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Corrosion Inhibition of Aluminium by Alkaloid Extract of Aerial Part of *Euphorbia neriifolia* Linn in HCl Solutions

O.P.Meena[1]*, Anil Kumar Nainawat[1] and Alok Chaturvedi[2]

[1]DESM, RegionalInstitute of Education (NCERT) Ajmer, India-305004
[2]SPC Govt. College, Ajmer, India-305001

Abstract : The corrosion inhibition of aluminum by *Euphorbia neriifolia* Linn extract in different solutions of HCl (1N, 2N, 3N) was investigated by weight loss and thermometric methods at 300K temperature. From the study it was found that the inhibition efficiency increases with the increase in the concentration of extract of aerial part of the plant in HCl solutions. Results indicate that *Euphorbia neriifolia* Linn extract was an efficient natural corrosion inhibitor in acidic media. The stem extract of the *Euphorbia neriifolia* Linn is better than leaf and flower extract of the plant. Absorption of *Euphorbia neriifolia* Linn depends on its chemical compositions which showed the presence of various compounds like alkaloids, flavonoids, steroids, tannins etc. which has O, N and S atoms with lone pair electrons to form co-ordinate bonding with metal.
Key words : Weight loss, Thermometric, Surface coverage, Inhibition efficiency, Corrosion rate, *Euphorbia neriifolia* Linn.

Introduction

Corrosion is a natural destructives chemical reaction in which metal and alloys are damaged and loss their quality andmetal is destructed gradually by chemical or electrochemical reaction with their surrounding environment. Since the open environment has many harmful gases and acids in the air, many metals are affected by this destructive process. Aluminium is the third abundant element after oxygen and silicon and most abundant metal after iron in the earth crust. Aluminium is one of the most important metals on the earth which is widely used in different kind activities of society. The special characteristics of aluminium like low density, good conductor of heat and electricityare made it important metal and due that it is widely used in aerospace industry, transportation industry and building industry. Generally aluminum metal exits in the forms of their oxides and sulphates compounds. Aluminum has high corrosion resistance to atmosphere and pure water but it is corroded adversely in presence of acid solutions. It does not much corroded in nitric and sulphuric acid solutions, since it forms a stable oxide film on its surface but in hydrochloric acidic it get corroded. Corrosion decreases the chemical and physical properties of the metal and hence the metal has loss their useable properties. [(1-6)]

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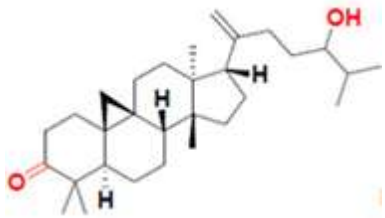
Heterocyclic compound containing O, N, S, and P, atoms have been used as corrosion inhibitors in acid media because the compound contains aromatic ring with free pi-electron pair for sharing with metal and donating their electron to the surface of metal and hence forms a coordinate bond between metal and inhibitor that reduce the corrosion rates. In this process inhibitor acts as nucleophile while metal acts aselectrophile centre's. Theelectrondensity, orientation, size and shape of molecules play significance role in the effectiveness of inhibition. In the mechanism the inhibitor got adsorbed on the active centre of metal surface and blocked the active corrosion site on the metal surface due to that liberation of H^+ ions and dissociation of metal is stopped in acidic media.

Naturally occurring plant product are easily available, less toxic, economic, eco-friendly and biodegradable so they are widely used as corrosion inhibitors without any side effects[(6-16)].

Plant description:

Euphorbia neriifolia Linn plant was selected for this study. This plant is a xerophytes shrub and is commonly available in desert climatic condition of India .It grows luxuriously in hilly, rocky areas of north India, central and south India. It easily found in climatic condition of Rajasthan .*Euphorbia neriifolia* Linn commonly known as thoar or sehund in Hindi and milk hedge in English andfrom review of literature we came to know that the plant is bitter, pungent, laxative, and carminative and improve appetite. It is useful in abdominal trouble, bronchitis, tumor, delirium, lucoderma, piles, inflammation, enlargement of spleen, enema, ulcers and it is also use for treating ear pain or ear disorder. The whole plant is very useful and the extract of plant contains; tannins, sugar, flavonoids, alkaloids, triterpenoids, saponins, etc. [(17-23)]



Neriifolione

Materials and Methods

Experimental metal

Commercially available aluminum sheet was used for this study. The specimens were prepared by cutting the aluminum sheet in to square shaped pieces having dimension 2.0 × 2.0 cm^2 containing a small hole of about 2 mm diameter near the upper edge were used for studying the corrosion rate.

Plant Extract

Euphorbia neriifolia Linn was identifying with help of subject experts and fresh plants were collected from Theme Park Botanical garden of RIE, Ajmer. The plant (including stem, leaves and flower) was air dried at room temperature, then grinded to make powder. The extract of powder stem, powder leaves and powder flower were obtained by refluxing the dried powder in soxhlet unit in ethanol solvent with refluxing by heating for sufficient time (15-20) hrs.

Chemicals used:-

1N, 2N, 3N solutions of HCl were prepared using analytical grade concentration and these acid solutions were used for corrosion analyses and for preparation of inhibitor solutions of different composition. (i.e. 0.1%, 0.3%, 0.5% and 0.7%)

Methods

Weight loss method:-

Each specimen was suspended by a V-shaped glass hook made of fine capillary and plunged into a beaker containing 50 mL of the test solution at room temperature. After the sufficient exposure, test specimens were washed with running tap water and dried with hot air dryer. Duplicate experiments were performed in each case and mean value of weight loss was calculated. The percentage inhibition efficiency was calculated [(24)] by this equation:

$$\eta\% = 100\left[\frac{(\Delta W_u - \Delta W_i)}{\Delta W_u}\right]$$

Where ΔW_u and ΔW_i are the weight loss of the metals in absence and presence of inhibitor solution, respectively. The degree of surface coverage by inhibitor was calculatedby this equation [(25)]

$$\text{Surface coverage } (\theta) = \frac{(\Delta W_u - \Delta W_i)}{\Delta W_u}$$

Thermometric method:

Inhibition efficiencies were determined by using thermometric method technique. This involved the immersion of single specimen of area 8 cm^2(both sides) in reaction chamber containing 50mL solution of acid at an initial temperature of 300K. Experiments were carried out in 1N, 2N, 3N, acid solutions and in absence and presence of differentconcentration of inhibitor viz. 0.1%, 0.3%, 0.5% and 0.7%. Thermometer bulb and specimen were completely immersed in experiment solution in a beaker. The beaker was kept in a thermally insulated chamber .Temperature changes were measured at intervals of 5 minutes using thermometer with a precision of -0.1^0C. The temperature increased slowly at first, then rapidly and attained a maximum value before failing the maximum temperature was recorded.

The reaction number(R N) is calculated by this equation:

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

Where T_m and T_i are maximum and initial temperature, respectively and t is the time in minutes required to attain maximum temperature. The percentage inhibition efficiencies (η%) were obtained by this equation [(26)]

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

Where RN_f, and RNiare the reaction number in the absence and in the presence of inhibitor, respectively.

The corrosion rate (CR) in mm/year can be calculated by the following equation [(27-30)]**.**

$$\text{Corrosion rate (mm/yr.)} = \frac{(\Delta \mathrm{W} \times 87.6)}{(\mathrm{A} \times \mathrm{T} \times \mathrm{d})}$$

Where ΔW is weight loss in mg, A is surface area of specimen in cm^2; t is time of exposure in hrs. and d is density of metal in g /cm^3.

Results and Discussions

The corrosion rate of aluminum was studied in different (1N, 2N, 3N) solutions of HCl by weight loss method in the absence and presence of stem extract, leaves extract and flower extract of *Euphorbia neriifolia* Linn plant at 300K temperature and percentage inhibition efficiency were calculated in both the conditions.

Weight loss data, percentage inhibition efficiency, corrosion rate and surface coverage for 1N and 2N HCl solutions with different concentration of inhibitor are given in table-1 and for 3N HCl are given in table-2 and corresponding graphs for both tables are shown in fig.-1 and fig.-2.

Table 1Weight loss, Percentage inhibition efficiency, surface coverage, and corrosion rate for Aluminium in (1N and 2N) HCl in the absence and presence of different concentration of inhibitors

Temperature: 300±0.1K						Area of Specimen: 13cm^2				
	1N HCl (45 min)					2N HCl (15 min)				
Concentration of inhibitor (%)	Weight loss in gram(Δw) (g)	Percentage Inhibition efficiency (η%)	Surface coverage (θ)	log (θ/1-θ)	Corrosion Rate	Weight loss in gram(Δw) (g)	Percentage Inhibition efficiency (η%)	Surface coverage (θ)	log (θ/1-θ)	Corrosion Rate
Uninhibited	0.1950				0.6488	0.3909				3.9022
Stem										
0.1	0.0341	85.51	0.8251	0.6736	0.1134	0.1041	73.36	0.7336	0.4399	1.0392
0.3	0.0226	88.41	0.8841	0.8824	0.0750	0.0896	77.07	0.7707	0.5264	0.8944
0.5	0.0131	93.08	0.9328	1.1423	0.0435	0.0721	81.55	0.8155	0.6454	0.7197
0.7	0.0099	94.92	0.9492	1.2714	0.0329	0.0516	86.79	0.8679	0.8175	0.5151
Leaf										
0.1	0.0509	73.89	0.7389	0.4517	0.1693	0.1196	69.40	0.6940	0.3556	1.1936
0.3	0.0432	77.84	0.7784	0.5156	0.1437	0.1056	72.98	0.7298	0.4315	1.0541
0.5	0.0301	84.56	0.8456	0.7385	0.1001	0.0881	77.46	0.7746	0.5361	0.8794
0.7	0.0251	87.12	0.8712	0.8301	0.0835	0.0684	82.50	0.8250	0.6734	0.6828
Flower										
0.1	0.0650	66.66	0.6666	0.2673	0.2162	0.1331	65.95	0.6595	0.2870	1.3287
0.3	0.0560	71.28	0.7128	0.3552	0.1863	0.1191	69.81	0.6981	0.3582	1.1779
0.5	0.0466	76.10	0.7610	0.5029	0.1550	0.1016	74.00	0.7400	0.4542	1.0142
0.7	0.0385	80.25	0.8025	0.6088	0.1281	0.0819	79.04	0.7904	0.5764	0.8176

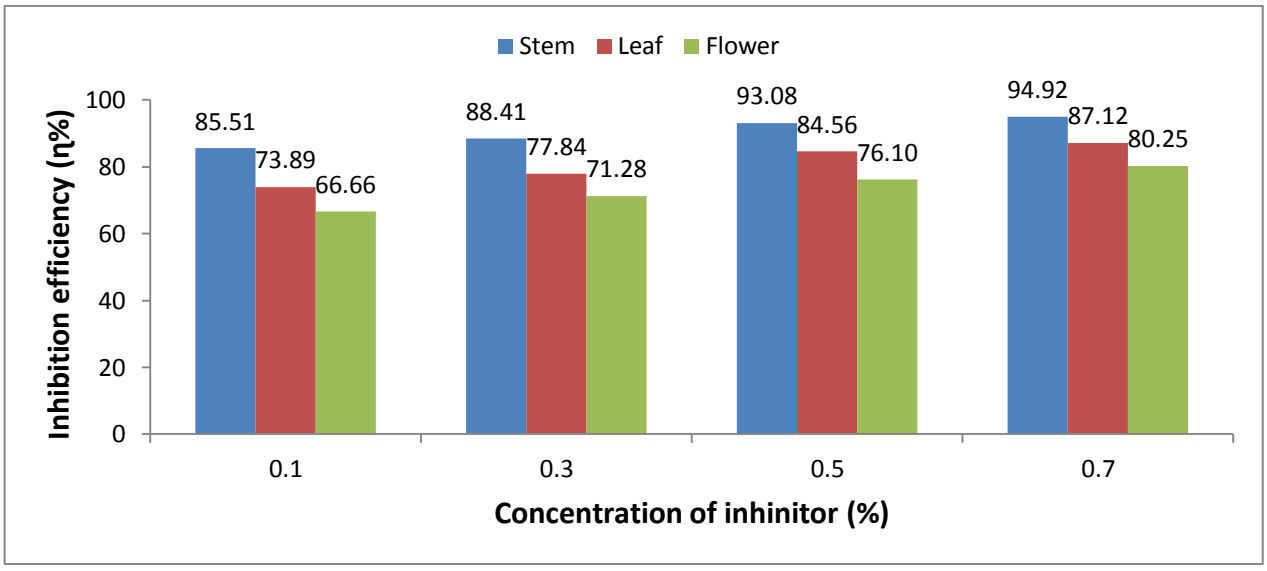


Fig . 1 Variation of inhibition efficiency (η %) with concentration of inhibitors for Aluminium in 1NHCl

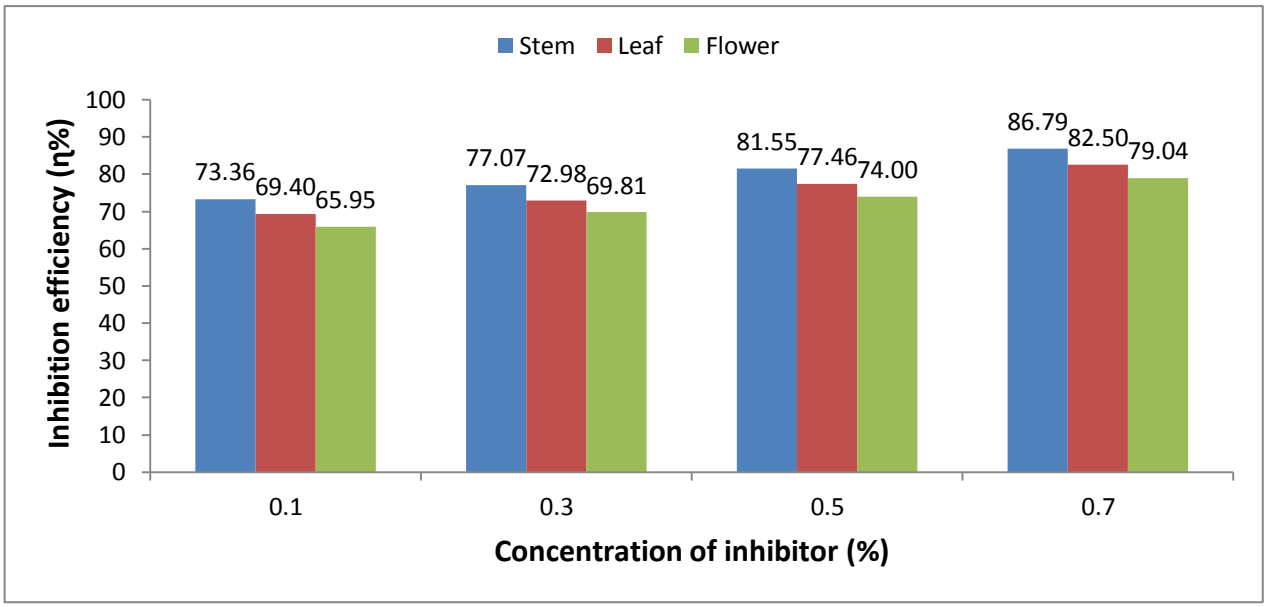


Fig. 2 Variation of inhibition efficiency (η %) with concentration of inhibitors for Aluminium in 2NHCl

Table 2 Weight loss, percentage inhibition efficiency, surface conversion, and corrosion rate data for Aluminium in (3N) HCl in the absence and with different concentration of inhibitors.

Temperature: 300±0.1K			Area of Specimen: 13cm^2		
		3N HCl (8Min.)			
Concentration of inhinitor (%)	Weight loss in gramΔw (g)	Percentage inhibition efficiency	Surface coverage (Θ)	log (θ/1-θ)	Corrosion Rate
Uninhibited	0.5146				9.6563
Stem					
0.1	0.1431	72.26	0.7226	0.4244	2.6852
0.3	0.1244	75.82	0.7707	0.5281	2.3343
0.5	0.1051	79.57	0.8155	0.6454	1.9721
0.7	0.0866	83.17	0.8679	0.8175	1.625
Leaf					
0.1	0.1606	68.79	0.6879	0.3432	3.0136
0.3	0.1419	72.52	0.7252	0.4214	2.6627
0.5	0.1226	76.17	0.7617	0.5046	2.3005
0.7	0.1041	79.67	0.7967	0.5931	1.9534
Flower					
0.1	0.1751	65.97	0.6597	0.2874	3.2857
0.3	0.1564	69.60	0.6960	0.3597	2.9348
0.5	0.1371	73.35	0.7335	0.4396	2.5726
0.7	0.1185	76.35	0.7635	0.5089	2.2236

The data was utilized for calculation of reaction number and percentage of inhibition efficiencies are given in table -3 for stem, leaf and flower extract in 1N, 2N,and 3N HCl and corresponding graphs are shown in fig.-3 ,fig.-4, and fig.-5.

We can see and observed from the table-1 and table -2 that inhibition efficiency decreases with increasing strength of hydrochloric acid and inhibition efficiency increases with increasing concentration of extract in strength of each acid solution.

The maximum efficiency has been observed in lowest concentration of HCl i.e. 1N HCl with highest concentration of inhibitor i.e. of 0.7% (94.92) for stem extract, where as it is (87.12) for leaf extract and (80.25) for flower extract insame concentration of HCl. The corrosion rate has been observed maximum in blank solution and it decreased with the increasing concentration of inhibitor in HCl solution of different strength.

Corresponding variation of inhibition efficiencies with concentration of inhibitor are shown in fig-1, fig-2, fig-3 for different concentration of HCl solution.

Table -3 indicates that reaction number increases with increasing strength of HCl solution as well as it decreases with increasing concentration of inhibitor in each solution.

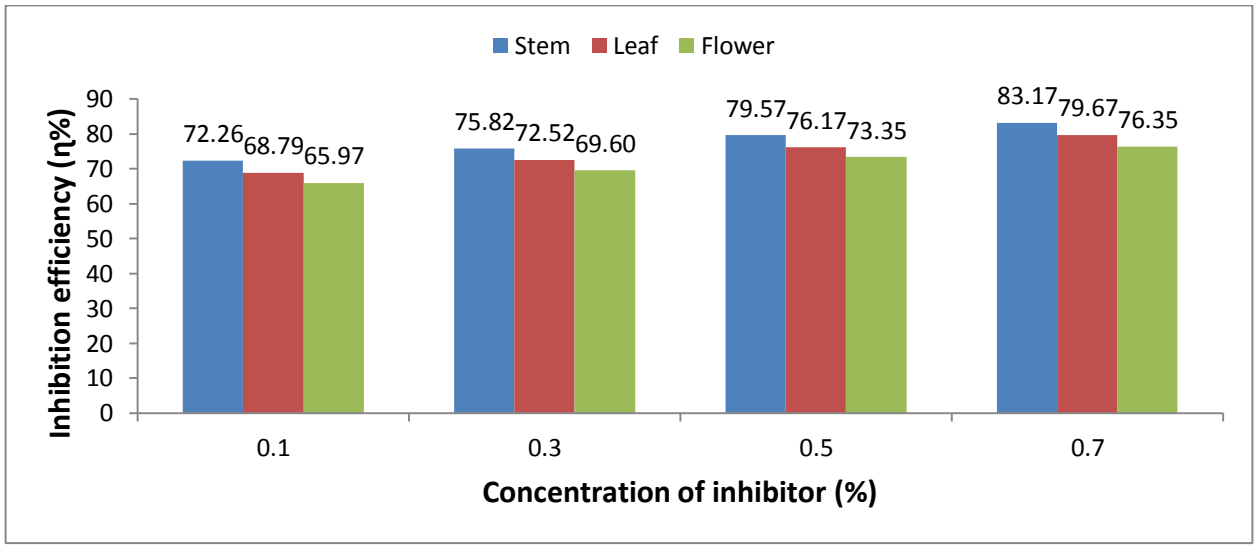


Fig. 3 Variation of inhibition efficiency (η %) with concentration of inhibitors for Aluminiumin 3N HCl

Table 3 Reaction number (RN) and inhibition efficiency (η %) for Aluminium in (1N, 2N, 3N) HCl in the absence and presence of inhibitors of stem, leaf and flower extract.

Table-3	Reaction number (RN) and inhibition efficiency (η%) for Aluminium in (1N, 2N, 3N) HCl in the absence and presence of inhibitors of stem, leaf and flower extract of Euphorbia neriifolia linn					
Temperature: 300±0.1K				Area of Specimen: 13cm^2		
1N HCl			2N HCl		3N HCl	
Concentration of inhinitor (%)	Reaction Number (RN)	Inhibition efficiency (η%)	R.N	I.E (η%)	R.N	I.E (η%)
Uninhibited	10.6666		68.00		157.8947	
Stem						
0.1	0.9333	82.51	7.200	73.36	21.0526	72.26
0.3	0.8000	88.41	6.800	77.07	20.3007	75.82
0.5	0.6666	93.28	6.400	81.55	19.5488	79.57
0.7	0.5333	94.92	6.000	86.79	18.7969	83.17
Leaf						
0.1	1.8666	73.89	9.600	69.40	22.8045	68.79
0.3	1.7333	77.84	9.200	72.98	21.0826	72.52
0.5	1.6000	84.56	8.800	77.46	20.1007	76.17
0.7	1.4666	87.12	8.400	82.50	19.2488	79.67
Flower						
0.1	2.4000	66.66	11.600	65.95	25.812	65.97
0.3	2.2666	71.28	11.200	69.81	24.0604	69.60
0.5	2.1333	76.10	10.800	74.00	23.3082	73.35
0.7	2.0000	80.25	10.400	79.04	22.5563	76.35

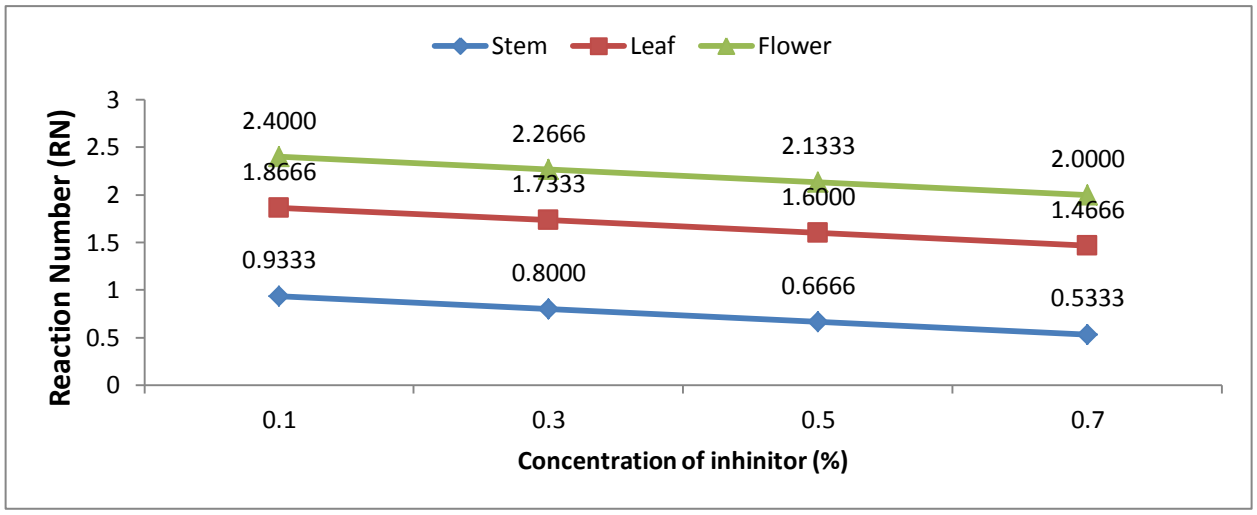


Fig. 4 Variation of Reaction number with Concentration of inhibitors for Aluminium in 1N HCl.

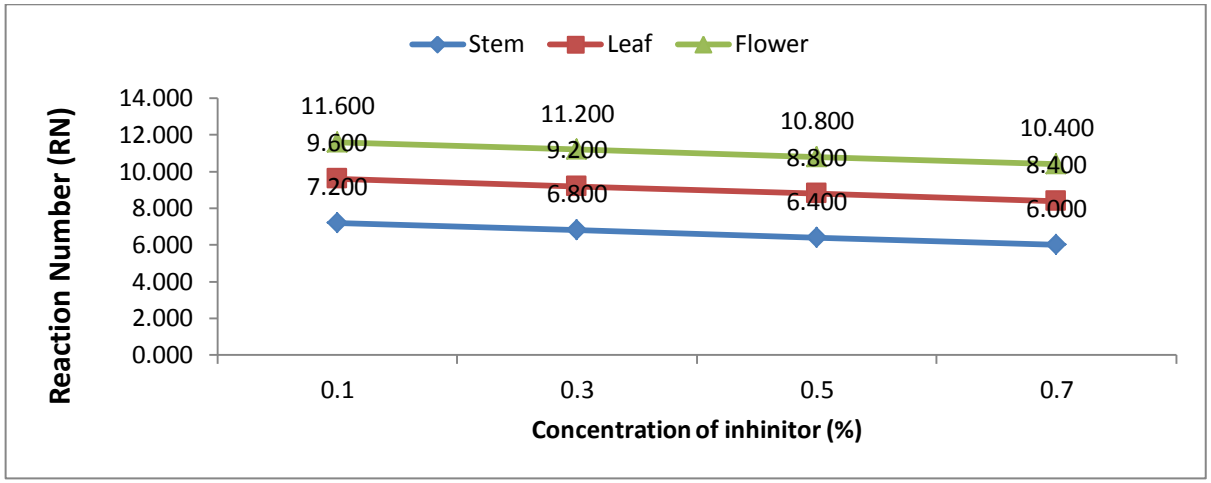


Fig. 5 Variation of Reaction number with Concentration of inhibitors for Aluminium in 2N HCl.

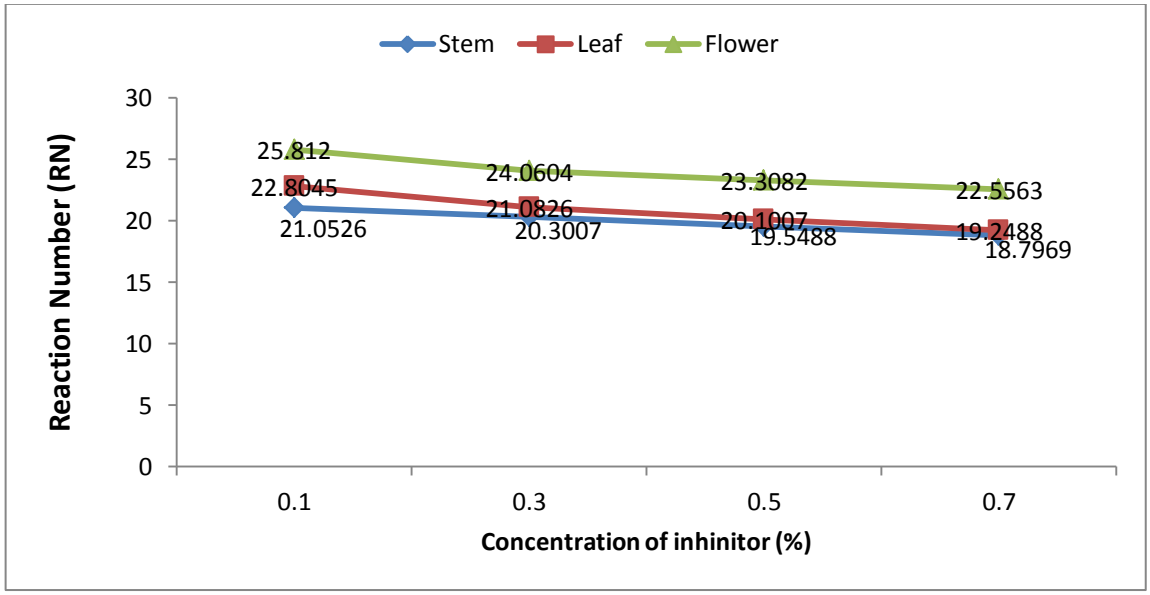


Fig. 6 Variation of reaction number with concentration of inhibitors for Aluminium in 3N HCl.

Inhibition efficiency increases with increasingconcentration of inhibitor and it decreases with increasing strength of HCl solution and corresponding curves for the variation in reaction number with concentration of inhibitor aregiven in fig. - 4, fig.- 5, and fig.-6 for different concentration of HCl solutions

It is clear from the study thatthe inhibition efficiency is maximum at higher concentration of inhibitor. This is because of fact that high electronegative atoms of inhibitor forms coordinate bond with metal and block the active Centre's on the metal surface, which essentially stopped the discharge of H^+ionsand dissolution of metal ion in acid media so they are reduce the corrosion rate of tin with inhibitor.

Conclusion

The study of aerial part of *Euphorbia neriifolia* Linn has showed that it would be better corrosion inhibitor for aluminium in different solution of HCl. From the study it was found that the inhibition efficiency increases with the increase in the concentration of extract in HCl solutions. Results indicate that the *Euphorbia neriifolia* Linn extract was an efficient natural corrosion inhibitor in acidic media. The maximum inhibition efficiency shown by stem extract was 94.92 for 0.7% concentration of inhibitor for 1N HCl solution, whereas it was observed 87.12 forleaf extract and 80.25 for flower extract in the same of concentration inhibitors for the same acid solutions. It was conclude that extract of stem is better corrosion inhibitor than the leaf and flower.

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References

1. Song J. ; Wang L. ; Zibart A. ; Koch C. , Metals ,2012 , 2, 450- 477
2. SharmaPoojaetal. ,Elixir Corrosion 2012, 46, 8382-8385
3. Roberge P. R., Handbook of Corrosion Engineering, McGrav-Hill, New York, 2000.
4. Ahemad Z., Principles of Corrosion Engineering and Corrosion Control, Elsevier, Oxford, 2016.
5. Sumitra A.; Nikhila G., International journal of Chemtech Research 2018, 11, 129-139.
6. Rodriquez –Clemente E.; Gonzalez –Rodriquez J.G.; Valladarez G.;Dominquez –PatinoG.P., Int. J. Electrochem. Sci. ,2011,6,6360-6372
7. Wan Nik W.B.;Zulkifli F. ; Rosliza R. and Rahman M.M. , International Journal of Basic and Applied Sciences , 2011,11, 75-80
8. Oguzle E.E.,Portugaliae Electrochemica Acta. 2008,26,303-314
9. Magda Ameer ; AzzaGhoneim ; AmanyFekry ,Electro Chemical Corrosion Inhibition of Al –Alloy in Phosphoric acid , 2012 ,2,1
10. Geeta S. ; Lakshmi S. ; Bharathi K., International Journal of Advanced Scientific and Technical Research ,2013,3, 2249-9950
11. Abdallah M.; Zaafarany I.A.; Aljahdaly B.A., I .J. Mater Environ. Sci. ,2016 ,4, 1107-1118
12. Amitha Rani B.E. ; Bharathi Bai J. Basu , International Journal of Corrosion ,2011,2012,15
13. Eddy N.O. and Ebenso E.E., E- Journal of Chemistry , 2010 , 7, 442-448
14. ObotI.B.;Obi-Egbedi N.O.;Umoren S.A. and Ebenso E.E., Int. J. Electrochem. Sci. 2010 , 5, 994-1007
15. Abd- El- Nabey B.A.; Abdel- Gaber A.M.; Elawady G.Y. and El- Housseiny S., Int. J. Electrochem. Sci. 2012 , 7, 7823- 7839
16. El. Etre A.Y. , Journal of Colloid and Interface Science , 2007, 314, 578- 583
17. Shaikh Arshal Ahmed et al. International Research Journal of Pharmacy , 2011, 2, 41-48
18. Chinmayi Upadhyaya and Sathish S. , International Journal of Pharma and Chemical Research , 2017, 3, 149-154
19. Bapu R. Thorat and VikkyBolli , Biomedical Journal of Science and Technical Research , 2017, 01, 000523
20. Papiya Bigoniya and Rana A.C. , Academic Journal of Plant Science , 2009, 2 (4) 252-259
21. Kalpesh Gaur; RanaA.C.; Nema P.K.; KoriM.L.; and Sharma C.I. , Asian Journal of Pharmaceutical and Clinical Research , 2009, 2

22. Kumar Swamy M ; Neeraj Pokharan ; Santosh Dahal and Anuradha M., Journal of Medical Plant Research , 2011, 5 (24) , 5785-5788
23. Pracheta ; Veena Sharma ; Ritu Paliwal and Sadhana Sharma, International Journal of Pharma Tech Research ,2011 , 3 , 124-132
24. Dish RiskiGustiE. etal,J . Chem. Pharm. Res. , 2015 (12) , 398 – 405
25. Saedah R. Al – Mhyawi , African Journal of Pure and Applied Chemistry , 2014, 8(1) , 9- 22
26. Norzila Mohd. ; Anis SuhainaIshak , Indian Journal of Science and Technology , 2015 , 8 (7)
27. Srikanth A.P. et al , Der Pharma Chemica , 2016 , 8(12), 78 - 83
28. Leelavathi S. ;Rajalakshmi R. , Journal of Mater and Environmental Science , 2013 , 4 (5), 625-638
29. De Ryck I. et al. , Journal of Cultural Heritage , 2004 , 5 , 189- 195
30. Pathak R.K. ; Mishra Pratiksha , International Journal of Science and Research , 2016 , 5 , 671 – 67
31. Power D.H. and Fox C., The effect of cosmetic emulsions on the stratum corneum, J.Soc. Cosmet. Chem., 1959, 10,109-116.

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