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Corrosion Inhibitive Effects of Extract of Leaves of *Tylophora Indica* on Aluminium in HCl

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ABSTRACT

Corrosion is a natural process which converts a refined metal in to a more chemically stable from. It is the gradual destruction of material by chemical of electrochemical reaction with their environment. It can be prevented if the metal is coated with something which does not allow moisture and oxygen to react with it. It can be controlled by either sacrificial protection or by antirust solution. The naturally occurring plant product are ecofriendly, compatible, non polluting, less toxic, easily available, biodegradable so can widely be use without side effect. *Tylophora indica* has been selected for the study of it's corrosion inhibition efficiency. It is easily available in any season. It is also called annatmul. It is endemic to southern and eastern part of India. it is used for the treatment of jaundice, inflammation, dermatitis and rheumatism It contains septicine, isatylocrebrine , sterol, wax, tylophorinicine. Corrosion inhibition efficiency of leaves of *Tylophora indica* was studied for aluminium in HCl solution. Maximum inhibition efficiency was found 70.50% in 0.5 N HCl an 0.7% inhibitor for concentration. Inhibition efficiency was studied in three different acid like- HCl,H_2SO_4 ,HNO_3 in four different concentrations like [0.5N,1N,1.5N,2N] with different concentrations of inhibitors [0.1,0.3,0.5,0.7] Weight loss method and thermometric method were used. Inhibition efficiency was found to be increase in concentration of inhibitor and decrease with increase in acid strength

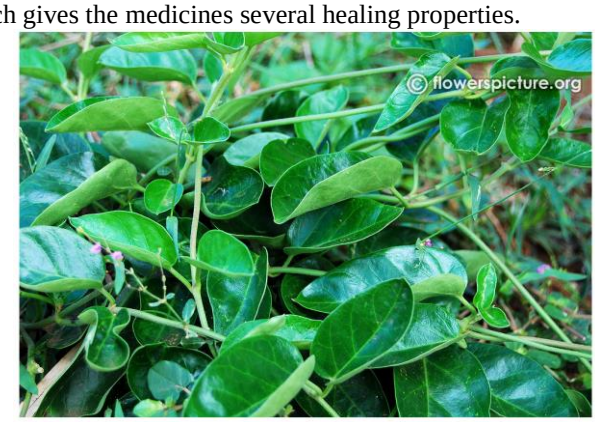
Introduction

Aluminium is a silvery white ductile metallic element. Aluminium is nontoxic (as the metal) nonmagnetic and non-sparking. Aluminium never occurs in the free state in nature owing to its great affinity for oxygen. It is the third most abundant element after oxygen and silicon . It is estimated that aluminium composed about 8 % of the earth crust.It is having good conductivity and thermal properties alumininum is widely used in industries , building industries transportation, light etc. The sulphites and oxides are the most useful compounds of Aluminum.In the industries acids are widely used as metal and alloy by corrosion so it is essential that we use corrosion inhibitor which prevent or decrease the loss of metal. A number of N and S containing ligands have been synthesized [1-5] as effective corrosion inhibitor in our as well as other laboratories. Some heterocyclic compounds and their derivative have been also used for metals as corrosion inhibitors in acidic media [6-9] Schiffs bases []10-13] and Mannich bases [14-15] are also studied as good corrosion inhibitor . Epoxy ester was also inhibit the corrosion of aluminium in alkaline media [16] all the above compounds are good corrosion inhibitors but these are toxic, harmful, pollutants so eco-friendly inhibitors are required. The naturally occuring plant products are eco-friendly, non-polluting, less-toxic, biodegradable, easily available like *Ginger* [17], *Ficus, Religeora* [18] *withania somnifera* [19] Holi *Basil* [20] *ocimum sactum* [21] *Euphorbia coudicifolia* [22] *Tylophora Indica* [23] stem extract is found effective corrosion inhibitor for tin in different acidic media like, sulphuric acid, nitric acid and hydrochloric acid. In the proposed investigation *Tylophora Indica* leaves part are used as corrosion inhibitor in hydrochloric acid on aluminium.

Plant Description:

Tylophora Indica is endemic to southern and eastern part of India. It is located on plain and forest place. It is also called annatmul. Extract of *Tylophora Indica* is widely used in medicine. It is used for the treatment of rheumatoid, arthritis and crohn's disease. It is prevent to growth of tumors [26]

Tylophora Indica leaves contain alkaloids, steroids, reducing sugar tannis[27] flavonoids, proteins, terpenoids which gives the medicines several healing properties.



Tylophora Indica

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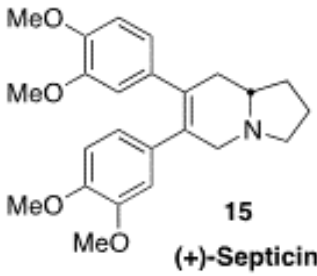

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(+)-Septicine

Experimental

The rectangular specimens of aluminium of dimensions of 2.0 cm x 2.0 cm containing a small hole of about 2mm diameter near the upper edge were cut from a large sheet of pure aluminum. The solutions of HCl acid were prepared using double distilled water. All chemical were used of analytical reagent grade. Different inhibitor solution were prepared in absolute ethanol. The extracts of dried leaves is obtained in a soxhlet using ethanol as solvent for sufficient time.

Each specimen was suspended with a V shaped glass hook made of fine capillary and plunged in to a beaker containing 50 mL of the test solution (HCl acid) at room temperature. After sufficient exposure, the test specimens were taken out, washed with running water and dried with hot air dryer and then the final weight loss of each specimen was taken. The percentage inhibition efficiency was calculated using the following formula [28].

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

and surface coverage (θ) was calculated as

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

Where ΔWu and ΔWi are the weight loss of the metal in uninhibited acid and in inhibited solution respectively.

The corrosion rate (CR) in mm/y can be calculated by the following equation [29]

$$\text{Corrosion rate (mm/y)} = \frac{\Delta W_u \times 87.6}{A \times T \times d}$$

Where ΔW is weight loss in mg, A is area of specimen in cm^2 , T is time of exposure in hours and d is density of metal in g/cm^3

Inhibition efficiency was also determined by thermometric method. In this method a specimen was immersed in a reaction chamber containing 50mL of solution at an initial temperature of 25°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

$$RN = \frac{RN_f - RN_i}{RN_f} \times 100$$

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

$$RN = \frac{Tm - Ti}{t}$$

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

Result and Discussion

Weight loss ,percentage inhibition efficiency , surface coverage and corrosion rate in 0.5N,1N, 1.5N and 2N HCl ,HNO_3 H_2SO_4 solution with different concentration of leaves extract inhibitor are given in Table -1 and Table - 2

It can be seen from table-1 and table-2 that inhibition efficiency of inhibitor increase with increasing concentration of inhibitor. The maximum inhibition efficiency 70.50% was obtained in 0.5 N HCl at an inhibitor concentration of 0.7% for leaves extract. The maximum inhibition efficiency in HNO_3 solution was obtained 65.78% in 0.5 N HNO_3 at an inhibitor concentration of 0.7% whereas the maximum inhibition efficiency in H_2SO_4 solution was obtained only 63.05% in 0.5% at an inhibitor concentration of 0.7% leaves extract. The results show that leaves extract have higher inhibition efficiency in HCl than HNO_3 and H_2SO_4.The variation of percentage inhibition efficiency with inhibitor concentration is depicted graphically in fig -1,2,3 and 4 in 0.5 N,1N,1.5N, 2N acid strength, respectively for leaves extract. It indicates that the inhibition efficiency increase with increasing concentration of inhibitor.

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.

Table 1. Weight loss Data and Percentage Inhibiton Efficiency for aluminium in HCl,HNO_3, H_2SO_4 With Inhibitor leaves extract.

Temperature 25°C ±0.1° C — Area of Specimen 8cm^2

	0.5 N HCl (45min.)					1 N HCl (35min.)				
C.I. %	W	I.E.	Corrosion Rate	Θ	Log (Θ /1-Θ)	W	I.E.	Corrosiom Rate	Θ	Log (Θ /1-Θ)
Uninhibited	0.539		11.9516			0.520		8.9168		
0.1	0.184	65.86	4.0799	0.6586	0.2853	0.188	63.84	3.2237	0.6384	0.2468
0.3	0.178	66.97	3.9469	0.6697	0.3069	0.186	64.23	3.1894	0.6423	0.2542
0.5	0.168	68.83	3.7251	0.6883	0.3440	0.184	64.61	3.1551	0.6461	0.2614
0.7	0.159	70.50	3.5256	0.7050	0.3783	0.180	65.38	3.0865	0.6538	0.2761
0.5N HNO_3 (218 hrs.)						1N HNO_3 (251 hrs)				
Uninhibited	0.532		3.9478			0.538		3.4675		
0.1	0.208	60.90	1.5435	0.6090	0.1924	0.216	59.85	1.3921	0.5985	0.1733
0.3	0.201	62.21	1.4915	0.6221	0.2164	0.207	61.52	1.3341	0.6152	0.2037
0.5	0.193	63.72	1.4322	0.6372	0.2445	0.199	63.01	1.2825	0.6301	0.2313
0.7	0.182	65.78	1.3505	0.6578	0.2837	0.191	64.49	1.2310	0.6449	0.2591
	0.5 NH_2SO_4 (267 hrs.)					1N H_2SO_4 (219 hrs.)				
Uninhibited	0.498		3.9311			0.503		3.2567		
0.1	0.193	61.24	1.5235	0.6124	0.1986	0.209	58.44	1.3532	0.5844	0.1480
0.3	0.191	61.64	1.5077	0.6164	0.2059	0.206	59.04	1.3337	0.5904	0.1587
0.5	0.186	62.65	1.4682	0.6265	0.2246	0.202	59.84	1.3078	0.5984	0.1731
0.7	0.184	63.05	1.4524	0.6305	0.2320	0.194	61.43	1.2560	0.6143	0.2021

Table -2.

	1.5 N HCl (25min.)					2 N HCl (15 min.)				
C.I. %	W	I.E.	Corrosion Rate	Θ	Log (Θ /1-Θ)	W	I.E.	Corrosiom Rate	Θ	Log (Θ /1-Θ)
Uninhibited	0.518		6.2790			0.515		3.8064		
0.1	0.205	60.42	2.4849	0.6042	0.1836	0.208	59.61	1.5373	0.5961	0.6190
0.3	0.198	61.77	2.4000	0.6177	0.2083	0.204	60.38	1.5078	0.6038	0.1829
0.5	0.197	61.96	2.3879	0.6196	0.2118	0.199	61.35	1.4708	0.6135	0.2006
0.7	0.194	62.54	2.3516	0.6254	0.2225	0.196	61.94	1.4486	0.6194	0.2114
	1.5 N HNO_3 (169 hrs.)					2 N HNO_3 (121 hrs)				
Uninhibited	0.524		2.6181			0.519		1.8566		
0.1	0.234	55.34	1.1691	0.5534	0.0931	0.243	53.17	0.8692	0.5317	0.0551
0.3	0.226	56.87	1.1292	0.5687	0.1200	0.236	54.52	0.8442	0.5452	0.07871
0.5	0.217	58.58	1.0842	0.5858	0.1505	0.228	56.06	0.8156	0.5606	0.1057
0.7	0.208	60.30	1.0392	0.6030	0.1815	0.219	57.80	0.7834	0.5780	0.1365
	1.5 N H_2SO_4 (167 hrs.)					2N H_2SO_4 (120 hrs.)				
Uninhibited	0.492		2.4291			0.513		1.8200		
0.1	0.214	56.50	1.0565	0.5650	0.1135	0.218	57.50	0.7734	0.5750	0.1312
0.3	0.211	57.11	1.0417	0.5711	0.1243	0.216	57.89	0.7663	0.5789	0.1382
0.5	0.205	58.33	1.0121	0.5833	0.1460	0.213	58.47	0.7556	0.5847	0.1485
0.7	0.198	59.75	0.9775	0.5975	0.1715	0.206	59.84	0.7308	0.5984	0.1731

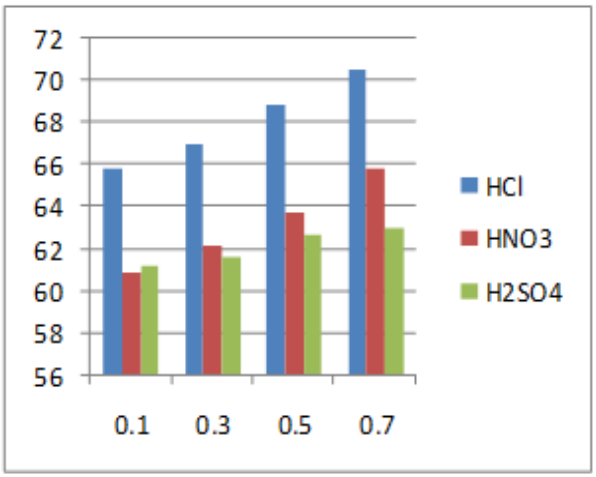

Figure 1. variation of inhibition efficiency with concentration of leaves extract for aluminium in 0.5N HCl , H_2SO_4 , HNO_3.

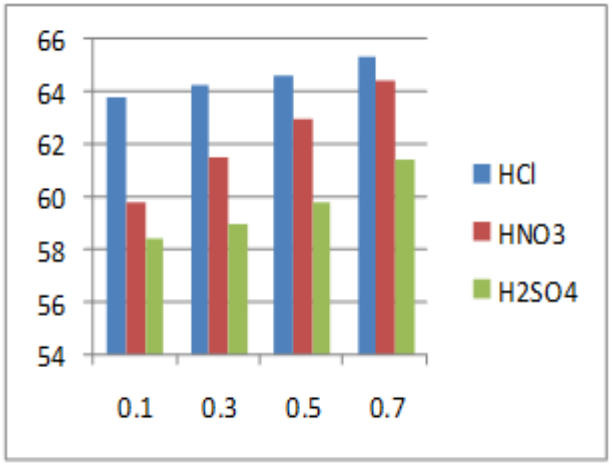

Figure 2. variation of inhibition efficiency with concentration of leaves extract for aluminium in 1N HCl , H_2SO_4 , HNO_3.

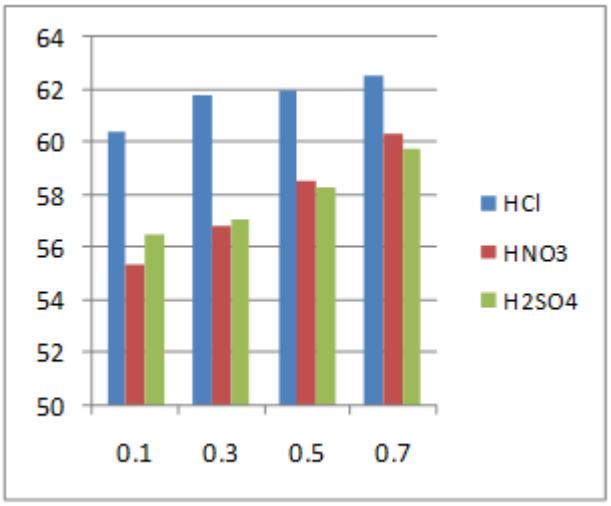

Figure 3. variation of inhibition efficiency with concentration of leaves extract for aluminium in 1.5N HCl , H_2SO_4 , HNO_3.

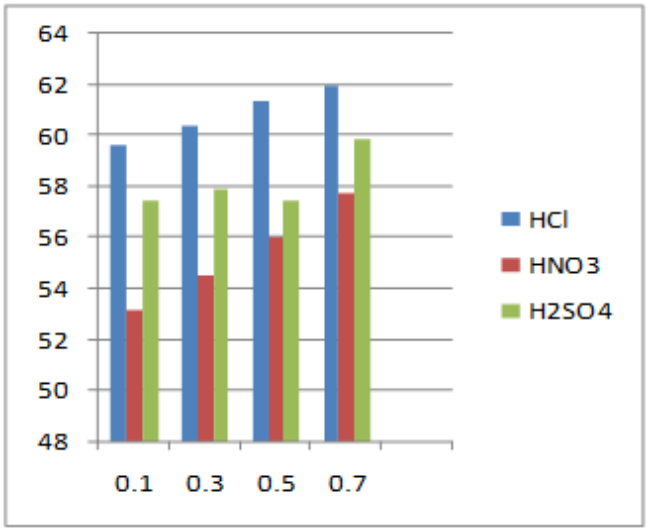

Figure 4. variation of inhibition efficiency with concentration of leaves extract for aluminium in 2N HCl , H_2SO_4 , HNO_3.

Table 3. Reaction number (RN) and inhibition efficiency for aluminium in 1N HCl , HNO_3, H_2SO_4 , in 2N , 3N and 4N HCl , HNO_3 and H_2SO_4 with inhibitor of leaves extract.

	2N HCl		3N HCl		4N HCl	
UnInhibited	RN	I.E	RN	I.E	RN	I.E
0.1	2.1703	38.00	0.9589	36.95	1.1396	34.01
0.3	2.1324	39.09	0.9428	38.01	1.1009	36.25
0.5	2.0690	40.91	0.9282	38.97	1.0878	37.01
0.7	2.0127	42.51	0.9124	40.01	1.0567	38.81
	2N HNO_3		3N HNO_3		4N HNO_3	
UnInhibited	RN	I.E	RN	I.E	RN	I.E
0.1	0.0147	30	0.0171	25.65	0.0194	25.38
0.3	0.0142	32.38	0.0165	28.26	0.0189	27.30
0.5	0.0141	32.85	0.0161	30.00	0.0188	27.69
0.7	0.0138	34.28	0.0157	31.6	0.0184	29.23
	2N H_2SO_4		3N H_2SO_4		4N H_2SO_4	
UnInhibited	RN	I.E	RN	I.E	RN	I.E
0.1	0.05378	35.20	0.05332	32.50	0.05709	29.51
0.3	0.05229	37.00	0.05269	33.30	0.05587	31.02
0.5	0.05071	38.90	0.05119	35.20	0.05370	33.70
0.7	0.04989	39.89	0.05056	36.00	0.05346	34.00

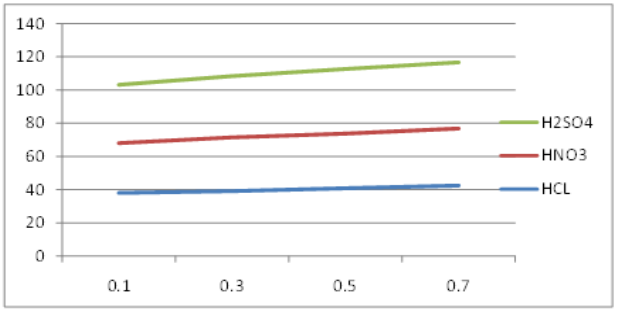

Figure 5. Variation of reaction number with concentration of leaves extract for aluminium in 2N, HCl , HNO_3 and H_2SO_4.

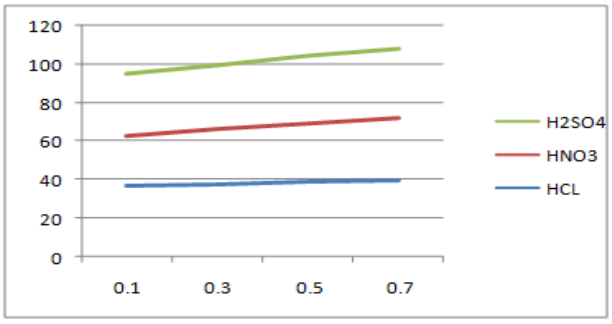

Fig 6. Variation of reaction number with concentration of leaves extract for aluminium in 3 N, HCl , HNO_3 and H_2SO_4.

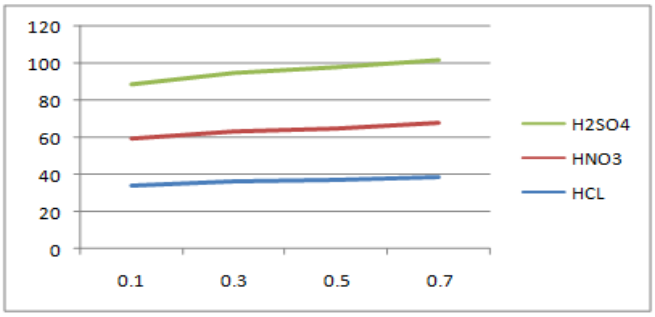

Fig 7. Variation of reaction number with concentration of leaves extract for aluminium in 4 N, HCl , HNO_3 and H_2SO_4.

Inhibition efficiency were also determined by using thermometric method. Thermometric method were carried at higher concentration of acid 2N, 3N and 4N because no appreciable change of temperature were observed at lower concentration at acid. The variation of reaction number with inhibitor concentration is depicted graphically in Fig. 5, 6 and 7 for HCl. The maximum inhibition efficiency was obtained with highest concentration of leaf extract at lowest concentration of acid.

Inhibition efficiency increase with increasing concentration of inhibitor and decrease with increasing concentration of acid.

Both methods (Weight loss and thermometric) show same trends in corrosion efficiency and results are in good agreement with each other's.

Conclusion

A study of extract of *Tylophora Indica* has shown that to be better corrosion inhibitor for aluminium in HCl. Weight loss and thermometric methods were shown that inhibition efficiency of leaves extract increase with increasing inhibitor concentration over the range 0.1% to 0.7% and decrease with decreasing concentration of acid.

The maximum inhibition efficiency of *Tyalophora Indica* was found up to 70.50% for aluminium in 0.5 N HCl at an concentration of 0.7 for leaves extract where as it was 65.78% in HNO_3 and 63.05% in H_2SO_4 with same inhibitors.

Thus it was concluded that leaves extract is a better corrosion inhibitor in HCl than in H_2SO_4 and HNO_3.

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