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Conservation of Environment and Corrosion Inhibition by Calotropis

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ABSTRACT: Corrosion occurs as a result of the interaction of a metal with its environment. The extent of corrosion depends on the type of metal, the existing conditions in the environment and the type of aggressive ions present in the medium. For example, CO_3^{2-} and NO_3^- produce an insoluble deposit on the surface of iron, resulting in the isolation of metal and consequent decrease of corrosion. There are two ways to look at the relationship between corrosion and pollution: (i) corrosion of metals and alloys due to environmental pollution and (ii) environmental pollution as a result of corrosion protection. This paper encompasses the scenarios and possible remedies for various cases, using 'green' inhibitors obtained from plant extracts.

The effect of Calotropis plant extract on the corrosion of aluminium in molar sulphuric acid was studied by mass loss method. The alcoholic extract of *Calotropis* reduces the corrosion rate. The inhibition efficiency increases with additive concentration. Mass loss experiment was employed with mixture of hydrochloric acid and sulphuric acid. Calotropis plant shows inhibition efficiency up to 83%.

KEYWORDS- Calotropis, aluminium, Metal, Corrosion etc.

I. INTRODUCTION

Corrosion is the destructive result of chemical reaction between metal and metal alloys and its environment[1]. Corrosion invades in almost every part of our lives. Hence corrosion is often regarded as a "necessary evil" to be tolerated. Corrosion reactions can be divided into two or more partial reaction[2-3]. One is the oxidation or de-electronation of metal and termed as anodic reaction. The second reaction is the electron consuming and is termed as cathodic, which can be of several types depending on the nature of metal

surrounding the metal. In acidic medium hydrogen evolution reaction predominates. Well known as non-toxic compounds and due to their availability and relatively low cost, naturally products find various applications in many fields. The diversity of their structures plays a major role in their use as corrosion inhibitors. There are numerous naturally occurring substances like *Ficus variens*[5], *Datura stramonium*[6], *Prosopis juliflora*[7], *Calotropis procera* and *Calotropis gigantean*[8], *Saponin*[9], Fenugreek[10], *Prosopiscineraria*[11], *Ficus relegeosa*[12], *Caparis deciduas*[13]. *Calotropis* treat common diseases such as fever, rheumatism, indigestion, cough, eczema, asthma, elephantiasis, nausea, vomiting and diarrhea.

II. EXPERIMENTAL

The sulphuric acid solution was prepared using doubly distilled water. The *Calotropis* extract was obtained by drying, then powdered and extracted with boiling alcohol. The solvent was vacuumed, distilled off and the residue treated with inorganic acid while the bases were extracted as their soluble salts. The free bases were liberated various solvents, e.g. Ether, Chloroform etc. The mixture of bases thus obtained is separated by various methods into the individual compounds. To clean the stuff obtained it was boiled with activated charcoal (2gm) to remove gung and pure plant extract is obtained.

SPECIMEN PREPARATION

Rectangular specimens of aluminium of dimension 2.5cm *1.5cm *0.02 cm containing a small hole of 2mm diameter near the upper edge were employed for the determination of corrosion rate. Specimens of aluminium were cleaned by

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buffing to produce a mirror finish with pumice powder and aluminium were cleaned with emery paper then degreased with acetone. The weight of the specimens before and after immersion was determined using a Schimadzu balance.

TEST SOLUTION PREPARATION

MASS LOSS MEASUREMENT

The acidic solution was prepared by using doubly distilled water. All chemicals were used of analytical reagent quality. The percentage inhibition efficiency was calculated as [14]

Where ΔM_u and ΔM_i are the mass loss of the metal in uninhibited and inhibited solution respectively.

The degree of surface coverage (θ) can be calculated as

The corrosion rate in mmpy (milli meter penetration per year) can be obtained by the following equation [15]

Corrosion rate = (Mass loss · 87.6) / (Area · Time · Metal density)

Where mass loss is expressed in mg, area is expressed in cm^2 of metal surface exposed, time is expressed in hours of exposure, metal density is expressed in gm/cm^3 and 87.6 is conversion factor.

THERMOMETRIC MEASUREMENTS

Mylius introduced this technique and originally developed to determine the corrosiveness of metal. The method of Mylius has been proved to be of considered value and help in studying the corrosion behaviors of a number of surface active agents.

In this method, the variation of temperature is followed as a function of time. The test specimen is immersed in a cell containing the test solution along with the thermometer bulb, which is immersed in a Dewar flask. Initially the temperature of the system remains almost constant. Subsequently, it rises quickly to attain a maximum value and ultimately declines. The weight of the specimens before and after immersion will determine using a Schimadzu balance. Temperature changes will measure at intervals of one minute using a thermometer with a precision of $\pm 0.5^\circ\text{C}$. The percentage inhibition efficiencies were calculated as [15].

Where RN_i and RN_f are the reaction number in the presence and absence of inhibitors respectively and RN ($^\circ\text{C}/\text{min}$) is defined as [16].

Where mass loss is expressed in mg, area is expressed in cm^2 of metal surface exposed, time is expressed in hours of exposure, metal density is expressed in gm/cm^3 and 87.6 is the conversion factor.

III. RESULTS AND DISCUSSION

The inhibition efficiency (%) calculated from the mass loss measurement for sulphuric acid solution with inhibitors [Tables 1-4]. It is observed that the inhibition efficiency increases with increase in the concentration of inhibition and decreases with increases in

acid strength. The corrosion rate decreases with increases in concentration of inhibitor.

The inhibitors have shown the efficiency in the range. *Calotropis procera* shows minimum 44.23% and maximum 82.98% for 0.5N sulphuric acid solution but *Calotropis gigantea* solution shows minimum 43.26% and maximum 82.82% inhibition efficiency.

Calotropis procera show minimum 48.58% and maximum 78.86% for 1.0N sulphuric acid solution whereas *Calotropis gigantea* solution shows minimum 48.69% and maximum 78.82% inhibition efficiency.

An attempt has been made to measure the corrosion rate of aluminum in mixture of hydrochloric acid and sulphuric acid solution. The inhibition efficiency (%) calculated from the mass loss measurement for mixture of sulphuric acid and hydrochloric acid solution with inhibitors. The adsorbed plant extract parts act to slow corrosion process by either:

1. Increasing the anodic and/or cathodic polarization behaviour.

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Vol. 4, Issue 9, September 2015

2. Reducing the movement or diffusion of ions to the metallic surface.

3. Increasing the electrical resistance of the metallic surface.

Surface analysis shows the plant extract adsorbed on metal surface and decrease the surface area for corrosion reaction.

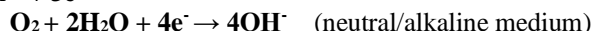
Organic corrosion inhibitors may function as:

1. Chemisorption of the molecule on the metallic surface.
2. Complexing of the molecule with the metal ion which remains in solid state.
3. Neutralising the corrodent.
4. Adsorbing the corrodent.
5. They offered large coverage due to the long hydrocarbon chain and by the presence of -OH group, being hydrophilic in nature, the -OH group counteracted the effects of chain length and ensured higher solubility.
6. Cathodic inhibitors slow down the reaction taking place at cathode (i.e. H₂ evolution) eg. Organic inhibitors like amine, substituted urea's, heavy metal soap etc. decreases H₂ evolution process. Aluminium salts deposits on cathode helps in decreasing the O₂ absorption process.
7. **Absorption of oxygen-** This type of corrosion occurs generally in aqueous solution.
8. The corrosion of aluminium and aluminium alloys precede through the following elementary reactions:

Anodic reaction



Cathodic reaction



All metal above the hydrogen in electrochemical series have a tendency to get dissolve in acidic solution releasing hydrogen.

Table-1 Mass loss data for aluminium in 0.5N sulfuric acid with ethanolic extract of leaves, latex and fruit of *calotropis procera*.

Inhibitor Concentration	Mass loss (gm)	Inhibition efficiency (%)	Corrosion rate (mmpy)	Surface coverage (θ)
Uninhibited	1842		33.0	
Leaves				
0.12	1012	45.00	18.2	0.4500
0.24	872	52.60	15.7	0.5260
0.36	653	64.51	11.7	0.6451
0.48	487	73.53	8.77	0.7353
0.60	348	81.08	6.27	0.8108
Latex				
0.12	987	46.35	17.7	0.4635
0.24	856	53.47	15.4	0.5347
0.36	641	65.16	11.5	0.6516
0.48	465	74.72	9.43	0.7472

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0.60	313	82.98	5.64	0.8298
Fruit				
0.12	1026	44.23	18.4	0.4423
0.24	898	51.19	16.1	0.5119
0.36	674	63.36	12.1	0.6336
0.48	465	74.72	8.38	0.7472
0.60	338	81.63	6.09	0.8163

Table-2 Mass loss data for aluminium in 0.5N sulfuric acid with ethanolic extract of leaves, latex and fruit of *calotropis gigantea*.

Inhibitor Concentration	Mass loss (gm)	Inhibition efficiency (%)	Corrosion rate (mmpy)	Surface coverage (θ)
Uninhibited	1840		33.1	
Leaves				
0.12	1023	44.40	18.4	0.4440
0.24	851	53.73	15.3	0.5373
0.36	634	65.54	11.4	0.6554
0.48	465	74.72	8.38	0.7472
0.60	327	82.22	5.89	0.8222
Latex				
0.12	951	48.31	17.1	0.4831
0.24	833	54.72	15.0	0.5472
0.36	627	65.92	11.3	0.6592
0.48	442	75.97	7.96	0.7597
0.60	316	82.82	5.69	0.8282
Fruit				
0.12	1044	43.26	18.8	0.4326
0.24	875	52.44	15.7	0.5244
0.36	653	64.51	11.7	0.6451
0.48	482	73.80	8.68	0.7380
0.60	319	82.66	5.74	0.8266

International Journal of Innovative Research in Science, Engineering and Technology

| Impact Factor: 5.442 | A Monthly Peer Reviewed & Referred Journal |

Vol. 4, Issue 9, September 2015

Table-3 Mass loss data for aluminium in 1.0N sulfuric acid with ethanolic extract of leaves, latex and fruit of calotropis procera.

Inhibitor Concentration	Mass loss (gm)	Inhibition efficiency (%)	Corrosion rate (mmpy)	Surface coverage (θ)
Uninhibited	2460		44.3	
Leaves				
0.12	1242	49.51	22.3	0.4951
0.24	935	61.99	16.8	0.6199
0.36	721	70.69	12.9	0.7069
0.48	663	73.04	11.9	0.7304
0.60	548	77.72	9.87	0.7772
Latex				
0.12	1263	48.58	22.7	0.4858
0.24	931	62.15	16.7	0.6215
0.36	748	69.59	13.4	0.6959
0.48	625	74.59	11.2	0.7459
0.60	520	78.86	9.37	0.7886
Fruit				
0.12	1186	51.78	21.3	0.5178
0.24	958	61.05	17.2	0.6105
0.36	712	71.05	12.8	0.7105
0.48	643	73.86	11.5	0.7386
0.60	574	76.66	10.3	0.7666

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Vol. 4, Issue 9, September 2015

Table-4 Mass loss data for aluminium in 1.0N sulfuric acid with ethanolic extract of leaves, latex and fruit of calotropis gigantea.

Inhibitor Concentration	Mass loss (gm)	Inhibition efficiency (%)	Corrosion rate (mmpy)	Surface coverage (θ)
Uninhibited	2460		44.3	
Leaves				
0.12	1262	48.69	22.7	0.4869
0.24	957	61.09	17.2	0.6109
0.36	734	70.16	13.2	0.7016
0.48	641	73.94	11.5	0.7394
0.60	523	78.73	9.42	0.7873
Latex				
0.12	1244	49.43	22.4	0.4943
0.24	950	61.38	17.1	0.6138
0.36	763	68.98	13.7	0.6898
0.48	619	74.83	11.1	0.7483
0.60	521	78.82	9.39	0.7882
Fruit				
0.12	1164	52.68	20.9	0.5268
0.24	934	62.03	16.8	0.6203
0.36	727	70.44	13.1	0.7044
0.48	651	73.53	11.7	0.7353
0.60	543	77.92	9.78	0.7792

**International Journal of Innovative Research in Science,
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Vol. 4, Issue 9, September 2015

Figure-1 Langmuir adsorption isotherm for aluminium in 0.5N H₂SO₄

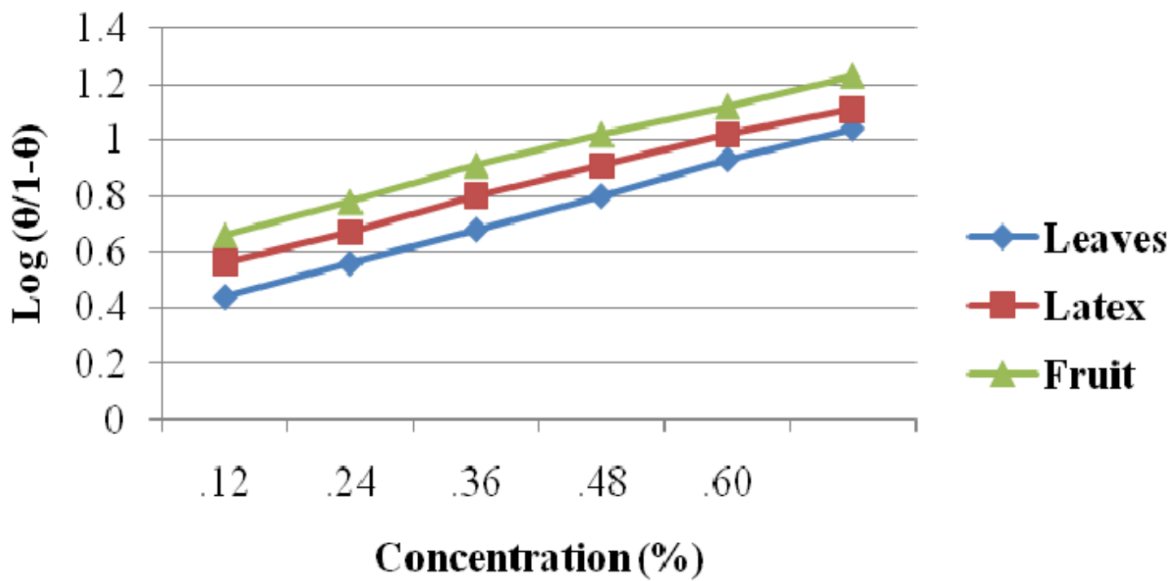
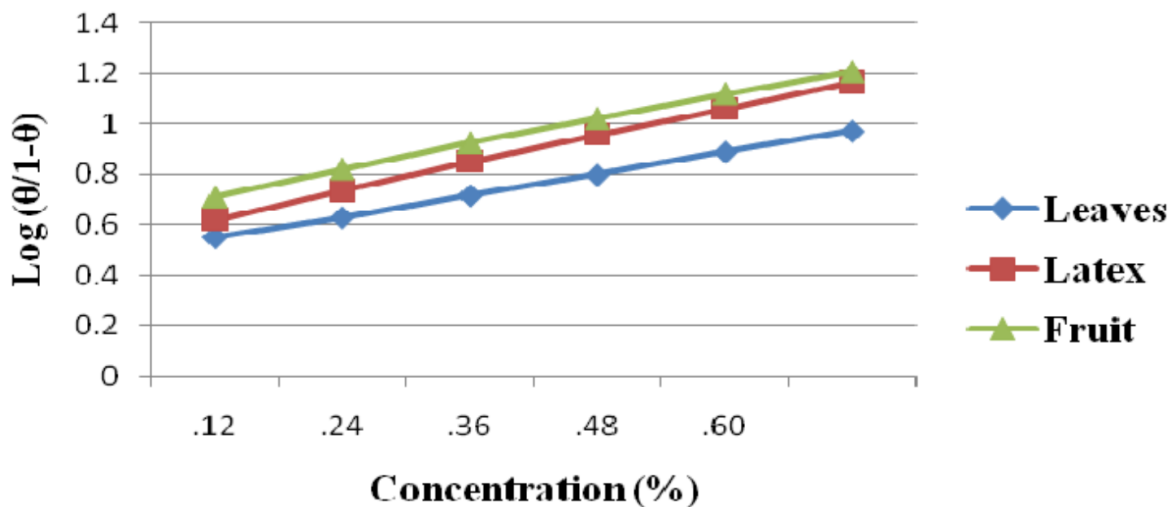


Figure-2 Langmuir adsorption isotherm for aluminium in 1N H₂SO₄



International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 4, Issue 9, September 2015

REFERENCES

1. H.H., Uligh, "Corrosion and corrosion control, an introduction to corrosion science and engineering" John Wiley and sons, New York, (1971).
2. J.C., Scully, "The fundamental of corrosion", 2nd Ed. Pergmann press London,249 (1975).
3. F.N., Speller, "Corrosion cause and prevention" Mc Graw Hill, New York (1951).
4. P.B. Raja, and M.G., Sethuraman, Materials Letters, 62, 113-116 (2008).
5. T. Jain, R. Chowdhary, and S.P., Mathur, Materials and Corrosion 57, 422-426 253 (2006).
6. G.S. Verma, P. Anthony, and S.P., Mathur, J. Electrochem. Soc. India, 51, 173- 255 177 (2002).
7. R. Chowdhary, and S.P., Mathur, J. Electrochem. Soc. India, 54, 1-10 (2005).
8. S. Kumar, S. Arora, M. Sharma, P. Arora, and S. P., Mathur, Journal of the 258 Chilean Chemical Society. 53, 83-88 (2009).
9. 'The useful plant of India' CSIR New Delhi, 'The wealth of India – raw 260 materials' CSIR, New Delhi, (1986).
10. E.A., Noor, International. J. Electrochem. Sci. 2, 996-1017 (2007).
11. M.K. Sharma, P. Arora, S. Kumar, S. P. Mathur, and R. Ratnani, Corrosion 263 Engineering Sci. and Tech. 43, 213-218 (2008).
12. T. Jain, R. Chowdhary, andS. P. Mathur, J. Electrochem. Soc. India. 53, 33-39 265 2004.
13. P. Arora, S. Kumar, M.K. Sharma, and S.P., Mathur, E-Journal of chemistry, 4 267 (4), 450-456 (2007).
14. N. Saxena, S. Kumar, and S.P., Mathur, Chemical Engineering Communications, 269 196(12), 1451-1465 (2009).
15. M.K. Sharma, S. Kumar, R. Ratnani and S.P. Mathur, Bull. of Electrochem. 22 (2006) 69.
16. P.B. Raja, and M.G. Sethuraman, Pigment and Resin Tech., 38 (2009) 33.