2965.45	-	-	-
0.2	0.191	2776.47	0.06	6.37	3.138
0.4	0.186	2703.79	0.09	8.82	4.533
0.8	0.177	2572.96	0.13	13.24	6.044
1.6	0.162	2354.91	0.21	20.59	7.771
3.2	0.135	1962.43	0.34	33.82	9.461
6.0	0.121	1758.92	0.41	40.69	14.747
8.0	0.098	1424.58	0.52	51.96	15.397
10.0	0.098	1424.58	0.52	51.96	19.245

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