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Corrosion Inhibition Effect of Flower of *Euphorbia Caducifolia* for Iron in Acid Media

Reena Sharma, Alok Chaturvedi and R.K. Upadhyay
Synthetic and Surface Science Laboratory, S.P.C. Govt College, Ajmer, Raj. India
Corresponding author: Reena Sharma

ABSTRACT: *Corrosion is a natural process. It is gradual destruction of metal by chemical or electrochemical reaction with their environment. It may be prevented by either alloying or by anti rust solutions. The naturally occurring plant products are eco-friendly, compatible, nonpolluting, less toxic, easily available, biodegradable and economic to be used as corrosion inhibitor. Euphorbia caducifolia has been selected to study its corrosion inhibition efficiency. It is easily available in any season. It is native to Thar Desert of India and located on rocky terrain, hills. It is used for treatment of bleeding wound, cutaneous eruption, urinary problems, kidney stones, rheumatic pain, bronchitis, jaundice, diabities, stomach pain, hernia etc. It is also called "Thor" and "Danda-thor". It contains caudicifolin) norcycloartane type triterpene, cyclocaducinol, triterpenes euphol, tirucallol and cycloartenol. Corrosion inhibition efficiency of flower of Euphorbia caducifolia was studied for iron in HCl,* HNO_3 *and* H_2SO_4*. Maximum inhibition efficiency was found 99.05% in 1N* H_2SO_4 *acid with 0.8% corrosion inhibitor whereas it was 93.26% in 2N* H_2SO_4 *with same concentration of inhibitor i.e. 0.8%.*

Inhibition efficiency was studied in different concentration of acid (1N, 1.5N, 2N and 2.5N) with different concentration of inhibitor (0.2%, 0.4%, 0.6% and 0.8%). Weight loss and thermometric methods were used. Inhibition efficiency was found to be increase with increase in concentration of inhibitor and decrease with increase in acid strength.

Keywords*: Alloying, anti rust solution, corrosion inhibitor, Euphorbia caducifolia, weight loss, thermometric.*

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I. INTRODUCTION

Corrosion is a natural process. It is gradual destruction of metals by chemical or electrochemical reaction with their environment. It affects almost all the metals and decays the metallic properties of metals. It is unavoidable process but it can be controlled by either alloying or by using corrosion inhibitors (anti rust solution)[1].

By mass iron is the most common element on earth and fourth most common element in earth's crust. Pure iron is very soft so it is hardened and strengthened by impurities. It is fairly cheap that's why it is commonly used in manufacturing machine, tools, automobiles, machine parts, building parts etc. Steel is made with iron combined with different element including carbon, silicon and nickel etc.

In the acid, oxidation of metal occurs and hydrogen gas evolved. In the environment so many harmful gases and acids are present in the air which disintegrate and degrade the metal and alloy by corrosion. In industries acids are widely used in many processes so we need to use corrosion inhibitors which prevent or decrease the loss of metal.

A number of N and S containing ligands have been synthesized [2-5] which are found as effective corrosion inhibitors. Some heterocyclic compounds and their derivatives have been also used for metals as corrosion inhibitors in acidic media[6-9]. Epoxy esters inhibit the corrosion of aluminium and reduce evolution of hydrogen gas in aqueous solution of alkaline media[10]. Schiff bases are good corrosion inhibitors[11-14]. Mannich bases are also investigated as good corrosion inhibitor[15-17]. All the above components are good corrosion inhibitors but these are costly, toxic, pollutant and harmful so we need eco-friendly inhibitors.

The naturally occurring plant products are eco-friendly, compatible, nonpolluting, less toxic, easily available, biodegradable and economic to be used as corrosion inhibitor. A number of natural products extracted from plants are also found effective corrosion inhibitor like: *Mucuna pruriens* seed extract[18], elephant grass species (*Pennisetum purpureum*)[19], *Thymus satureioides* essential oil (TSEO)[20],*Argemone mexicana*[21], *Withania somnifera*[22], *Holly Basil*[23-24], *ocimum sanctum*[25] etc.

Survey of literature reveals that extract of *Euphorbia caducifolia* is widely used in medicines. *Euphorbia caducifolia* is a Euphorbiaceae species native to Thar Desert of India, where latex of *E. caducifolia* (ECL) is used by the local inhabitants for treatment of bleeding wound, cutaneous eruption and other skin diseases[26]. The GCMS analysis of fraction isolated from latex showed presence of methyl palmitate, 5,9-

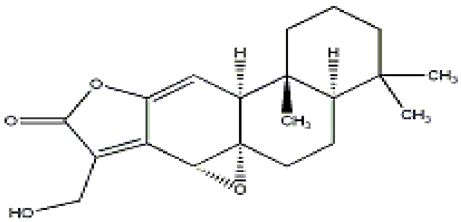
heptadecadienoate, methyl 11 octadecenoate, methyl octadecenoate and 3,7,11,15-tetramethyl- 2-hexadecene-l-ol. Isolated fraction of E. caducifolia (IFEC) and latex of E. caducifolia (ECL) were tested against S. aureus, M. luteus, B. subtilis, E. coli, S. typhi, A. niger and C. albicans[27]. However its corrosion inhibitory effect is unknown as yet. In the proposed investigation *euphorbia caducifolia* extract will be used as corrosion inhibitor in different acidic media like sulphuric acid, nitric acid and hydrochloric acid on iron.

PLANT DESCRIPTION

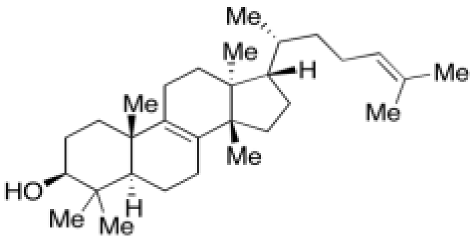
Euphorbia caducifolia is native to Thar desert of India and located on rocky terrain, hills. It is also called "Thor" and "Danda-thor".

Extract of *euphorbia caducifolia* is widely used in medicines. It is used for treatment of bleeding wound, cutaneous eruption, urinary problems, kidney stones, rheumatic pain, bronchitis, jaundice, diabetes, stomach pain, hernia etc.

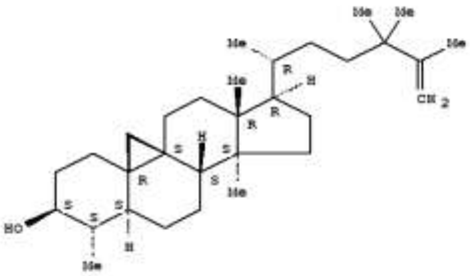
It contains caudicifolin[28] (8,14-epoxy-17-hydroxy-11,13(15)-abietadien-15,12-olide) norcycloartane type triterpene, cyclocaducinol, triterpenes euphol, tirucallol and cycloartenol[29].



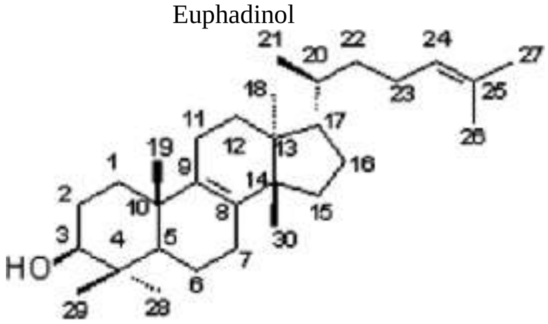
Caudicifolin



Euphadinol



Cyclocaducinol



Tirucallol

II. EXPERIMENTAL

Square specimen of iron of dimension 2.5x2.5 cm^2 containing a small hole of about 2mm diameter near the upper edge were used for studying of corrosion. Different solutions of HNO_3, HCl and H_2SO_4 were prepared using double distilled water.

Each specimen was suspended by a V shaped glass hook made of fine capillary tube and immersed in the beaker containing 100 ml of uninhibited and different concentration of inhibited test solutions. After the sufficient exposure, the specimen were taken out, washed thoroughly with running water and then dried with hot air dryer and then the final weight of each specimen was taken.

The percentage inhibition efficiency was calculated[30] as

$$\eta\% = \frac{\Delta W_u - \Delta W_i}{\Delta W_i} \times 100$$

and surface coverage (θ) was calculated as

$$\theta = \frac{\Delta W_u - \Delta W_i}{\Delta W_i}$$

Where ΔW_u is weight loss of metal in acid solution in the absence of inhibitor and ΔW_i is weight loss of metal in acid solution in the presence of known amount of inhibition.

The Corrosion rate (CR) in mm/yr can be obtained by following equation

$$R_{corr.} = \frac{\Delta W \times 87.6}{D \times A \times T}$$

Where △ W = weight loss in milligrams, D = metal density in g /cm^3, A = area of sample in cm^2, T= time of exposure of the metal sample in hours.

Inhibition efficiency was also determined by thermometric method. In this method a specimen was immersed in a reaction chamber containing 100ml of solution at an initial temperature of 25^{o}C. Temperature change were measured using a thermometer. Initially temperature increased slowly, then rapidly and attain a maximum value before falling. The maximum temperature was recorded.

Percentage inhibition efficiency were calculated as

$$\eta\% = \frac{RN_f - RN_i}{RN_f} \times 100$$

Where RN_f and RN_i are the reaction number in the absence and presence of inhibitor respectively and reaction number is defined as

$$RN = \frac{T_m - T_i}{t}$$

Where T_m and T_i are maximum and initial temperature and t is the time (in minutes) required to reach the maximum temperature.

III. RESULT AND DISCUSSION

Weight loss, percentage inhibition efficiency, surface coverage and corrosion rate in 1N, 1.5N, 2N and 2.5N HCl, HNO_3 and H_2SO_4 solution with different concentration of flower extract inhibitor are given in table1 and table 2.

Table 1. Weight loss data (△W) and percentage inhibition efficiency (%) for iron in1N and 1.5N HCl, HNO_3 and H_2SO_4 with inhibitor of flower extract

Temperature : 25 ± 0.1^{0}C Area of Specimen : 13 cm^2

	1N HCl (120 hours)				1.5 NHCl (96 hours)			
Conc. of inhibitor(%)	ΔW	I.E. (η%)	Surface coverage (θ)	Corrosion rate	ΔW	I.E. (η%)	Surface coverage (θ)	Corrosion rate
Uninhibited	1.813			12.928	1.726			15.384
0.2	0.423	76.64	0.7664	3.0163	0.480	72.14	0.7214	4.2785
0.4	0.365	79.85	0.7985	2.6027	0.456	73.53	0.7353	4.0645
0.6	0.329	81.83	0.8183	2.3460	0.427	75.21	0.7521	4.4255
0.8	0.304	83.19	0.8319	2.1677	0.367	78.68	0.7868	3.2712
	1N HNO_3 (70 min)				1.5N HNO_3 (35 min)			
Uninhibited	1.780			1305.5	1.759			2580.3
0.2	1.346	24.35	0.2435	987.23	1.439	18.16	0.1816	2110.8
0.4	1.288	27.64	0.2764	944.69	1.392	20.86	0.2086	2041.9
0.6	1.249	29.83	0.2983	916.08	1.367	22.23	0.2223	2005.2
0.8	1.201	32.51	0.3251	880.88	1.337	23.94	0.2394	1961.2
	1N H_2SO_4 (48 hour)				1.5N H_2SO_4 (30 hour)			
Uninhibited	1.635			29.147	1.754			50.029
0.2	0.204	87.51	0.8751	3.6367	0.317	81.91	0.8191	9.0418
0.4	0.169	89.62	0.8962	3.0127	0.230	86.87	0.8687	6.5603
0.6	0.117	92.81	0.9281	2.0857	0.181	89.67	0.8967	5.1627
0.8	0.015	99.05	0.9905	0.2674	0.062	96.46	0.9646	1.7762

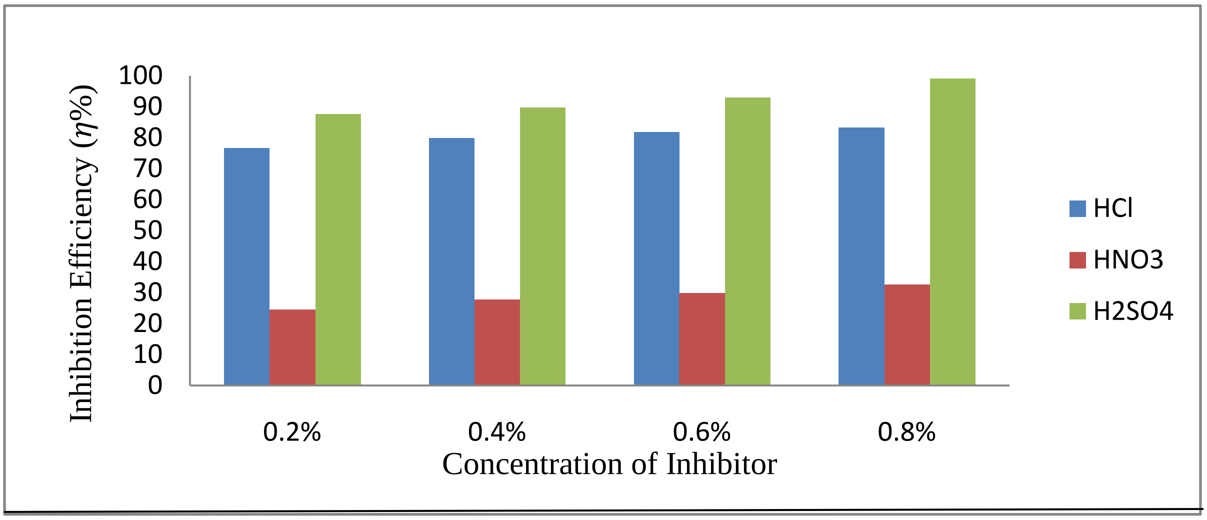


Fig.1 Variation of inhibition efficiency with concentration of flower extract for iron in 1N HCl, HNO_3 and H_2SO_4

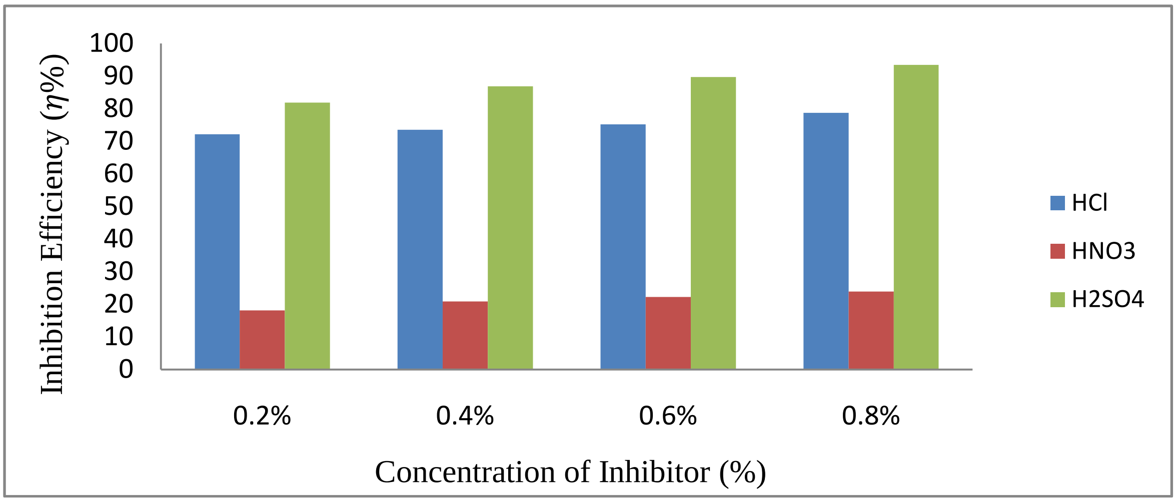


Fig.2 Variation of inhibition efficiency with concentration of flower extract for iron in 1.5N HCl, HNO_3 and H_2SO_4

Table 2. Weight loss data (ΔW) and percentage inhibition efficiency (%) for iron in 2N and 2.5N HCl, HNO_3 and H_2SO_4 with inhibitor of flower extract

Temperature : 25 ± 0.1^{0}C Area of Specimen : 13 cm^2

	2N HCL (74 hours)				2.5N HCl (60 hours)			
Conc. of inhibitor %	ΔW	I.E. (%)	Surface coverage (θ)	Corrosion rate	ΔW	I.E. (%)	Surface coverage (θ)	Corrosion rate
Uninhibited	1.735			20.062	1.683			24.002
0.2	0.636	63.34	0.6334	7.3543	0.623	62.94	0.6294	8.8850
0.4	0.551	68.21	0.6821	6.3714	0.597	64.53	0.6453	8.5142
0.6	0.528	69.56	0.6956	6.1055	0.569	66.19	0.6619	8.1148
0.8	0.479	72.39	0.7239	5.5389	0.526	68.74	0.6874	7.5016
	2N HNO_3 (20 min)				2.5N HNO_3 (12 min)			
Uninhibited	1.810			4646.4	1.645			7038.1
0.2	1.586	12.34	0.1234	4071.4	1.537	06.53	0.0653	6576.0
0.4	1.542	14.76	0.1476	3958.4	1.509	08.24	0.0824	6456.2
0.6	1.522	15.91	0.1591	3907.1	1.466	10.84	0.1084	6272.2

0.8	1.498	17.23	0.1723	3845.5	1.421	13.61	0.1361	6079.7
	2N H_2SO_4 (24hours)				2.5N H_2SO_4 (16hours)			
Uninhibited	1.695			60.433	1.829			97.817
0.2	0.388	77.07	0.7707	13.833	0.494	72.96	0.7296	26.419
0.4	0.289	80.29	0.8029	10.304	0.378	79.28	0.7928	20.215
0.6	0.223	86.81	0.8681	7.9508	0.330	81.91	0.8191	17.648
0.8	0.114	93.26	0.9326	4.0645	0.267	85.37	0.8537	14.279

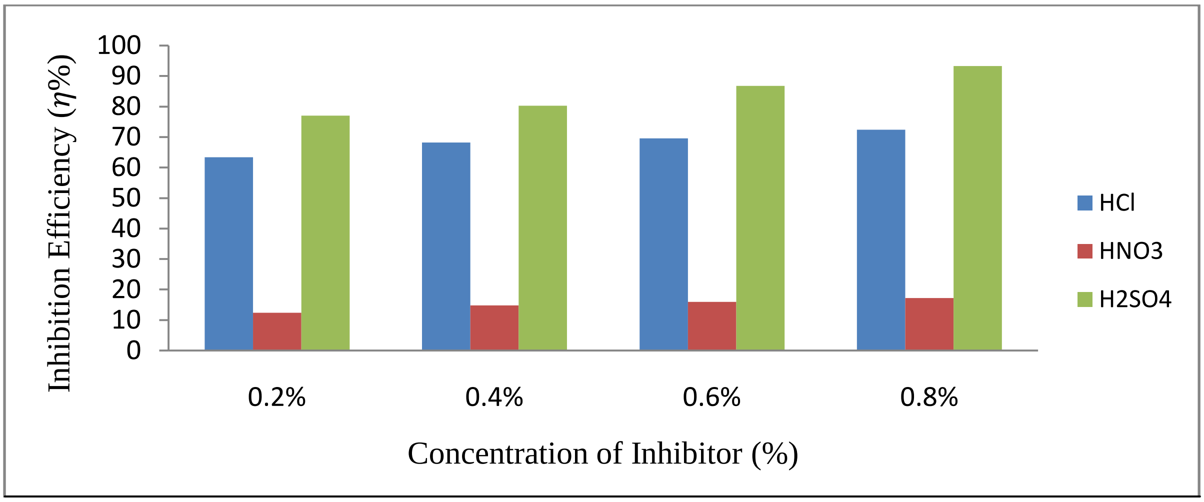


Fig.3 Variation of inhibition efficiency with concentration of flower extract for iron in 2N HCl, HNO_3 and H_2SO_4

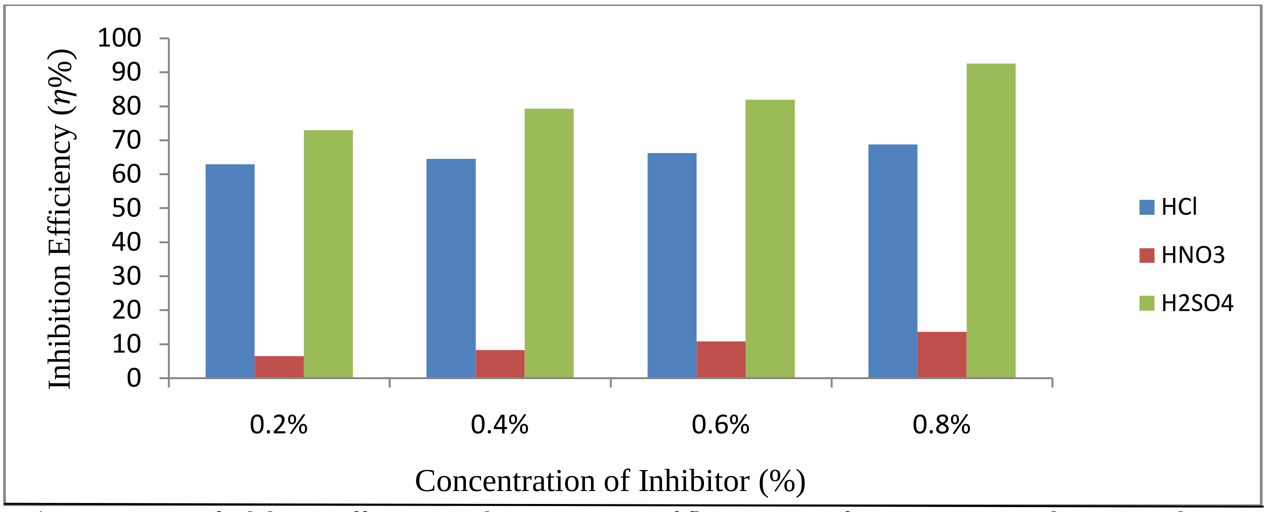


Fig.4 Variation of inhibition efficiency with concentration of flower extract for iron in 2.5N HCl, HNO_3 and H_2SO_4

Table – 3. Reaction number (RN) and inhibition efficiency (%) for iron in 2N, 3N and 4N HCl, HNO_3 and H_2SO_4 with inhibitor of flower extract

Conc. of inhibitor (%)	2N HCl		3N HCl		4N HCl	
	RN	I.E.	RN	I.E.	RN	I.E.
Uninhibited	0.2365		0.4013		0.7314	
0.2	0.1053	55.46	0.2198	45.21	0.4515	38.26
0.4	0.1036	56.19	0.2073	48.34	0.4319	40.94
0.6	0.0949	59.84	0.2035	49.27	0.4129	43.54
0.8	0.0894	62.18	0.1999	50.18	0.4074	44.29
	2N HNO_3		3N HNO_3		4N HNO_3	
Uninhibited	1.3284		1.5492		1.8658	

0.2	0.8832	33.51	1.1377	26.56	1.6766	10.14
0.4	0.8645	34.92	1.1050	28.67	1.6282	12.73
0.6	0.8208	38.21	1.0602	31.56	1.5793	15.35
0.8	0.7884	40.65	1.0179	34.29	1.5558	16.61
	2N H_2SO_4		3N H_2SO_4		4N H_2SO_4	
Uninhibited	0.6498		0.7216		0.9724	
0.2	0.2902	55.34	0.3516	51.27	0.5879	39.54
0.4	0.2804	56.84	0.3309	54.14	0.5712	41.25
0.6	0.2495	61.59	0.3169	56.08	0.5601	42.39
0.8	0.2256	65.28	0.2861	60.35	0.5429	44.16

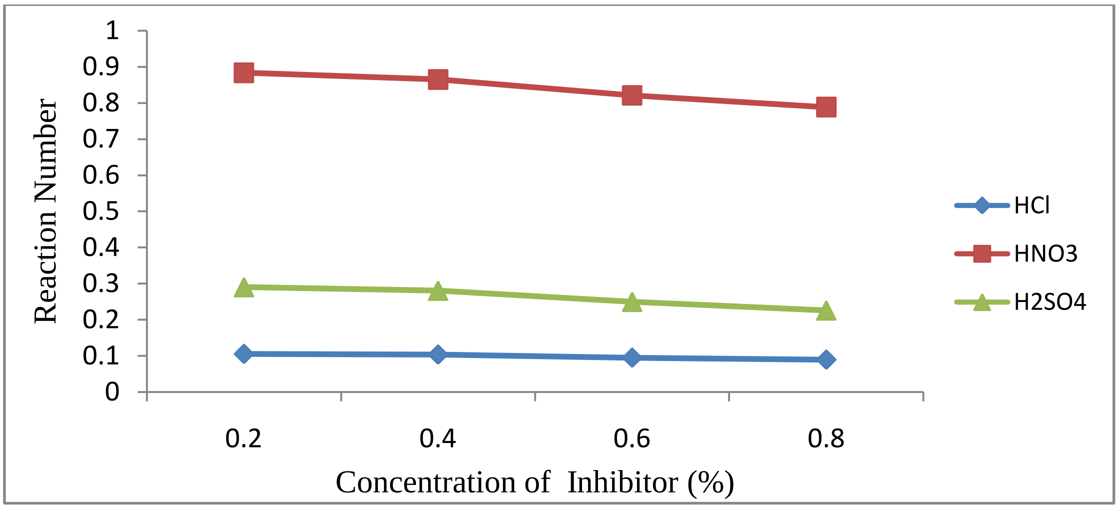


Fig.5 Variation of reaction number with concentration of flower extract for iron in 2N HCl, HNO_3 and H_2SO_4

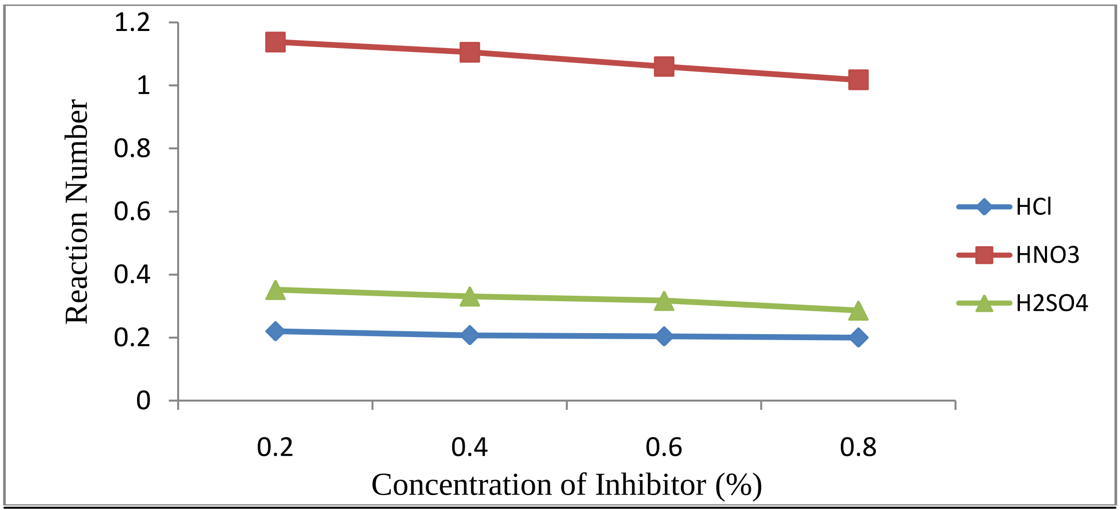


Fig.6 Variation of reaction number with concentration of flower extract for iron in 3N HCl, HNO_3 and H_2SO_4

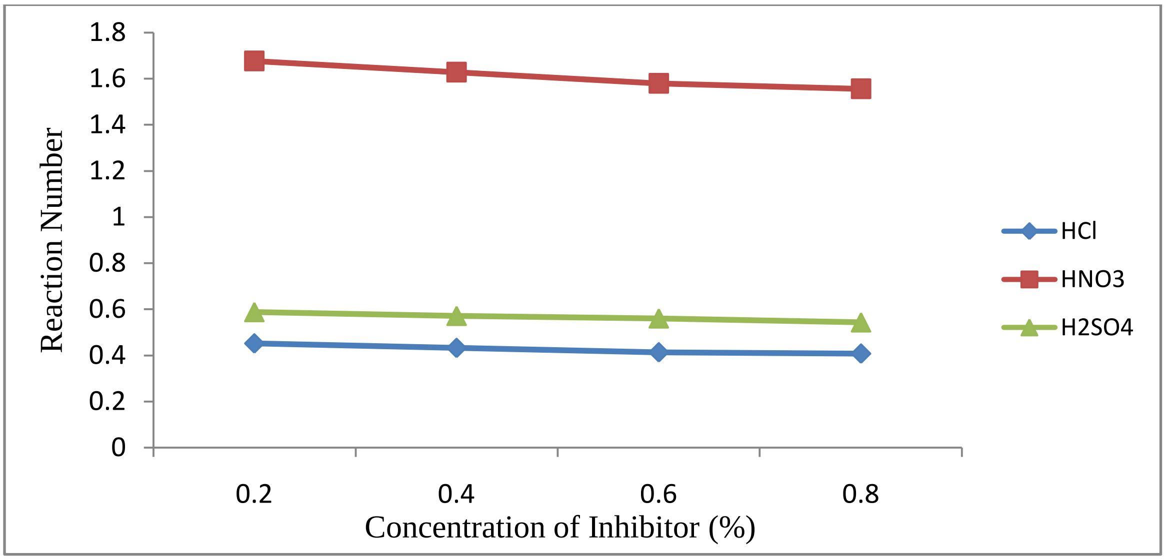


Fig.7 Variation of reaction number with concentration of flower extract for iron in 4N HCl, HNO_3 and H_2SO_4

It can be seen from tables that inhibition efficiency of inhibitor increases with increasing concentration of inhibitor. The Maximum inhibition efficiency 99.05% was obtained in 1N H_2SO_4 at an inhibitor concentration of 0.8% for flower extract. Maximum inhibition efficiency in HCl was found 83.19% in 1N HCl with 0.8% corrosion inhibitor whereas maximum Inhibition efficiency in HNO_3 was obtained only 32.51% in 1N HNO_3 with 0.8% corrosion inhibitor. The result shows that flower extract have higher inhibition efficiency in H_2SO_4 than HCl and HNO_3.

The variation of percentage inhibition efficiency with inhibitor concentration is depicted graphically in fig-1, 2, 3 and 4 in 1N, 1.5N, 2N and 2.5N acid strength respectively for flower extract. It indicates that the inhibition efficiency increases with increasing inhibitor concentration.

From table 1 and table 2 it is clear that the surface coverage increase with increasing concentration of inhibitor and corrosion rate decrease with increasing concentration of inhibitor.

Inhibition efficiencies were also determined by using thermometric method. Thermometric experiments were carried out at higher concentrations of acid i.e. 2N, 3N and 4N because no appreciable changes of temperature were observed at lower concentrations of acid. Results summarized in table 3 show a good agreement with the results obtained by weight loss method. The variation of reaction number (RN) with inhibitor concentration is depicted graphically in fig. 5, 6 and 7 for HCl, HNO_3 and H_2SO_4. The maximum inhibition efficiency was obtained with the highest concentration of inhibitor at lowest concentration of acid. Inhibition efficiency increases with increasing concentration of inhibitor and decreases with increasing concentration of acid. Both methods (weight loss as well as thermometric) show same trends in corrosion efficiency and results are in good agreement with each others.

IV. CONCLUSION

A study of flower extract of euphorbia caducifolia has shown that to be better corrosion inhibitor for iron in H_2SO_4. Weight loss and thermometric methods were shown that inhibition efficiency of flower increases with increasing inhibitor concentration over the range 0.2% to 0.8% and and decreases with decreasing concentration of acid. The maximum inhibition efficiency was found up to 99.05% for iron in 1N H_2SO_4 at a concentration of 0.8% for flower extract whereas it was 83.19% in 1N HCl and 32.51% in 1N HNO_3 with same concentration of inhibitor. Thus, it was concluded that flower extract is a better corrosion inhibitor in H_2SO_4 than in HCl and HNO_3.

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