



Electrochemical Behaviour of Jatropha Curcas Plant Extract on Brass in Hydrochloric Acid Medium

KEYWORDS

Electrochemical, inhibition, Brass, efficacy

Deepa Rani. P

Assistant professor of chemistry, Aditanar college of arts and science, Thiruchendur- 628216, Tamil Nadu, India

Selvaraj. S

Associate professor of chemistry, Sri Paramakalyani College, Alwarkurichi-627412, Tamil Nadu, India

ABSTRACT

The inhibition efficacy of *Jatropha curcas* leaves (JCL) extract on the corrosion of Brass (60/40) in 1N Hydrochloric acid environment is studied by potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) measurements. The inhibition efficiency is increased with increase of inhibitor concentration and achieved maximum of more than 80% for polarization as well as impedance measurements. Electrochemical measurements show that both polarization and charge transfer resistances increases with increase of inhibitor concentration. In bode phase plot, the increasing concentration of JCL inhibitor in hydrochloric acid solution results in more values of phase angle at high frequencies also suggested that, there was greater surface coverage and charge transfer resistance.

1. Introduction

Copper and its alloy are widely used in industry because of their good resistance to corrosion in cooling water systems, for shipboard condensers, power plant condensers and petrochemical heat exchangers etc. Copper and its alloy are very interesting because of its great industrial importance; most of the scientists are attempted for their research work. The heavy loss of metals is a result of its contact with the pollution environment can be minimized to a great extent by the use of corrosion inhibitors [1]. Inorganic compounds like chromates, phosphates, molybdates etc. and a variety of organic compounds containing heteroatom like nitrogen, sulphur and oxygen are being investigated as corrosion inhibitor [2]. Pure synthetic chemicals are costly, but some of them are easily bio-degradable and their disposal creates pollution problems. Plant extracts are environmentally friendly, bio-degradable, non-toxic, easily available and of potentially low cost. Some investigator [3-4] studied the plant extracts and the derived organic species become more important as an environmentally benign, readily available, renewable and acceptable source for a wide range of inhibitors. Several efforts have been made using corrosion preventive practices and the use of green corrosion inhibitors. The plant extract are rich sources of molecules which have appreciably high inhibition efficiency and hence termed as "Green Inhibitors". These inhibitors are biodegradable and do not contain heavy metals or other toxic compounds. The successful uses of naturally occurring substances to inhibit the corrosion of metals in acid and alkaline environment have been presented by some research groups running through references [5 to 7]. Already we have studied the non electrochemical behavior of *jatropha curcas* leaves extract on Brass (60/40) in hydrochloric acid and sea water environment [8]. In our present study the continuous of the above inhibitor, i.e, the influence of *Jatropha curcas* leaves extract in 1N Hydrochloric acid environment on Brass (60/40) is investigated by electrochemical methods.

2. Materials and method

2.1. Chemical properties of *Jatropha curcas* leaves extract

Jatropha curcas belongs to Euphorbiaceae family and it's all part contain HCN [9] and other toxic chemicals. The main phytochemical constituents that have been isolated from *Jatropha curcas* leaves include the flavonoids apigenin, vitexin and isovitexin, sterols stigmasterol, alpha-D-sitosterol and its alpha -D-glucoside. *Jatropha curcas* is a valuable multi-purpose crop when crushed; the resulting oil from the seeds can

be processed to produce a high-quality biodiesel that can be used in a standard diesel engine. It gives better results than gazoil because of its high oxygen content.

2.2. Specimen preparation

2.2.1. Potentiodynamic polarisation studies

The electrode of 1 cm² area with stem were cut from the respective metals sheets and one side of the electrode and stem was masked with araldite. The electrodes were polished with emery papers and degreased with trichloroethylene. Accurately 100 ml of the test solution was taken in three-electrode cell. The electrode was introduced into the test solutions in the polarisation cell and it was allowed to attain a steady potential value for about 20mts. Then the electrode potential was fixed at 200 mV to the open circuit potential (OCP). Polarisation measurements were carried out potentiodynamically at a sweep rate of 1mV/sec using electrochemical analyser Princeton applied research Model: PARSTAT 2273 (Advanced electrochemical system) The potential of the working electrode was measured with respect to a saturated calomel electrode (SCE) and the platinum electrode was used as an auxiliary electrode. The corrosion current as well as b_a and b_c values were obtained from the polarisation curves by extrapolation of anodic and cathodic curves back to the corrosion potential. The E_{corr} value taken as mV and I_{corr} values A/cm² converted in to $\mu A/cm^2$ was taken and all the experiments were carried out at room temperature. The experiments were performed with and without the addition of inhibitors.

2.2.2. Electrochemical impedance spectroscopy measurement

The well-polished electrode was introduced into 100 ml of test solution and allowed to attain a steady state potential value. A.C. signal of amplitude 10 mV was impressed to the system with frequencies ranging from 100 mHz to 10 kHz using electrochemical analyser Princeton applied research Model: PARSTAT 2273 (Advanced electrochemical system).

3. RESULTS AND DISCUSSION

3.1. Polarisation studies

The anodic and cathodic polarisation curves of brass (Cu-40Zn) in the presence and absence of JCL extract in 1.0N Hydrochloric acid environment is shown in Fig.1. The corrosion potential was shifted to noble or passive direction i.e., from -299 to -277mV, indicating an adherent film on the surface of brass in acid media (Table- 1). The value of I_{corr} decreased

from 6.87 to 1.23 $\mu\text{A}/\text{cm}^2$ and the inhibitive efficacy was found to be in the range of 62.59 to 82.09% with increase of inhibitor concentration from 10 to 1000ppm. This result agreed with the mass loss methods. The corrosion potential shifted to nobler or passive direction indications that the inhibitor was mixed type and the inhibitor were effective in controlling the dissolution rate of copper and zinc. Hoar [10] showed that inhibitor molecules adsorbed to varied extents on different types of surface sites and influenced the anodic and cathodic reactions unequally. He further indicated that the adsorption of inhibitor molecules reduced the number of reactions sites and thus inhibition become more predominant when the surface was covered with nearly a monolayer of the inhibitor. In JCL extract, the O and CN was act as reaction centres through which it formed the complex with the metal ions. This active group formed the complex mainly with copper ions and this complex film was unable to prevent the zinc dissolution from the surface of the alloy.

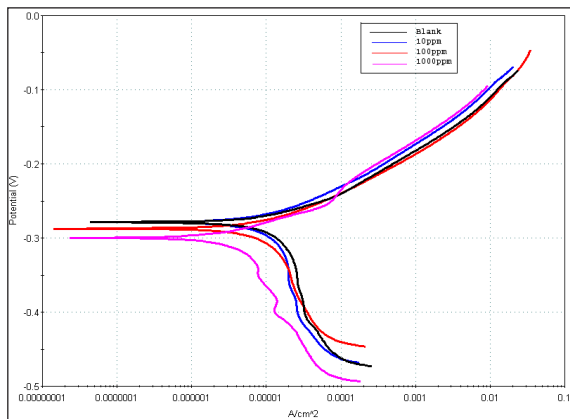


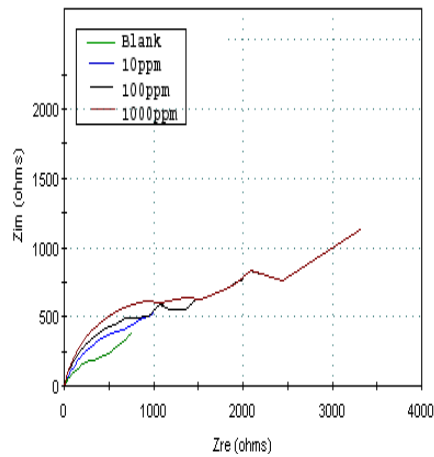
Figure.1 Polarisation curves for brass (Cu-40Zn) in 1.0N Hydrochloric acid containing various concentration of JCL inhibitor.

3.2. Electrochemical Impedance (EIS) studies

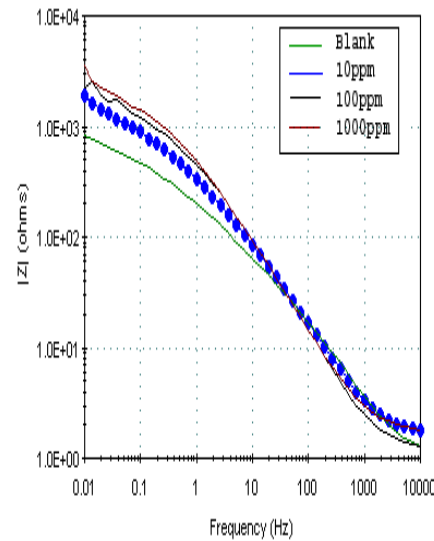
Electrochemical impedance parameters such as charge transfer resistance (R_{ct}), anodic and cathodic Tafel slopes (b_a and b_c) and percentage inhibition efficiency (IE) for the corrosion of brass in Hydrochloric acid at room temperature in the absence and presence of different concentrations of extract are given in Table-1 and its corresponding curves are shown in Figure.2(a). Also, these impedance diagrams were not perfect semicircles which related to the frequency dispersion as a result of the roughness and inhomogeneous of electrode surface. The R_{ct} values increased from 120 to 987 Ω with increase of inhibitor concentration from 0 to 1000ppm. The double layer capacitance values decreased with increase of inhibitor concentration. The Nyquist plot for brass indicated that the charge transfer resistance followed by diffusion control.

Table- 1 Parameters derived from electrochemical measurements of brass (cu-40Zn) in 1N Hydrochloric acid containing various concentration of JCL inhibitor.

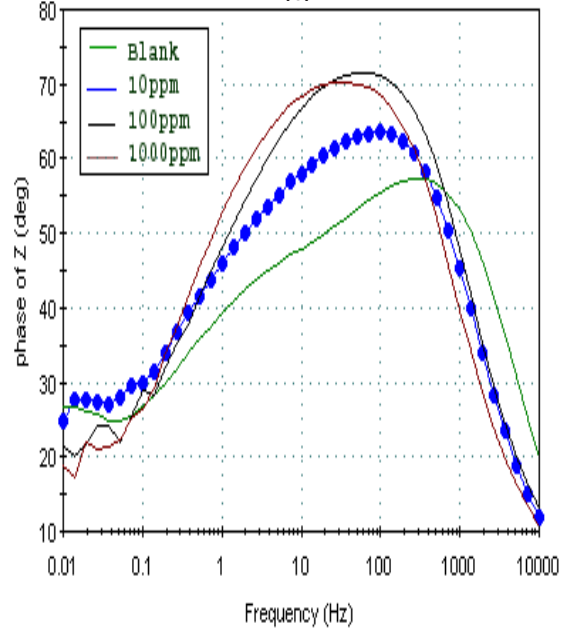
| Conc. (ppm) | Polarisation studies | | | | | Impedance studies | | |
|-------------|------------------------|-------------------|--------------------|--|---------|-----------------------|--|---------|
| | E_{corr} (mV vs SCE) | b_a (mV/decade) | $-b_c$ (mV/decade) | I_{corr} ($\mu\text{A}/\text{cm}^2$) | I.E (%) | R_{ct} (Ω) | C_{dl} ($\mu\text{F}/\text{cm}^2$) | I.E (%) |
| Blank | -299 | 62.19 | 236.34 | 6.87 | --- | 120 | 3.2 | --- |
| 10 | -279 | 65.37 | 703.99 | 2.57 | 62.59 | 385 | 1.5 | 68.83 |
| 100 | -287 | 69.97 | 703.80 | 2.02 | 70.59 | 573 | 2.7 | 79.06 |
| 1000 | -277 | 66.36 | 684.70 | 1.23 | 82.09 | 987 | 2.0 | 89.66 |



(a)



(b)



(c)

Figure. 2 (a-c). Electrochemical impedance plots, Nyquist (a) Bode impedance plot (b), phase angle plot (c), for brass (Cu-40Zn) in 1.0N Hydrochloric acid containing vari-

ous concentration of JCL inhibitor.

Bode impedance plots as shown in Figure.2 (b), reflect that the impedance value in the presence of inhibitor was larger than the blank solution. These mean that the corrosion rate reduced in the presence of inhibitor. Bode phase plot in Figure. 2(c) (f vs. Theta), it was only one time constant, which indicated that increasing concentration of JCL inhibitor in hydrochloric acid solution results in more values of phase angle at high frequencies, indicating that there was greater surface coverage and charge transfer resistance.

4. Conclusion

From our present study the following conclusions can be drawn.

The *Jatropha curcas* leaves (JCL) is used as good inhibitor for brass in 1N Hydrochloric acid environment. In Potentiodynamic polarisation studies the corrosion potential was shifted to noble or passive direction, indicating an adherent film formed on the surface of brass in acid media and achieved more than 80% inhibition efficiency. The corrosion potential shifted to nobler or passive direction indications that the inhibitor was mixed type and the inhibitor were effective in controlling the dissolution rate of copper and zinc. The electrochemical impedance studies revealed that the value of R_{ct} increased from 120 to 987 Ω and maximum of 89.66% of inhibition efficiency was received in the presence of inhibitor. Bode phase plot may suggest that the increasing concentration of JCL inhibitor in hydrochloric acid solution results in more values of phase angle at high frequencies, indicating that there was greater surface coverage and charge transfer resistance

Acknowledgement

I express my gratitude to Dr, P.T.Perumal, Deputy Director, the Central Leather Research Institute, (CLRI), Adyar, Chennai and Dr, K. Pandian, Associate professor, Madras University, Chennai for giving the opportunity to take the spectral studies. Also I would express our heartfelt thanks to the management of Sri Paramakalyani College, Alwarkurichi, for providing the lab facilities.

REFERENCE

1. R. Saratha, V.G. Vasudua, E. journal of chemistry. 7 (2010) 673-677.. | 2. K. F. Khaled, M.M. Al- Qahtani, Materials chemistry and physics. 11 (2009) 150-155. | 3. L.A. Nnanna, B.N. Onwuagba, I.M. Mejeha, K.B. Okeoma, African journal of pure and Applied chemistry. 4 (2010) 011-017. | 4. S. Rajendran, J. Jeyasundari, P. Usha, J.A. Selvi, B. Narayanasamy, A.P. P. Regis, P. | Rengan, Portugaliae electrochimica acta. 27 (2009) 153-161. | 5. Muhamath, Basha Mubarak Ali, Kulanthai and Kannan. J.Appl.Sci.Enviro.Manage. 13 | (2009) 27- 32. | 6. A. O. James, O. Akaranta, J.Pure.Appl.Chem. 3 (2009) 262-268. | 7. A. Ehteram Noor, Journal of Engineering and Applied Sciences. 3 (2008) 25- 35. | 8. P. Deepa Rani, S. Selvaraj, Pacific journal of science and technology. 12 (2011) 38- 49. | 9. S.M. Khafagy, Y.A. Mohamed, N.A. Abdel, Z.F. Mahmoud, Plant. Med. 31 (1977) 274. | 10. T.P. Hoar and R.D. Holliday, J. Appl. Chem., 3 (1953) 502. |