Emblica Officinalis Leaves Extract as Corrosion Inhibitor

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Absract: The inhibition potentials of *Emblica officinalis* leaves extract (EOLE) was investigated by evaluating the corrosion behavior of mild steel immersed in 1 N HCl solution containing varied concentration of the extract ranging from 200 ppm to 1000 ppm. The corrosion inhibition of the extract was evaluated using weight loss studies. The inhibition efficiency increased with increase in concentration of the inhibitor and the highest %IE was obtained at 1000 ppm. UV and SEM, provided the confirmatory evidence of improved surface condition, due to adsorption, for the corrosion protection.

Keywords: Adsorption, Corrosion, *Emblica officinalis,* Inhibition

Introduction

Numerous studies have been carried out on the corrosion of metals in different environment and their inhibition and most of the known inhibitors suitable for the corrosion inhibition of mild steel are heterocyclic compounds[1-2]. For these compounds their adsorption on the metal; surface is the initial step of inhibition[3-5]. The two main modes of adsorption that occur as a result of interaction between organic inhibitors and the metal surfaces are physical and chemical adsorption. The adsorption of inhibitor can be enhanced by the presence of hetero atoms such as N, O, P and S[6-8]. It has been reported that the extent of adsorption of an inhibitor is greatly influenced by the nature and surface coverage of the metal, mode of adsorption and the concentration of the inhibitor[9-10].

Many industrial processes have put to use inorganic inhibitors for corrosion protection but as a result of cost and toxicity, attention is currently shifted towards the use of more eco-friendly inhibitors[11]. Natural products have been studied extensively as corrosion inhibitors both in product mixtures extracted from natural sources such as plants or essentially pure products derived from animals or plants (*i.e*. vitamins and amino acids). In the last years, Umoren *et al*. evaluated plant extracts as corrosion inhibitors, for example, *Phyllanthus amarus*[12], *Pachylobus edulis*[13-14]*, Raphia hookeri*[15-16] and *Ipomoea involcrata*[17] and also

described the inhibitive action of ethanolic extracts from leaves of *Chlomolaena Odorata* L. (LECO) as eco-friendly corrosion inhibitor of acid corrosion of aluminum in 2 M HCl, using hydrogen evolution and thermometric techniques[18]. Plant extracts have become important as environmentally acceptable, readily available and renewable source for wide range of inhibitors[19].

The present study was undertaken with the following objectives:

1. To determine the inhibition efficiency of *Emblica officinalis* leaves extract.
2. To investigate the formation of protective film on metal surface

Experimental

Green leaves of plant *Emblica officinalis* were washed and oven dried. 50 g of dried powder of leaves was boiled in 1000 mL 1 N HCl with reflux condenser and kept overnight. Next day it was filtered and the filtrate volume was made upto 1000 mL using 1 N HCl acid[20].

Specimen preparation

Mild steel A (C=0.040%, Mn= 0.170%, S=0.170%, P=0.006%, Si=0.010%, Cr=0.001%, Ni=0.001%, N=0.005%, Al= 0.044%, Cu=0.006 and rest Fe) and B (C=0.162%, Mn=0.900%, S=0.008%, P=0.009%, Si=0.008%, Al=0.030% and rest Fe) from ESSAR Steel Ltd., Hazira-394270, Dist, Surat, Gujarat, India having two different composition was utilized as test material for this work.

Coupons of rectangular specimens of the dimensions (1x5) cm^2 were used. The samples were degreased with the vapours of trichloroethylene followed by mechanical polishing with different polishing papers (Coarse, Medium, Fine & Extra fine). The samples were rinsed with ethanol, followed by distilled water and dried with a clean tissue paper[21].

Determination of inhibition efficiency by weight loss method

The rectangular specimens with dimension of (1x5) cm^2 were weighed using digital weighing balance with 0.001 mg accuracy and recorded as W_i. Then 25 mL of corrosive medium was introduced into reaction beakers. The pre-weighed coupons were fully immersed into each of the test media using twine tied to a small stick for support for 3 h. The experimental set up was kept in a cool place at 295±1 K in the laboratory away from direct sunlight. Each coupon was retrieved from the test medium, washed under running water and then air dried. The coupons were reweighed and the final weights, W_f was recorded. Weight loss of mild steel coupons immersed in 25 mL of the electrolyte with and without the extract of plant was determined[22].

The percentage inhibition efficiency (IE%) was then calculated from the following equation:

$$I E\% = \frac{W_0 - W_{inh}}{W_0} \times 100 \tag{1}$$

Where W_o and W_{inh} are weight losses of mild steel in absence and presence of the extract[23].

Investigating the formation of protective film on the surface of mild steel

Scanning electron microscopic (SEM) studies

The change in surface morphology of modified mild steel was assessed using scanning Electron Microscopic technique[21] and SEM photo images for magnification x1000 were recorded[24], using Electron probe micro analyzer.

UV-Visible spectrophotometric studies

The adsorption behavior of the organic molecules present in the plant extract was analysed using UV-Visible spectrum. The mild steel specimen A and B were immersed in a beaker having extract for 4 hours. After immersion they were dip washed 3-4 times in distilled water. Again specimens were dipped in 1 N HCl for half an hour. This HCl acid solution was examined for UV-Visible spectrum using UV-Vis single beam Spectrophotometer[25].

Results and Discussion

Determination of inhibition efficiency by weight loss measurements

Table 1 presents the weight loss for the mild steel samples (A) and (B) immersed in 1 N HCl in absence and presence of varied concentrations of the *Emblica officinalis* leaves extract.

Table 1. Weight loss of mild steel (A) and (B) in 1 N HCl in absence and presence of various concentrations of EOL extract 295±1 K for 3 h

Inhibitor	Mild steel	Concentration of inhibitor, ppm	Initial weight of the coupon, g	Final weight of the coupon, g	Difference in weight, g	% IE
EOLE	A	0 (Blank)	14.4098	14.3833	0.0265	
		200	14.4417	14.4319	0.0098	63.0
		400	14.4363	14.4276	0.0087	67.1
		600	14.3106	14.3028	0.0078	70.5
		800	14.2113	14.2657	0.0056	78.8
		1000	14.2729	14.2680	0.0049	81.5
	B	0 (Blank)	23.5527	23.5271	0.0256	
		200	23.4472	23.4390	0.0082	67.9
		400	23.5702	23.5632	0.0070	72.6
		600	23.5171	23.5125	0.0046	82.0
		800	23.6845	23.6810	0.0035	86.3
		1000	23.4382	23.4353	0.0029	88.6

It is observed that there is a significant reduction in the weight loss of the steel samples with the addition of the *Emblica officinalis* leaves extract in comparison with the sample in which no EOL extract was added and the highest inhibition efficiency was found at 1000 ppm inhibitor[11].

Scanning electron microscopy

SEM micrograms of polished surface of mild steel A and B exposed for 4 h in 1 N HCl solutions in absence and presence of 1000 ppm of EOLE are shown in Figure 1(a) & (b). In comparison of SEM micrograms in absence and presence of the extract, there was a rough surface on mild steel in absence of the extract. There was a smooth surface with deposited extract on it in presence of the extract. In Figure 1(b), there were some scratches imprint which may be attributed to mechanical polishing by SiC course polishing paper[26].

UV-Visible spectrophotometric studies

Corrosion inhibition of mild steel in hydrochloric acid solution by EOLE can be explained on the basis of molecular adsorption. When inhibitor was introduced, acid soluble organic components dissolved in the solution interacted with the negatively charged mild steel surface.

It caused adsorption of inhibitor molecules at metal/solution interface as supported by UV-Visible spectroscopy *(*Figure 2 & 3). On the basis of this fact, it can be concluded that the organic compounds present in the EOLE were adsorbed on the mild steel surface[25].
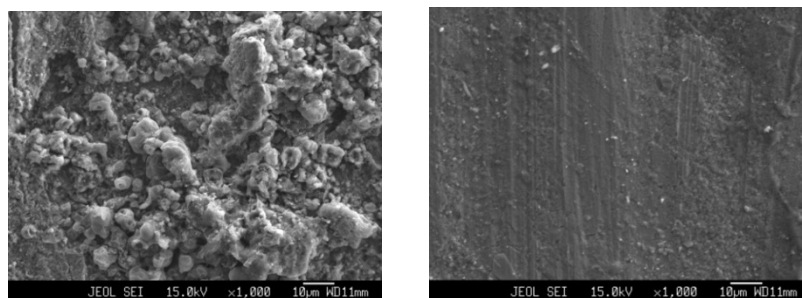

Figure 1(a). Scanning electron microgram of polished mild steel A (x1000) after exposed to (a) 1 N HCl (b) 1 N HCl containing 1000 ppm of EOL extract
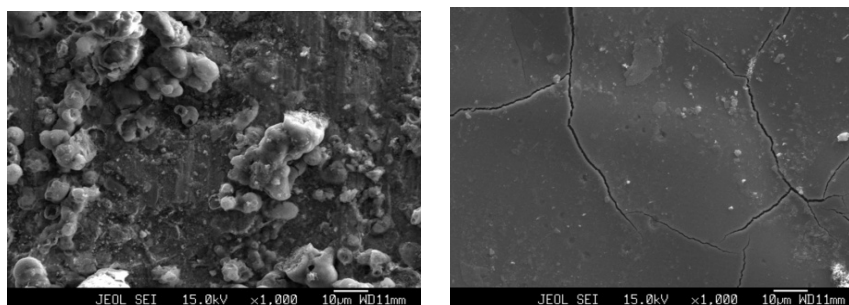

Figure 1(b). Scanning electron microgram (SEM) of polished mild steel B (x1000) after exposed to (a) 1 N HCl (b) 1 N HCl containing 1000 ppm of EOL extract
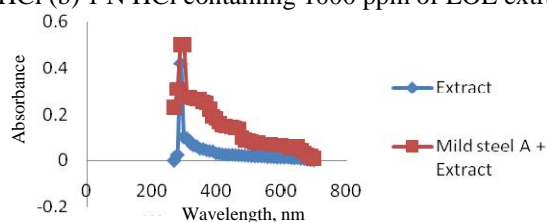

Figure 2 . UV-Visible spectra of the *Emblica officinalis* leaves extract and the washings of the mild steel A specimen incubated in extract
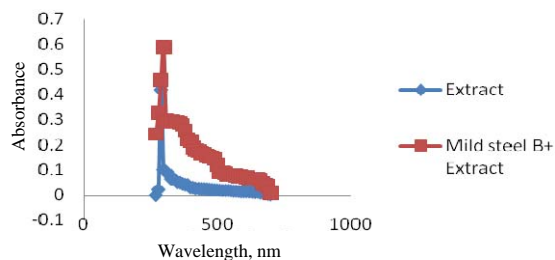

Figure 3. UV-Visible spectra of the *Emblica officinalis* leaves extract and the washings of the mild steel B specimen incubated in extract

Conclusion

The *Emblica officinalis* leaves extract has good inhibition efficiency for preventing the corrosion of mild steel in 1 N hydrochloric acidic medium. EOL extract formed a protective layer on the surface of the mild steel and improved surface condition, due to adsorption, for the corrosion protection.

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