International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 09 | Sept - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Green Inhibitory Effect of Raw Tamarind Extract on Steel Plates in Acid Medium

Chandrakala M[1], Anima Upadhyay[2],

[1]Assistant Professor, Department of Chemistry, Cambridge Institute of Technology North Campus, Bangalore, Karnataka, India.
[2]Assistant Professor, Department of Chemistry, Sir M Visveswaraya Institute of Technology, Bangalore, Karnataka, India.

Abstract - The corrosion inhibition of steel plates by tamarind extract in 1% H_2SO_4 and 1% HCl has been studied at room temperature up to 120 hours. The experimental results obtained reveals that there was an increase in the weight of steel plates at around 72 hours when steel plates were immersed in tamarind solution. Similar, observation in the increase in the weight of the steel plates at around 48 hours was observed when steel plates were immersed in mixture of tamarind and sulphuric acid, tamarind and hydrochloric acid. This increase in weight of the steel plates shows the formation of an oxide layer on its surface, thus preventing and inhibiting corrosion of the steel plates.

Key Words: Corrosion, Raw Tamarind, Steel plates, Oxide layer, Inhibition.

1.INTRODUCTION

Corrosion is a natural phenomenon and defined as the destruction of the metal / alloy due to its slow oxidation with the surrounding environment. The wet chemical theory describes the corrosion of metals / alloys in various mediums / environment. Rate of corrosion depend upon many factors. Surface and nature of the material play a important role in corrosion and is a determining factor in the corrosion rate. Existence of air, moisture, salts, free ions, gases (mainly acidic gases) affect the rate of corrosion and may lead to excessive corrosion. Recently there is a revolution in the medical field where artificial organs (made up of metals and alloys) are implanted in the body if the original organs fail to function. These artificial organs should possess high corrosion resistance otherwise the patients would undergo severe effects caused by the corrosion of the implanted organs. With modernization started the growth of Industries and cities. During this growth, infrastructure has played a major role and require various kinds of alloys, metals and composite materials, but it requires a recurring monetary expenditure on maintenance. Therefore, many authors have studied the role of environment on the corrosion of the metal using weight loss method [1 – 22]. The other downside of the modern age is that the people are busy in their hectic schedule and finding it difficult to cook food every day, hence they depend upon the readymade food stuff. This normally comes in packed cans made of tinned iron. Thus, there is an extensive use of metals and alloys in our day-to-day life compared to the people in the ancient. Hence the study of corrosion has become the necessity of the day. If the rate of corrosion is studied prior to its usage we can save ourselves from large damages that could ruin our lives due to corrosion effects.

Corrosion is explained well with the help of electrochemical theory. According to this theory formation of galvanic cells leads to corrosion of metals and alloys. These cells have anodic and cathodic sites, the metal at the anode starts corroding resulting into the loss of the metal when exposed to the environment. Corrosion can be significantly reduced by using certain agents called retarders, inhibitors or passivating agents. Passivation is described as the formation of a thin layer of metal oxide (nonporous, uniform and inert) on the metal surface which prevents further corrosion of the metal. Several studies have been carried out on the corrosion behaviour of various metals and alloys [23-29] but very little has been done in the direction of passivation by natural agents such as plants and fruit extracts.

Considerable attempts have been employed to find suitable corrosion inhibitors of organic origin in various corrosive media [30-33]. In acid media, nitrogen-base materials and their derivatives, sulphur-containing compounds, aldehydes, thioaldehydes, acetylenic compounds, and various alkaloids (papaverine, strychnine, quinine, and nicotine) are used as inhibitors. In neutral media, benzoate, nitrite, chromate, and phosphate act as good inhibitors. Inhibitors reduce or prevent the reaction of the metal with the media. They reduce the rate of corrosion rate by adsorption of ions/molecules onto metal surface, increasing or decreasing the anodic and/or cathodic reaction, decreasing the diffusion rate for reactants to the surface of the metal, decreasing the electrical resistance of the metal surface, inhibitors that are often easy to apply and have in situ application advantage. Several factors including cost, easy availability and safety to environment need to be considered when selecting an inhibitor. Recently we came across inhibitory behaviour of tartaric acid [34-36] on steel which showed promising for protection of steel from corrosion.

The object of the present study is to reduce corrosion by the use of natural passivizing agents. For this study raw tamarind extract that contains tartaric acid [37-38] was selected and passivation behaviour of these extracts on the metal through weight loss method was investigated.

2. MATERIALS AND METHODS

Sample preparation

Square steel (length 3cm and height 3cm) plates were used as sample to study the passivation behaviour in different acid (sulphuric acid and hydrochloric acid) and raw tamarind media. The plates were cleaned with double distilled water to remove dust, degreased by acetone, dried and weighed.

Natural extracts

50 g of raw tamarind was weighed, crushed, grinded and filtered and an extract of it was made with double distilled water and diluted to 200 ml and stored as stock solution.

Test solutions

40, 30, 20 and 10% raw tamarind solutions were prepared from stock solution using double distilled water. 1% solutions of H_2SO_4 and HCl acid were prepared using double distilled water. The reagents used for the study were of analytical grade.

Experimentation

The previously weighed steel plates having surface area of 9 sq.cm were immersed in the mixture of 70 ml (40, 30, 20 and 10%) raw tamarind solution with 10 ml 1% acid (HCl/ H_2SO_4), maintaining the final volume of the mixture to 80 ml. The plates were immersed for 24, 48, 72, 96 and 120 hours respectively. After an immersion period of the above time, they were removed carefully from the solution washed with water, dried thoroughly and weighed. The plates were then immersed again and the procedure was continued for up to 120 hours. The loss or gain in the weight was recorded.

Weight loss measurements

The weight loss method was adopted to study the rate of corrosion of surface treated steel plates having surface area of 9 sq.cm. The loss/or gain in the weight of the steel plates is shown in the figures.

3. RESULTS AND DISCUSSION

The weight loss of corrosion of steel in mixture of tamarind extract and HCL, tamarind extract and H_2SO_4, tamarind extract is shown in the graph. The figure 1 shows that the weight loss of the steel plates in tamarind extract after 72 hours was maximum in 20 % tamarind extract followed by 40% and 30 % tamarind extract. After 72 hours there is an increase in weight in 10 % tamarind extract indicates the formation of oxide layer on the surface of the steel plates but there is a decrease in weight in the remaining tamarind extract.

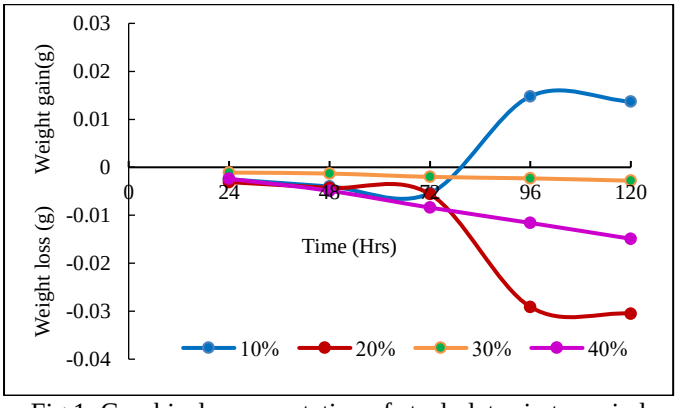

Fig 1: Graphical representation of steel plates in tamarind extract

The figure 2 shows that the weight loss of the steel plates in a mixture of tamarind extract and H_2SO_4 after 48 hours was maximum in 30 % tamarind extract and H_2SO_4 mixture followed by 40% and 20 % tamarind extract and H_2SO_4 mixture. After 48 hours there is an increase in weight in 10 % tamarind extract and H_2SO_4 mixture indicates the formation of oxide layer on the surface of the steel plates but there is a decrease in weight in the remaining tamarind extract and H_2SO_4 mixture.

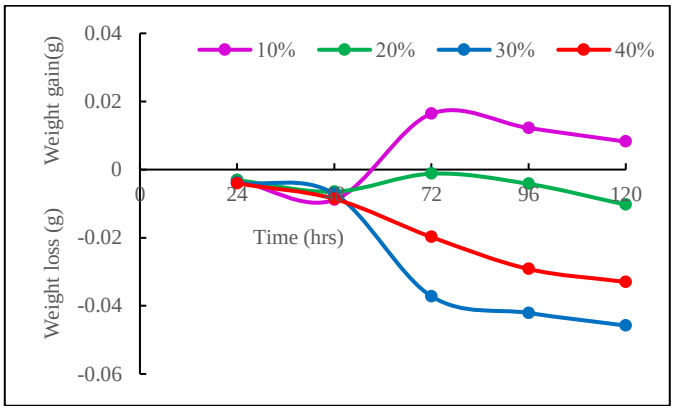

Fig 2: Graphical representation of steel plates in mixture (Tamarind extract and sulphuric acid)

The figure 3 shows that the weight loss of the steel plates in a mixture of tamarind extract and HCl after 48 hours was maximum in 10 % tamarind extract and HCl mixture followed by 20% and 40 % tamarind extract and HCl mixture. After 48 hours there is an increase in weight in 30 % tamarind extract and HCl mixture indicates the formation of oxide layer on the surface of the steel but there is a decrease in weight in the remaining tamarind extract and HCl mixture.

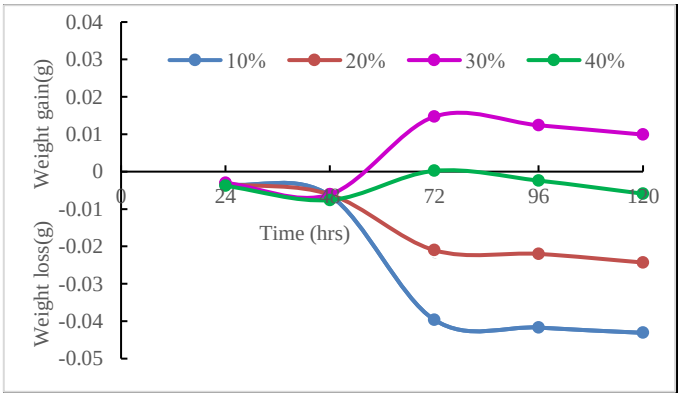

Fig 3: Graphical representation of steel plates in mixture (Tamarind extract and Hydrochloric acid)

3. CONCLUSIONS

Passivation of steel in the green tamarind extract is achieved as confirmed by the observations and results obtained in the present study. This is in accordance with the studies of inhibitory effect of tartaric acid on steel plates. Hence tamarind as the green source of tartaric acid to passivate steel and inhibit corrosion can be used to inhibit corrosion.

ACKNOWLEDGEMENT

Authors extend thanks to the management and administration for their help and cooperation to carry out this study.

REFERENCES

1. Rajendran, A., Karthikeyan, C.: The Inhibitive Effect of Extract of Flowers of Cassia Auriculata in 2 M HCl on the Corrosion of Aluminium and Mild Steel. International Journal of Plant Research., 2 (2012) 9-14.
2. Sahaya Raja, A., Angel, P., Sonisheeba, R., Thomas Paul raj, J., Sivakumar, S., Venkatesan R.: Corrosion Control by Green Solution - An Overview, International Journal of Advanced Research in Chemical Science., 1 (2014) 10-21.
3. Aminu D. Usman., Linus N. Okoro.: A Review: Weight Loss Studies on the Corrosion Behavior of Some Metals in Various Media. Chem Sci Rev Lett., 4 (2015) 17 – 24.
4. Anyanwu Samuel Ikechukwu., Eseonu Obioma., Nwosu Harold Ugochukwu.: Studies on Corrosion Characteristics of Carbon Steel Exposed to Na_2CO_3, Na_2SO_4 and NaCl Solutions of Different Concentrations. The International Journal Of Engineering And Science., 3 (2014) 48-60.
5. Bobic, B., Mitrovic, S., Babic M., Bobic, I,: Corrosion of Aluminium and Zinc-Aluminium Alloys Based Metal-Matrix Composites. Tribology in industry., 31 (2009).
6. Chinwko Emmanuel Chuka, Odio, B. O., Chukwuneke J. L., Sinebe J. E.: Investigation of The Effect of Corrosion on Mild Steel In Five Different Environments. International Journal of Scientific & Technology Research., 3 (2014).
7. Ehteram A Noor., Aisha Al-Moubaraki.: Corrosion Behavior of Mild Steel in Hydrochloric Acid Solutions. International journal of electrochemical science., 3 (2008) 806-818.
8. Geetha Mable Pinto., Jagannath Nayak., Nityananda Shetty, A.: Corrosion Behaviour of 6061 Al -15vol. Pct. SiC Composite and its Base Alloy in a Mixture of 1:1 Hydrochloric and Sulphuric Acid Medium. Int. J. Electrochem. Sci., 4, (2009) 1452 – 1468.
9. Guddi Choudhary., Arpita Sharma., Alka Sharma.: Corrosive behavior of Al, Cu and MS in different acidic media. International Journal of Innovative Research in Science, Engineering and Technology., 2 (2013).
10. Zarrok, H., Oudda, I., Zarrouk, A., Salghi, R., Hammouti, B., Bouachrine, M.: Weight Loss Measurement and Theoretical Study of New Pyridazine Compound as Corrosion Inhibitor for C38 Steel in Hydrochloric Acid Solution. Der Pharma Chemica., 3 (2011) 576-590.
11. Ikpesu., Jasper Ejovwokoghene.: Investigation of weight loss and corrosion rate of bi-metals and tri-metal in acidic environment. Journal of Research in Environmental Science and Toxicology., 3 (2014) 15-20.
12. Hemalatha, J., Sankar, A., Ananth Kumar, A., Ramesh Kumar, S.: Nelumbo nucifera flower extract as mild steel corrosion inhibitor in 1n H_2SO_4 medium. International Journal of Computer Engineering & Science, 3 (2013) 15-20.
13. Kingsley, O., Oparaodu., Gideon C. Okpokwasili.: Comparison of Percentage Weight Loss and Corrosion Rate Trends in Different Metal Coupons from two Soil Environments. International Journal of Environmental Bioremediation & Biodegradation., 2 (2014) 243-249.
14. Mamatha. G.P., Pruthviraj, R.D., Ashok, S. D.: Weight Loss Corrosion Studies of Aluminium-7075 Metal Matrix Composites Reinforced with SiC Particulates in HCl Solution. International Journal of Research in Chemistry and Environment., 1 (2011) 85-88.
15. Ajide, O.O., Agara, K.W.: Comparative Study of Corrosion Characteristics of MCS and KS7 SS In Selected Acid Media. International Journal of Metallurgical Engineering, 1 (2012) 7-11.
16. Osarolube, E., Owate, I.O., Oforka, N.C.: Corrosion behaviour of mild and high carbon steels in various acidic media, Scientific Research and Essay, 3 (2008) 224-228.
17. Selva Kumar, R., Chandrasekaran, V.: Chaetomorpha Antennia Extract as a Green Inhibitor for Corrosiono Brass in 0.1 N Phosphoric Acid Solution, Material Science Research India, 12 (2015) 68-78.
18. Radha Mishra.: Plants Extracts as Green Corrosion Inhibitors for Mild Steel in Corrosive Fluids. International Journal of Chemistry, 1 (2014) 18–21.
19. Khalid Hasan, S., Pinky Sisodia.: Paniala (flacourtia jangomas) plant extract as eco-friendly inhibitor on the corrosion of mild steel in acidic media. Rasayan J. Chem, 4 (2011) 548-553.
20. SYED, S.: Atmospheric corrosion of materials. Emirates Journal for Engineering Research, 11 (2006) 1-24.
21. Rathi, V.R., Nirmal S.D., Kokate, S.J.: Corrosion study of mild steel, tor steel and CRS steel by weight loss method. J. Chem. Pharm. Res., 2 (2010) 97-100.
22. Ya Zhang, Y., Sen Wu., Qiurong Chen., Xuehua Zhou., Zhongling Wei.: The Research on Corrosion Properties of Some Magnesium Alloys for Biomaterials. Int. J. Electrochem. Sci., 10 (2015) 1015 – 1026.
23. Walaa, A. Hussein., Amal S.I. Ahmed., Wafaa, A. Ghanem., Ghalia, A.: Gaber, Studies of Corrosion and Electrochemical Behavior of Cu-Zn Alloys in H_2SO_4 and HNO_3 Acid Solutions. Journal of Metallurgical Engineering, 5 (2016) 27-37.
24. Anima Upadhyay., Chandrakala, M.: Corrosivity of Different Media on Brass. International Journal of Modern Trends in Engineering and Research, 4 (2017) 1 – 5.
25. Devarayan Kesavan., Maya Krishnan Gopiraman., Nagarajan Sulochana.: Green Inhibitors for Corrosion of Metals: A Review. Che Sci Rev Lett, 1(2012) 1-8.
26. Memon Samina., Abdul Karim., Venkatachalam, A.: Corrosion Study of Iron and Copper Metals and Brass Alloy in Different Medium. E-Journal of Chemistry. 8 (2011) 44-48.
27. Marko Chigondo., Fidelis Chigondo.: Recent Natural Corrosion Inhibitors for Mild Steel: An Overview. Journal of Chemistry (2016) 1-7.
28. Anima Upadhyay., Chandrakala, M.: Corrosion Studies on Tinned Iron Plates from Infant Food Cans. Material Science Research India, 13 (2016) 106-109.
29. Raphae., Shadai Oguike.: Corrosion Studies on Stainless Steel (FE6956) in Hydrochloric Acid Solution. Advances in Materials Physics and Chemistry, 4 (2014) 153-163.
30. Bouklah, M., Hammouti, B., Benhadda, T., Benkadour, M.: Thiophene derivatives as effective inhibitors for the corrosion of steel in 0.5MH2SO4. Journal of Applied Electrochemistry, 35 (2005) 1095–1101.
31. Fouda, A.S., Al-Sarawy, A.A., El-Katori, E.E.: Pyrazolone derivatives as corrosion inhibitors for C-steel HCl solution. Desalination, 201 (2006) 1–13.
32. Fiala, A., Chibani, A., Darchen, A., Boulkamh, A., Djebbar, K.: Investigations of the inhibition of copper corrosion in nitric acid solutions by ketene dithioacetal derivatives. Applied Surface Science, 253 (2007) 9347–9356.
33. Evans, U.R.: The Corrosion and Oxidation of Metals, Hodder Arnold, London, 1976.
34. Marina Cabrini., Sergio Lorenzi., Denny Coffetti., Luigi Coppola., Tommaso Pastore.: Inhibition effect of Tartrate ions on the Localized Corrosion of Steel in Pore Solution at Different Chloride Concentrations. Buildings, 10 (2020) 1-14.
35. Quiang, Y., Guo L., Zhang, S., Li, W., Yu, S., Tan J.: Synergistic effect of tartaric acid with 2,6-diaminopyridine on the corrosion inhibition of mild steel in 0.5 M HCl. Scientific reports, (2016) 1-14.
36. Robert, E. Coleman., Roger, B. Boulton., Alexei, A. Stutcherbrukhov.: Chain reaction of Fenton autooxidation of tartaric acid: critical behaviour at low pH. The journal of Physical Chemistry B, 127 (2023) 4300–4308.
37. Abukakar, M.G., Ukwuani, A.N., Shehu, R.A.,: Phytochemical Screening and Antibacterial Activity of Tamarindus Indica Pulp Extract. Asian Journal of Biochemistry, 3 (2008) 134-138.
38. Santosh Singh Bhadoriya., Aditya Ganeshpurkar., Jitendra Narwaria., Gopal Rai., Alok Pal Jain.: Tamarindus indica: Extent of explored potential. Pharmacogn Rev, 5 (2011) 73–81.