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ORIGINAL ARTICLE

Adsorption and corrosion inhibiting behavior of *Lannea coromandelica* leaf extract on mild steel corrosion

P. Muthukrishnan [a], B. Jeyaprabha [b], P. Prakash [a,*]

[a] *Department of Chemistry, Thiagarajar College, Madurai 625009, India*
[b] *Department of Civil Engineering, Fatima Michael College of Engineering & Technology, Madurai 625020, India*

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KEYWORDS

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Abstract *Lannea coromandelica* leaf extract (LCLE) as a corrosion inhibitor in 1 M H_2SO_4 was investigated by weight loss and electrochemical techniques. Inhibition efficiency of LCLE was found to increase with increasing concentration but decreased with increasing temperature. Polarization measurements revealed that the LCLE acted as a mixed type inhibitor. Nyquist plots showed that on increasing the LCLE concentration, the charge transfer resistance increased and the double layer capacitance decreased. The adsorption of LCLE on mild steel obeyed the Langmuir adsorption isotherm. FT-IR, XRD, SEM and AFM techniques confirmed the adsorption of LCLE on mild steel surface.

1. Introduction

Acid solutions are widely used in industry for several processes such as acid pickling, industrial acid cleaning, acid descaling and oil well acidizing (Zhang and Hua, 2009). During the past decade, many techniques have been used to minimize the corrosion of iron due to attack by acids. One of the techniques for minimizing corrosion is the use of inhibitors (Ravi chandran and Rajendran, 2005; Atul Kumar, 2008). Most of the corrosion inhibitors are organic compounds having hetero atoms in their aromatic ring (N, S, O, P) or long chain carbon (Ebenso et al., 2008b; Eddy and Ebenso, 2008; Popova et al., 2004). Most of the synthetic chemicals are toxic to the environment. Due to the toxicity of some corrosion inhibitors, there has been increasing search for green corrosion inhibitors (Shahid, 2011). Most of the natural inhibitors are environmentally friendly, non-toxic, biodegradable, inexpensive and readily available in plenty (Lebrini et al., 2011; Okafor et al., 2008; El-Etre, 2007; Lecante et al., 2011; Satapathy et al., 2009). Corrosion inhibition of leaf extracts of *Occimum viridis*, *Telferia occidentalis*, *Azadirachta indica* and *Hibiscus sabdariffa* on mild steel in acidic solutions was investigated by Oguzie (2008). Other than the plant extracts, pure organic compounds extracted from natural products such as ascorbic acid (Goncalves and Mello, 2001), succinic acid (Amin et al., 2007), tryptamine (Moretti et al., 2004), caffeine (Fallavena et al., 2006), Pennyroyal oil (Bouyanzer et al., 2006), amino acids (Zhang et al., 2008) and caffeic acid (De Souza and Spinelli, 2009) have also been used for the inhibition of corrosion. An investigation has

* Corresponding author. Tel.: +91 9842993931; fax: +91 4522312375.
E-mail address: kmpprakash@gmail.com (P. Prakash).

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been made in this present work on the corrosion of mild steel in 1 M H_2SO_4 using the extract of *Lannea coromandelica* as corrosion inhibitor by the weight loss method and the electrochemical method, FT-IR, XRD, SEM and AFM. Additionally, thermodynamic and kinetic parameters were calculated and discussed. *L. coromandelica* is an easily available plant in India. It belongs to the anacardiaceae family which is commonly known as the Indian Ash Tree. The extract of this plant contains numerous naturally environmental organic compounds. The genus of *L. coromandelica* is known to contain significant amounts of polyphenols including Flavonoids, Tannins, Terpinoids, Gums and polysaccharides (Avinash Kumar Reddy et al., 2011; Vadivel et al, 2012). The leaf of the plant is biodegradable and a renewable material. It has never been reported so far on the use of leaf extract of LC on the corrosion of mild steel in 1 M H_2SO_4.

2. Experimental

2.1. Preparation of the specimens

Composition of mild steel specimen was C: 0.13, Si: 0.18, P: 0.39, S: 0.04, Cu: 0.025 and balance Fe. The specimens were mechanically cut into sizes with 2.5 cm × 2.5 cm × 0.4 cm dimensions and abraded with different emery papers up to 4/0 grades. Each specimen was degreased by washing with acetone, dried at room temperature and preserved in a moisture-free desiccator. All chemicals and reagents were of analar grade. The concentration of test solution (1 M H_2SO_4) was prepared by using triple-distilled water and AR grade sulfuric acid.

2.2. Extraction of LCL extract

LC leaves were collected in and around Madurai, India. The leaves were dried, ground and soaked in bidistilled water for 24 h. After 24 h, the crude extracts were boiled, cooled and triple filtered. The amount of plant material extracted into solution was quantified by comparing the weight of dried residue with the initial weight of the dried plant material before extraction. From the respective stock solutions, inhibitor test solution was prepared in the concentration range from 50 to 250 mg/l.

2.3. Gravimetric experiments

Gravimetric experiment was conducted at different temperatures in the range 308–328 K for 12 h in 1 M H_2SO_4. The specimens were immersed in 100 ml of the respective inhibitor and test solutions in a thermostated bath. The specimens were weighed before and after immersion. The difference in weight was taken as the weight loss of mild steel. From the weight loss (ΔW), corrosion rate (λ) and the percentage of inhibition efficiency (IE%) were calculated using the following equation:

$$\lambda\,(\text{mpy}) = 534 \times \Delta W/DAT \tag{1}$$

$$\text{IE}\% = (W_0 - W_1)/W_0 \times 100 \tag{2}$$

Here $\Delta W = (W_b - W_a)$, where W_b and W_a are the specimen weights before and after immersion in the tested solution, W_0 and W_1 are the weight loss of mild steel in the absence and presence of inhibitor respectively, D is the density of the iron (g/cm^3), A is the area of the specimen in inch^2 and T is the period of immersion in hours.

2.4. Electrochemical measurements

Tafel polarization curves and Nyquist impedance curves were recorded using H and CH electrochemical workstation impedance Analyzer Model CHI 604D. A cell containing three compartments for electrode was used. The working polished mild steel electrode with exposed area of 0.5 cm^2 was immersed in

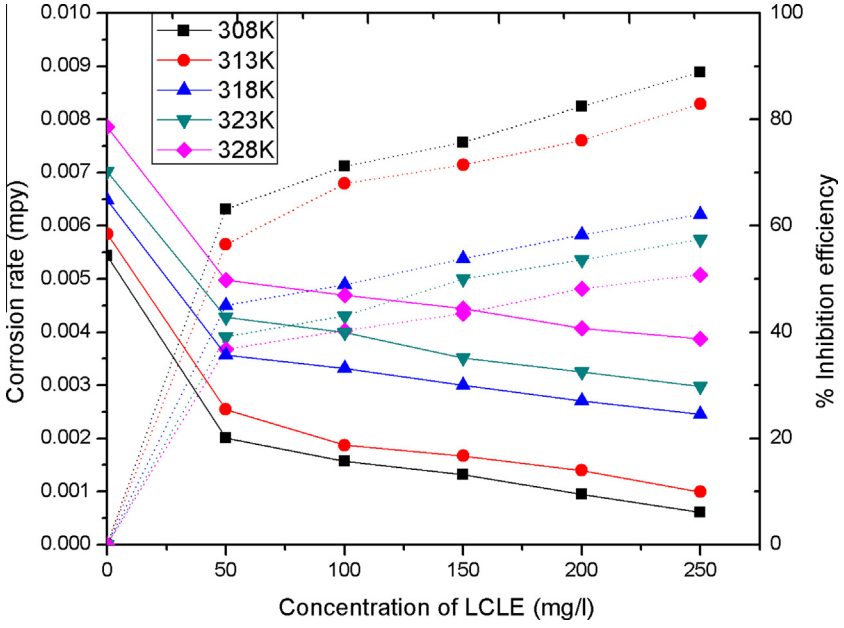

Figure 1 Corrosion rate and Inhibition efficiency of mild steel specimens immersed in 1 M H_2SO_4 with and without LCLE at 308, 313, 318, 323 and 328 K (-) corrosion rate (---) inhibition efficiency.