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CORROSION INHIBITION OF COPPER BY ACID OF *TECOMELLA UNDULATA*

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ABSTRACT

Corrosion inhibition of copper by the extracts of *Tecomella undulata* in HCl media was studied. Mass loss studies have been carried out at room temperature. The effects of temperature and concentration variation on the inhibition performance of the extracts have also studied. The results are discussed.

Key words: corrosion inhibitor, copper, acids, *Tecomella undulata*.

INTRODUCTION

Copper is used in nearly all coinage and remained the second most utilized metal. Copper is also trace element essential to the healthy life of plants and animals; in which, it usually occurs as part of oxidizing enzyme.

It suffer from sever corrosion in aggressive environment. HCl and H_2SO_4 acids have been used for drilling operation, picking bath and in decaling process.[1] To reduce the corrosion problems in these environment, inhibitive effects of various organic compounds have been tried so for metallic corrosion is a very common but serious problem, causing considerable whole word. Mitigation of corrosion requires the application of various engineering techniques and scientific knowledge on the role of the alloying element in the reduction of corrosion losses and application of film forming inhibitors are well known[2].

Organic compounds having heteroatom are found to have higher basicity and electron density and thus assist in corrosion inhibition[3]. There are numberous naturally, occurring substance like Embellio officinalis, Terminalia bellerica[4], Prosopis joliflora[5],

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honey and naturally accuring ginger[6], A mixture of the later tree, Sapindus trifolinus and Acacia concianna[7], Swertia anugustiflolia[8], quinoline base Cinchona alkaloids[9], Saponin[10], tobacco & cariandum stivum[11]and Henna[12] have been evaluated a effective corrosion inhibitors. Due to the bio-degradability, co-friendliness, cost-effectiveness, less toxicity and easy availability of these compound, the fiend of using them have become increasingly important in the recent years.

The present work is directed to evaluate the extracts of tecomella as probable a corrosion inhibitors in HCl media for copper.

EXPERIMENTAL

Specimen preparation

Rectangular specimens of copper metal dimensions 1.5 × 2.5 × 0.035 cm, with a small hole of about 2 mm diameter near the upper edge were employed for the determination of mass loss measurements.

Copper specimens of chemical composition iron .2%, copper .2%, silica .2%, titanium .03%, zinc .07% and rust. Buffing to produce a mirror finish with the help of emery paper cleaned specimens and was them degreased with acetone. Each specimen was suspended by a glass hook and immersed in a beaker containing 50 mL of test solution at 299 ± 2 K and left exposed to air. Evaporation losses were made up with distilled water. After the test specimens were cleaned with benzene[13]. Duplicate experiments were performed in each case and mean values of the mass were calculated.

Test solution preparation

The solution of 1 N HCl was prepared using doubly distilled water. The *Tecomella undulata* extract was obtained by boiling 5 g. Dry powders of roots, branches, leaves and seeds in 100 mL 1 N HCl for 2 hrs. On water bath at 500^{o}C and then kept overnight. Next day the filtrate volume was made 100 mL using distilled water to make 1 N concentration of acid of 5% of w/v Tecomella content. The acid solution was using A.R. grade reagents and inhibited solution respectively.

The percentage inhibition efficiency was calculated as[14] -

$$I.\ E. = 100\ (\Delta M_u - \Delta M_i) / \Delta M_u$$

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

The degree of surface coverage p can be calculated as[15] -

$$\theta = (\Delta M_u - \Delta M_i) / \Delta M_u$$

Where θ surface coverage and ΔM_u and ΔM_i are the mass loss of the metal in uninhibited acid and inhibited solution, respectively.

The corrosion rate in mmpy (milli meter per year) can be obtained by the following equation.

$$\text{Corrosion Rate (mmpy)} = \frac{\text{Mass loss x } 87.6}{\text{Area x Time x Metal density}}$$

Where mass loss is expressed in mg, Area is express in square inches of metal surface exposed, Time is expressed in hours of exposure, and metal density is expressed in gms/cm^3.

RESULTS AND DISCUSSION

Result of inhibitor concentrations

Effect of inhibition efficiency (I.E.) calculated from the mass loss measurement for 1 N HCl. It is found that efficiency increase with the increase of inhibitor concentration for roots, branches, leaves and seeds extracts from 0.5% to 5%.

Effect of immersion period

The inhibition efficiency (I.E.) Calculated from the mass loss measurements for 1 N HCl. It is found that roots, branches, leaves and seeds extracts inhibitor efficiency decrease up to 24 hours and then show a decline as show in tables.

Effect of acid solution

It was found that the roots, branches, leaves and seeds extracts for 1 N HCl have a good property to inhibit the corrosion of copper even when the exposure time is also large.

Roots extracts for 1 N HCl acid have shown the inhibitor efficiency from 12% to 41% for 3 hours. Whereas after 72 hours duration, the efficiency was obtained in range of 52% to 87% for 0.5%-5% concentration (Table 1).

Table 1: Inhibition efficiencies for copper in 1 N HCl with roots of *Tecomella undulata*

Root conc. %	Inhibitor efficiency % η %						
	3 hrs.	**12 hrs.**	**24 hrs.**	**36 hrs.**	**48 hrs.**	**60 hrs.**	**72 hrs.**
0.5	13.72	19.43	21.73	29.15	34.51	38.73	52.24
1.0	17.49	24.10	30.88	36.93	42.13	51.54	61.32
1.5	19.60	32.25	42.71	48.20	52.07	56.12	64.17
2.0	25.49	39.48	49.28	55.49	62.50	67.16	71.29
2.5	34.86	44.02	56.21	62.78	67.42	72.10	78.81
5.0	40.43	54.35	62.14	69.54	73.05	77.43	86.72

Branches extracts for 1 N HCl acid have shown the inhibitor efficiency from 20% to 42% for 3 hours. Whereas after 72 hours duration, the efficiency was obtained in range of 49% to 90% for 0.5%-5% concentration (Table 2).

Table 2: Inhibition efficiencies for copper in 1 N HCl with branches of Tecomella undulata

Branches conc. %	Inhibitor efficiency % η %						
	3 hrs.	**12 hrs.**	**24 hrs.**	**36 hrs.**	**48 hrs.**	**60 hrs.**	**72 hrs.**
0.5	19.60	22.05	26.58	32.60	42.46	45.40	49.58
1.0	22.72	24.89	31.45	40.40	48.87	50.12	53.20
1.5	25.49	29.02	34.52	46.54	54.63	58.32	69.49
2.0	31.37	34.35	39.64	53.51	62.30	67.41	74.07
2.5	33.18	41.53	54.73	62.27	79.03	79.16	82.41
5.0	41.17	49.12	52.26	71.82	83.09	84.56	89.27

Leaves extracts for 1 N HCl acid have shown the inhibitor efficiency from 9% to 39% for 3 hours. Whereas after 72 hours duration, the efficiency was obtained in range of 47% to 86% for 0.5%-5% concentration (Table 3).

Table 3: Inhibition efficiencies for copper metal in 1 N HCl with leaves of Tecomella undulata

Leaves conc. %	Inhibitor efficiency % η %						
	3 hrs.	**12 hrs.**	**24 hrs.**	**36 hrs.**	**48 hrs.**	**60 hrs.**	**72 hrs.**
0.5	9.80	18.24	28.12	34.78	41.31	44.16	47.31
1.0	13.43	22.02	31.62	38.10	43.67	48.23	52.47
1.5	15.22	27.53	33.14	42.02	49.12	50.88	58.62
2.0	19.20	29.23	39.38	47.14	54.79	56.23	63.54
2.5	23.52	35.38	48.73	53.58	58.59	61.20	70.02
5.0	39.21	52.18	61.63	68.12	74.71	79.15	86.13

Seeds extracts for 1 N HCl acid have shown the inhibitor efficiency from 11% to 60% for 3 hours. Whereas after 72 hours duration, the efficiency was obtained in range of 48% to 94% for 0.5%-5% concentration (Table 4).

Table 4: Inhibition efficiencies for copper metal in 1 N HCl with seeds of Tecomella undulata

Seeds conc. %	Inhibitor efficiency % η %						
	3 hrs.	**12 hrs.**	**24 hrs.**	**36 hrs.**	**48 hrs.**	**60 hrs.**	**72 hrs.**
0.5	11.63	14.35	18.66	27.61	38.15	42.09	48.28
1.0	18.91	23.58	29.66	34.39	41.38	54.55	62.18
1.5	23.52	26.66	32.87	39.38	48.52	57.60	64.90
2.0	31.37	35.76	39.89	49.05	56.38	623.80	71.27
2.5	39.21	44.28	52.28	52.28	67.05	73.44	79.45
5.0	60.08	64.10	70.03	79.79	86.03	89.53	93.84

A very wide range of can inhibit the corrosion of metal in aqueous acid solution. These include relative simple substance such as Cl^- and I^- ions and many organic compounds particularly those containing elements such as nitrogen, oxygen, sulphur,

phosphorous, arsenic and selenium. The primary stem in the action is generally agreed to be adsorbed on the metal surface.

The loss of inhibition efficiency in the presence of high concentration of extract may be due to a competition between ions to be adsorbed on the surface. The competition leads to a random arrangement of the adsorbed anion and hence decreasing the inhibition efficiency[16-17].

In HCl, it appears that the basic species extracted might have been protonated and these cationic species[18-20] might have been adsorbed electrostatical via Cl^- ions (of HCl) on the copper surface probably by vertical adsorbtion[21-23].

CONCLUSION

The alcoholic extract of *Tecomella undulata* is found to be effective inhibitors in acid media given up to 90% efficiency and can be safely used without hydrogen damage toxic effect and pollution problems.

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REFERENCES

1. F. Reverdin, Helv. Chim. Acta, **10**, 34 (1927).
2. J. Vishal Anand, T. S. Prasanna Kumar and D. Mukherji, Bull. Electrochem., **15**, 148 (1999).
3. I. N. Putilova, S. A. Bbalizin and V. P. Barannik, Metallic Corrosion Inhibitors, Pergaman Press, London (1960).
4. M. J. Sanghvi, S. K. Shukla, A. N. Mishra, M. R. Pach and G. N. Mehta, 5th National Congress on Corrosion Controls, New Delhi, (NCCI, CECRI, Kqaraikudi) (1995).
5. R. Chowdhary, T. Jain, M. Rathoria and S. P. Mathur, Bull. Electrochem, **20**, 67 (2004).
6. A. Bouyanzer and B. Hammouti, Bull. Electrochem, **20**, 63 (2004).
7. M. J. Sanghavi, S. K. Shukla, A. N. Mishra, M. R. Pach and G. N. Mehta, Trans MFA, **5**, 143 (1996).

8. S. J. Zakvi and G. N. Mehta, Trans SAEST, **4**, 23 (1988).

9. G. N. Mehta and T. P. Sastry, Proc. 2nd Int. Symp. India, and Oriented Basic Electrochemistry, Madras Prepr., **6**, 24, SAEST, CECRI, Karaikudi. (1980).

10. S. J. Zakvi and G. N. Mehta, Trans SAEST, **24**, 407 (1988).

11. K. J. Joshi and K. S. Parikh, Proceeding of 7th International Symposium on Advances in Electrochemical Sciences and Tech., (ISAEST-VII), Chennai, India, **3** (2003).

12. M. Prazak, Worksite Corros, Bull. Electrochem, **25**, 607 (1974).

13. F. A. Champion, Corrosion Testing Procedures, Chapman & Hall. U.K. (1964).

14. J. D. Talati and D. K. Ghandi, Ind. J. Tech., **29**, 277 (1991).

15. R. S. Dubey and S. N. Uppadhyay, J. Electrochem. Soc. India, **143**, 73 (1944).

16. M. Abdullah, Electrochem. Soc. India, **48**, 121 (1999).

17. L. I. Antripov, Corrosion Sci., **7**, 607 (1967).

18. N. Hacckerman, D. D. Justics and E. Mc. Cafferty, Corrosion, **31**, 240 (1975).

19. R. K. Uppadhyay and S. P. Mathur; E-J. Chem., **4**, 408 (2007).

20. M. A. Quarishi, Bull. Electrochem, **19**, 20 (2003).

21. A. Kumar, Abha Goyal and V. K. Swami, J. Ultra Chem., **4(2)**, 279 (2008).

22. Abha Goyal and V. K. Swami and S. P. Mathur, E-J. Chem., **7**, 123 (2010).

23. R. Poonia, S. Kumar and V. K. Swami, Int. J. Chem. Sci., **10(4)**, 1897 (2012).

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