Inhibition of Corrosion of Carbon Steel in Double Layer Distilled Water by Natural Peepal Tree Leaf Dye Zn^{2+}

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Abstract: The corrosion inhibition behavior of carbon steel in well water has been investigated using natural peepal leaf dye (PD) in the presence of Zn^{2+} ions. Surface analysis was carried out using scanning electron microscopy (SEM). FTIR spectra confirmed the formation of a protective film consisting of a complex between the active component of peepal leaf extract and Zn^{2+} ions. UV–Visible spectra indicated the formation of a protective layer of Fe^{2+}–Ficus religiosa complex on the metal surface.

Keywords: Corrosion Inhibition, Carbon Steel, Weight Loss Method, SEM, FTIR

1. Introduction

Corrosion is a natural process that converts refined metals into more chemically stable oxides. It is a gradual deterioration of materials by chemical or electrochemical reaction with their environment. Corrosion engineering is the field dedicated to controlling and preventing corrosion. Iron rusting, for example, involves formation of iron oxides via moisture and oxygen action.

2. Experimental

2.1 Preparation of Specimens

Carbon steel specimens were polished, degreased with trichloroethylene, and prepared for mass-loss and surface examination.

2.2 Preparation of Inhibitor Solution10 g of peepal tree leaves were boiled in double distilled water. The dark brown solution was filtered and made up to 100 mL. PD was used as corrosion inhibitor.

2.3 Weight-Loss Method

Specimen dimensions were measured using vernier calipers. Specimens were weighed before and after immersion in test solutions. Corrosion rate and inhibition efficiency were calculated using standard formulas.

2.4 Surface Examination

Surface films on specimens were analyzed using FTIR and SEM techniques.

2.5 Synergism Parameters

Synergism between PD and Zn^{2+} was calculated using surface coverage values.

2.6 AC Impedance Measurements

Charge transfer resistance and double-layer capacitance were determined using AC impedance analyzer.

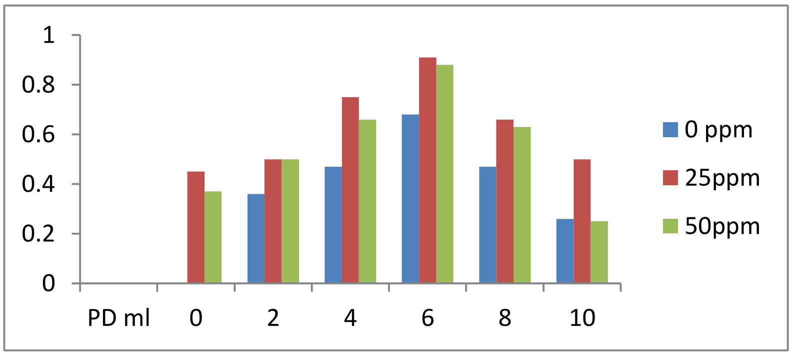
3. Results and Discussion

3.1 Mass-Loss Results

Inhibition efficiency increased in the presence of Zn^{2+}. For 10 mL PD and 2.5 ppm Zn^{2+}, 91% inhibition efficiency was observed.

Table 1: Inhibition Efficiency of Peepal Dye in Double Layer Distilled Water

PD ml	IE%		
	0 ppm	**25 ppm**	**50 ppm**
0	0	45%	37%
2	36%	50%	50%
4	47%	75%	66%
6	68%	91%	88%
8	47%	66%	63%
10	26%	50%	25%



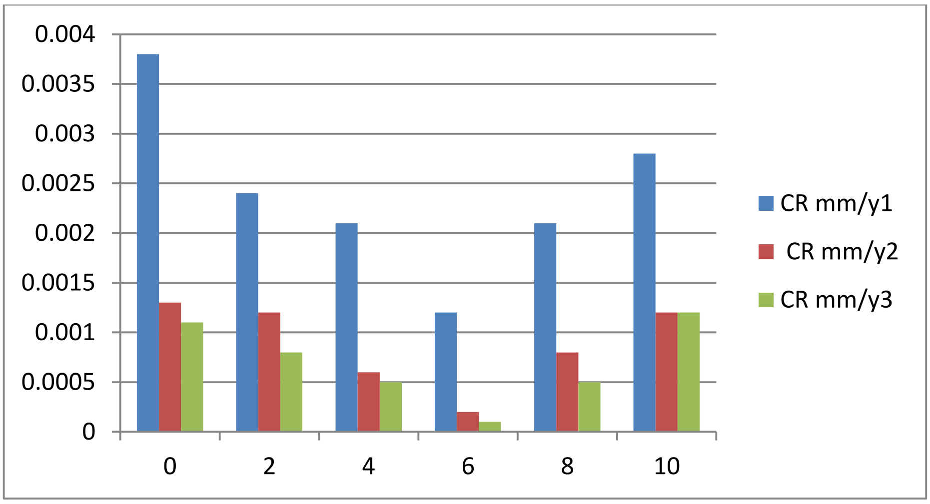
3.2 Influence of Immersion Period

Protective film stability decreased with prolonged immersion, due to chloride attack.

Table 2: Corrosion Rates vs Immersion Period

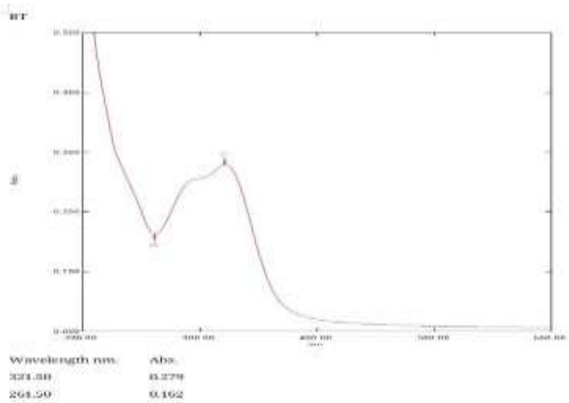
Inhibitor system: peepal dye(PD)=Zn^{2+} period of immersion:1day

CR mm/y	CR mm/y	CR mm/y
0.0038	0.0013	0.0011
0.0024	0.0012	0.0008
0.0021	0.0006	0.0005
0.0012	0.0002	0.0001
0.0021	0.0008	0.0005
0.0028	0.0012	0.0012



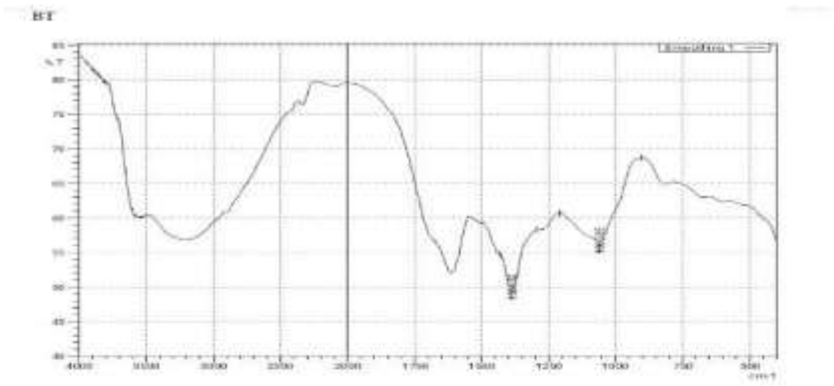
3.3 UV–Visible Analysis

UV–Visible spectra confirmed protective layer formation on metal surface.



3.4 FTIR Analysis

FTIR spectra showed complex formation between Fe^{2+} and Ficus religiosa extract, confirming protection.



3.5 SEM Analysis

SEM micrographs confirmed formation of uniform protective film in presence of inhibitor.

SEM micrographs of

a) Carbonsteel:MagnificationsX100,(control)

b) Carbon steel immersed in double layer distilled water: Magnifications x100

c) Carbonsteelimmersedindoublelayerdistilledwatercontainig6mlofPD-25ppmofZn2+ Magnification X100

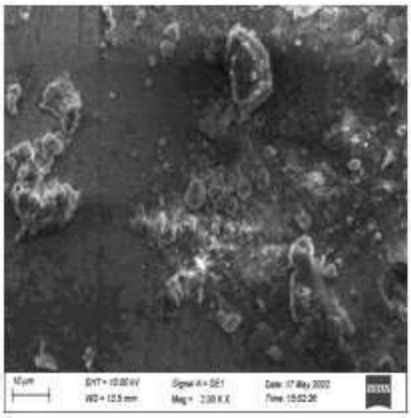


Fig 4.10(a) polished carbon steel

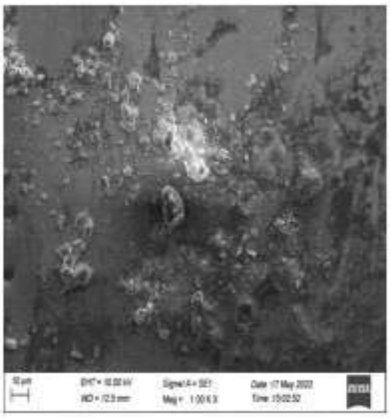


Fig 4.10(b) carbon steel in immersed aqueous medium

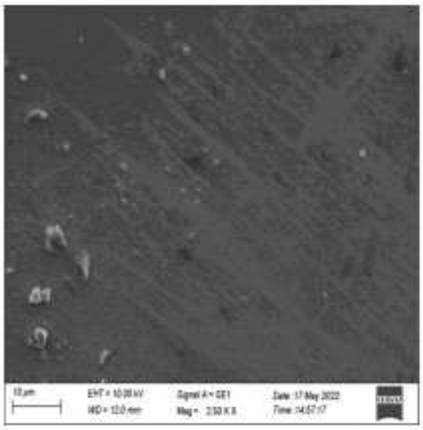


Fig 4.10(C)

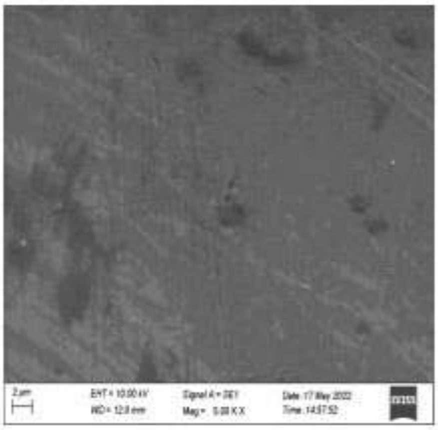
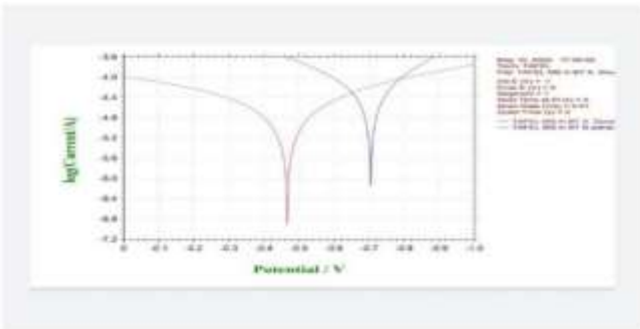


Fig 4.10(d)

3.6 AC Impedance Analysis

AC impedance spectra indicated enhanced charge transfer resistance with inhibitor, showing film formation.



Equation 1:

Corrosion Rate = Loss in weight / Surface area of the specimen (dm^2)

4. Conclusion

Peepal leaf dye Zn^{2+} system effectively inhibits corrosion of carbon steel in aqueous solution.

Protective film confirmed by UV–Visible, FTIR, SEM, and AC impedance analyses.

Synergistic effect exists between PD and Zn^{2+}.

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