International Journal of ChemTech Research
CODEN(USA): IJCRGG ISSN : 0974-4290
Vol.4, No.3, pp 991-995, July-Sept 2012

Adsorption and Inhibitive Properties of Coffee seed (Coffea arabica) Extract on Mild Steel in Hydrochloric acid

HariKrishna S[1], Abida Begum*

***Department of Chemistry, P.E.S School of Engineering, Bengaluru 560100, India.**
[1]Department of Chemistry Shirdi Sai Engg. College, Anekal, Bengaluru 562106,India.

Corres.author: abida.altaf@gmail.com

Abstract: The corrosion inhibitive effects of roasted coffee seed (*Coffea Arabica*) extract for mild steel in 1 M HCl solution and the influence of potassium iodide additives on the inhibition efficiency was assessed using Mylius thermometric technique at 30 ,40, 50 and 60 ^{o}C temperature. Inhibition efficiency was determined by comparing the corrosion rates in the absence and presence of inhibitor. It was found that the coffee seed extract acts as an inhibitor for acid-induced corrosion of mild steel. In general, at constant sulphuric acid concentration, the inhibition efficiency increases with increase in the inhibitor concentration. Inhibition efficiency of the mild steel decreased with an increase in concentration of the coffee seed extract and with increase in temperature. On the other hand, inhibition efficiency synergistically increased on addition of potassium iodide but decreased with increase in temperature. The adsorption of roasted seeds of the coffee plant onto the mild steel surface was found to obey the Fruendlich adsorption isotherm. Free energy values for adsorption process show that the process is spontaneous[1-3].
Keywords: Mylius thermometric technique; *Coffea Arabica*; Mild steel; corrosion; hydrochloric acid; synergism.

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 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 plants. Constituents of Roasted Coffee are oil, wax, caffeine, aromatic oil, tannic acid, caffetannic acid, gum, sugar, protein.

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 5x1cm^2 were cut from a large sheet. The specimens were polished successively with emery sheets, degreased and dried. Twelve 250ml beakers in triplicate containing 1N

HCl were maintained at 30°C, 40 °C, 50 °C and 60°C constitute three sets of experiments. Previously weighed mild steel coupons were each suspended in each beaker through a 0.1cm hole in diameter. The steel coupons at 30°C, 40 °C, 50 °C and 60°C were retrieved at 1hour interval progressively for 6 hours. Each retrieved coupon was scrubbed with sand paper several times inside water to remove corrosion product, dried in acetone and then reweighed. The weight loss was calculated in grams as the difference between the initial weight prior to immersion, and weight after removal of the corrosion product. Each reading reported is an average of three readings recorded upto the 4th decimal on an analytical balance[4].

Roasted coffee seed were washed with distilled water and dried in sunlight and powered. The resulting fine powder was stored in a sample bottle. Six different concentrations (0.01g/ dm^3, 0.02g/dm^3, 0.03g/ dm^3, 0.04g/ dm^3, 0.05g/ dm^3 and 0.10g/ dm^3) of the extract were prepared with 1N hydrochloric acid solution and were used for all measurement.

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.), 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[5,6].

The corrosion rate for room temperature with various concentrations of inhibitor and various concentrations of anions was obtained from the following formula----

$$\text{C.R. (mpy)} = \frac{436.095 \times 1000 \times W}{A \times T}$$

Where, W = Weight loss in grams, A = Area of specimen in cm^2

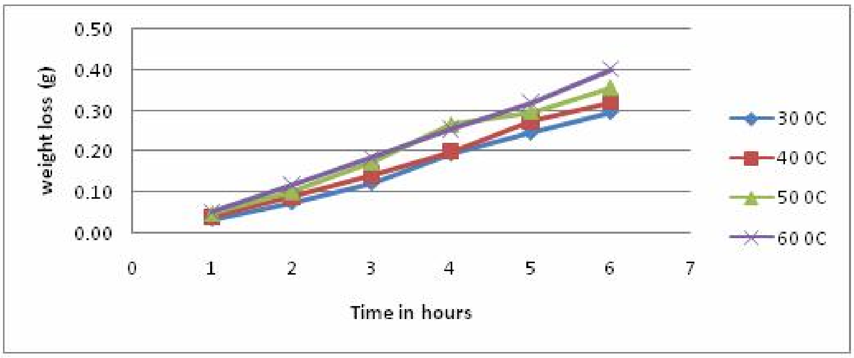
T = Exposure time in hours. The unit of the corrosion rate is in mills per year (mpy).

$$\text{IE\%} = \frac{[\text{Weight loss without inhibitor - weight loss with inhibitor}]}{\text{Weight loss without inhibitor}} x100$$

The corrosion rate was calculated by measuring the amount of mild steel dissolved in the solution analytically.

$$\text{Surfacecoverage } (\theta) = \frac{\text{Weightloss without inhibitor} - \text{weight loss withinhibitor}}{\text{weight loss without inhibitor}}$$

Figure-1: Weight loss verses time for mild steel in 1 N hydrochloric acid at the given Temperatures



Weight loss verses time for mild steel in 1 N hydrochloric acid at the given temperatures is shown in the figure-1. The values of C.R, IE% and θ at different inhibitor concentrations are listed in Table-1. The data in table reveals that as the inhibitor concentration is increased, the corrosion rate decreases while the efficiency percent and surface coverage increases[7]. This behavior may be attributed to be the increased surface coverage (θ) due to the increase in the number of adsorbed molecules on mild steel surface. A good efficiency is observed at constant concentration of inhibitor (0.1 g/dm3).

The values of the rate constant was calculated using the first order rate law,
 k = (2.303/t) log ([Ao] / [A]). Here [Ao] is the initial mass of the metal and [A] is the mass corresponding to time't'. The half-life ($t_{1/2}$) was calculated using the relationship, $t_{1/2} = 0.693 / k$. The values of rate constant and half-life ($t_{1/2}$) obtained from the above relations are also summarized in Table-1. This is confirmed that the corrosion of mild steel in hydrochloric acid and in the presence of coffee seed extract solution follows first order reaction.

Table-1 Effect of inhibitor concentration on corrosion rate (CR), inhibition efficiency (IE %) and surface coverage (θ) of mild steel in 1NHCl at 30 ^{0}C .

Temperature (^{0}C)	Inhibitor Conc, (g/dm3)	Weight Loss (g)	Inhibition efficiency, (%)	Surface coverage (θ)	Corrosion Rate (mpy)	Rate constant	Half life
30	Blank	0.044	-	-	7675.27	-	-
	0.01	0.043	2.27	0.02	7500.83	0.01051	65.92
	0.02	0.041	6.82	0.07	7151.96	0.00746	92.88
	0.04	0.0376	14.55	0.15	6558.87	0.00536	129.38
	0.08	0.0278	36.82	0.37	4849.38	0.00278	249.64
	0.1	0.0176	60.00	0.60	3070.11	0.00142	488.30
40	Blank	0.045	-	-	7849.71	-	-
	0.01	0.043	4.44	0.04	7500.83	0.00865	80.11
	0.02	0.039	13.33	0.13	6803.08	0.00560	123.80
	0.04	0.0365	18.89	0.19	6366.99	0.00463	149.67
	0.08	0.0248	44.89	0.45	4326.06	0.00223	311.41
	0.1	0.0159	64.67	0.65	2773.56	0.00121	572.20
50	Blank	0.05	-	-	8721.90	-	-
	0.01	0.048	4.00	0.04	8373.02	0.00894	77.49
	0.02	0.045	10.00	0.10	7849.71	0.00640	108.33
	0.04	0.0395	21.00	0.21	6890.30	0.00434	159.83
	0.08	0.0265	47.00	0.47	4622.61	0.00210	330.37
	0.1	0.0155	69.00	0.69	2703.79	0.00103	672.22
60	Blank	0.056	-	-	9768.53	-	-
	0.01	0.035	37.50	0.38	6105.33	0.00273	254.31
	0.02	0.032	42.86	0.43	5582.02	0.00235	294.39
	0.04	0.0301	46.25	0.46	5250.58	0.00214	323.48
	0.08	0.0255	54.46	0.54	4448.17	0.00169	410.51
	0.1	0.0145	74.11	0.74	2529.35	0.00083	832.40

Figure-2 Langmuir adsorption of Coffee seed extract in 1N HCl

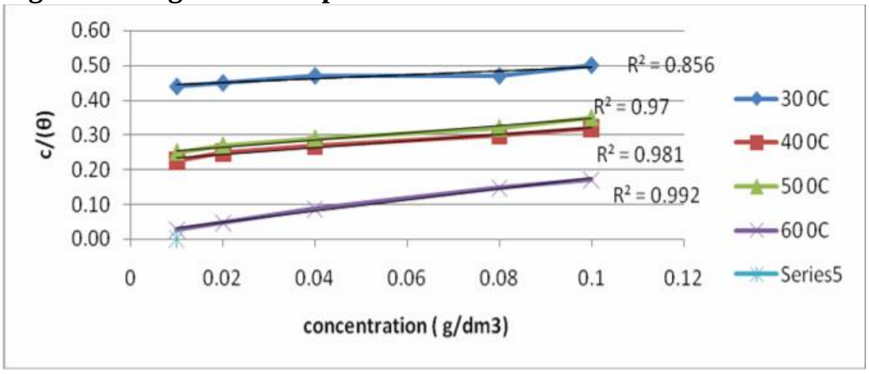


Table 2. Rate of constant (k) and half-life values for the corrosion of mild steel at different temperatures and in the presence of inhibitor and KI at 6 hours immersion times

Temperature (°C)	Inhibitor (g/dm3) + KI	Weight Loss (g)	Inhibition efficiency, (%)	Surface coverage (θ)	Corrosion Rate (mpy)	Rate constant	Half life
30	0.1+ 0.05 M KI	0.0122	72.27	0.72	2128.14	0.00090	768.15
40	0.1+ 0.05 M KI	0.0122	72.89	0.73	2128.14	0.00088	788.77
50	0.1+0.05 M KI	0.0203	**59.40**	0.59	3541.09	0.00145	478.88
60	0.1+0.05 M KI	0.0231	**58.75**	0.59	4029.52	0.00148	468.97

The relationship between C/θ and C presents linear behaviour at all temperatures studied (Fig-2) with slopes equal to unity. This suggests that the adsorption of coffee seed extract on metal surface followed the Langmuir adsorption isotherm.

To study the stability of the inhibitor and the presence of potassium iodide at higher temperature, temperature study has been performed at 30°C, 40 °C, 50 °C and 60°C. The time of immersion of temperature study was fixed for 6 hours. Results are tabulated in table-2. As the temperature increased from 30°Cto 60°C the inhibition efficiency gradually decreased. The efficiency was found to be 73 % at 40°C for coffee seed extract (0.1+ 0.05 M KI).

Conclusion :

The study of effect of coffee seed extract on the corrosion of mild steel in 1 N HCl conducted by weight loss method draws the following conclusions:

- The coffee seed extract acts as an efficient inhibitor for corrosion of mild steel in HCl medium; the inhibition efficiency increases with increase of inhibitor concentration to attain a maximum value of 60% at 0.1 g/dm^3.
- Temperature effect shows that coffee seed extract exhibits constant efficiency until 60°C.
- Addition of potassium iodide also gives an opportunity to use this natural compounds as efficient inhibitor for mild steel. Its inhibition attains 73%.
- Coffee seed extract adsorbs on the metal surface according to the Langmuir isotherm.

References

1. Ambrish Singh, Ishtiaque Ahamad, V. K. Singh and Mumtaz Ahamed Quraishi Inhibition effect of environmentally benign Karanj (*Pongamia pinnata*) seed extract on corrosion of mild steel in hydrochloric acid solution, *Journal solid state electro chemistry*, 2011,15 ,6,1087-1097.
2. Rawath J and Quraishi MA, Inhibition of mild steel corrosion by macrocy compounds in hot and concentration hydrochloric acid, *Materials Chemistry and Physics*, 73, 2002, 118-122.
3. Abida begum , Harikrishna, Veena K and Irfanulla Khan, Enhancement of the inhibitor efficiency Atropine Methochloride in corrosion control of mild steel in sulphuric acid, *E J Chem.*, 4,2008, 774-781.
4. Abida begum and Harikrishna S, Corrosion Inhibitive Properties of Benzofuron-2-carboxylic acid in the presence of halides for mild steel, *Proceedings of the national Symposium on Electrochemical science and technology*, IISc., 2010, 13.
5. Abida Begum, Rosmarinus Officinalis L. herb as Corrosion inhibitor for mild steel in sulphuric acid medium, *International journal of pharmaceutical science research and review*, 2011, 10 (1),167-169.
6. Subhashini S, Rajalakshmi R, Prathiba A, Mathina A , Corrosion Mittigating effect of Cyamopsis Tetragonaloba Seed Extract on mild steel in acid medium, *E J Chem*, 4, 2010 1133-1137.
7. Abida Begum, Evaluation of plants and weeds extract on the Corrosion inhibition of mild steel in Sulphuric Acid *E J Chem* E Journal of Chemistry 2011,8(S1) S488-S494..

*****