Electro Chemical Behaviour of Alangium Salvifolium Leaves For Mild Steel in 1.0N HCl

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***Abstract*: The inhibitive effect of *Alangium Salvifolium* Leaves extract on mild steel corrosion in 1.0N HCl solution was studied using electro chemical techniques. Observed result indicates that the corrosion inhibition efficiency was increased with increase of inhibitor concentration. The corrosion current (I_{corr}) decreased with increase of inhibitor concentration (from 58.56 to 12.90 mA cm^2) studied by potentio dynamic polarisation. By using impedance spectroscopy the charge transfer Resistance (R_{ct}) value increased from 7.989 to 44.432 Ωcm^2. This results very good agreement with the non electrochemical methods.**

***Keywords*: Acid, Alangium Salvifolium Leaves, Mild steel, Polarization, Impedance spectra.**

1. Introduction:

Mild steel is most familiar material widely employed almost all the field in world wide. But the facing main problem of using this material undergoes dissolution in acidic environments. In industry, for cleaning processes, mostly acid solutions are commonly used for the removal of rust and scale. Use of inhibitor is one of the best method to prevent metal dissolution is very common. Corrosion of materials is a natural phenomenon that is a cause of concern as it has incurred a total damage of billions of dollars to many industries. Many ways of overcoming the corrosion problem such as inhibitors, anodic protections, Cathodic protections and coatings are developed. Among all the methods, corrosion inhibitors are popular due to the ease in application and the advantage of in situ application without disruption of the process. Corrosion inhibitors are substances which when added in small concentrations to the corrosive environment will reduce the rate of corrosion [1]. The heterocyclic organic compounds and their derivatives have been successful as corrosion inhibitors, although their toxicity is an important disadvantage, for it limits their application due to environmental impact reason [2,3]. The use of corrosion inhibitors as a means of protection is necessary in many industrial cases: surface preparation, transport and storage of metals, cooling circuits, rehabilitation of reinforced concrete, painting and Cathodic protection [4-6]. The adsorption characteristics mild steel of corrosion inhibitors depend upon the chemical moiety of the molecule, type of functional gro ups and the electron density at the donor atoms. Organic compounds, containing hetero atom's (N, O, S and P), electronegative functional groups, π-electrons and aromatic rings as electron density rich centres which are considered as good adsorptive centre [7-9]. These heterocyclic organic inhibitors get adsorb onto the steel surface or form protective insoluble layer and block corrosion sites, which reduces contact of corroding material with the corrosive medium/steel [10]. Recent studies using plants containing heteroatom such as oxygen, nitrogen and sulphur *like Cnidoscolus chayamans, Solanum Torvum, Pisonia Grandis, mimusops elengi, Sauropus Androgynus, Kingiodendron pinnatum, Wrightia Tinctoria,* Lagenaria Siceraria Peel, Tephrosia Purpurea *[11-19]* have also been used for inhibition of corrosion. In the present study, *Alangium Salvifolium* Leaves extracts was investigated for its corrosion inhibition potential by using potentio dynamic measurement, electrochemical impedance spectroscopy.

2. Materials And Methods

(i). Alangium Salvifolium Leaves Is Used As Corrosion Inhibitor.

(ii). Electrochemical measurements

Electrochemical measurements were carried out using CH Instruments reference 640 with three electrode system, Mild steel specimen with an exposure area 1cm^2 was used as working electrode, platinum electrode (pt) as the auxiliary electrode while the saturated calomel electrode (SCE) was used as the reference electrode. All the electrochemical studies were carried out at room temperature (27±3°C). The open circuit potential (OCP) was recorded as a function of time up to 30 minutes.

(III). POLARISATION METHOD

The corrosion rates in the presence [I_{corr}] and in the absence [I_{corr}] of the inhibitors were determined by Tafel (extrapolation) method. The inhibition efficiency (I.E) was determined by the following relationship.

$$I.E\ (\%) = \frac{[I_{corr} - I_{corr}(I)]}{I_{corr}} \times 100 \qquad \text{.......... (4.4)}$$

(IV). IMPEDANCE MEASUREMENTS

Inhibition efficiencies were also determined from R_{ct} values with and without inhibitors by using the following relationships.

$$I.E\ (\%) = \frac{[R_{ct}\ \text{with (I)} - R_{ct}]}{R_{ct}\ \text{with (I)}} \times 100 \qquad ......\ (4.5)$$

where, R_{ct} with(I) = charge transfer resistance with inhibitor
R_{ct} = charge transfer resistance without inhibitor

3. Result and Discussions:

3.1. ELECTROCHEMICAL STUDIES

3.1.1. Polarisation studies

Fig.1 shows that the potentiodynamic polarisation behaviour of mild steel in 1.0N Hydrochloric acid containing different concentration of ASL inhibitor and the observed data were placed in Table- 1. It is clear that the corrosion current density (I_{corr}) decreased from 58.56 **to** 12.90 mA/cm^2 with increase of inhibitor concentration (from 0 to 1000ppm) and the corrosion potential (E_{corr}) was shifted to positive direction (from -494 to -477mV). It clearly revealed that the ASL extract inhibit the corrosion of mild steel in 1.0N Hydrochloric acid which predominantly control cathodic protection and thus inhibitor behaved as cathodic type. Inhibition efficiency calculated from the extrapolation of the anodic (b_a) and cathodic (b_c) Tafel slopes were in good agreement with those observed from the previous datas.

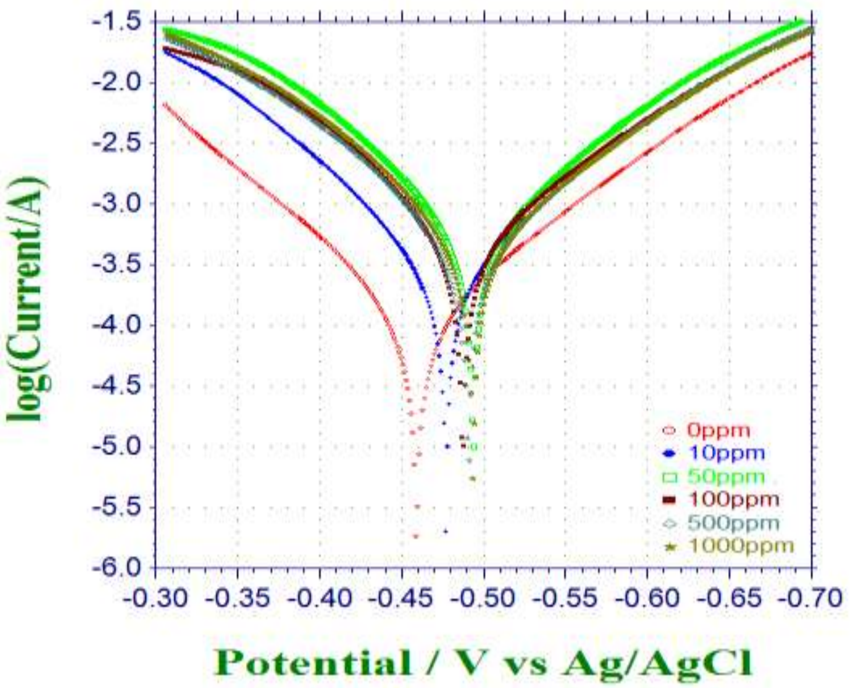


Fig. 1. Polarisation curves for mild steel in 1.0N Hydrochloric acid containing various concentration of ASL inhibitor.

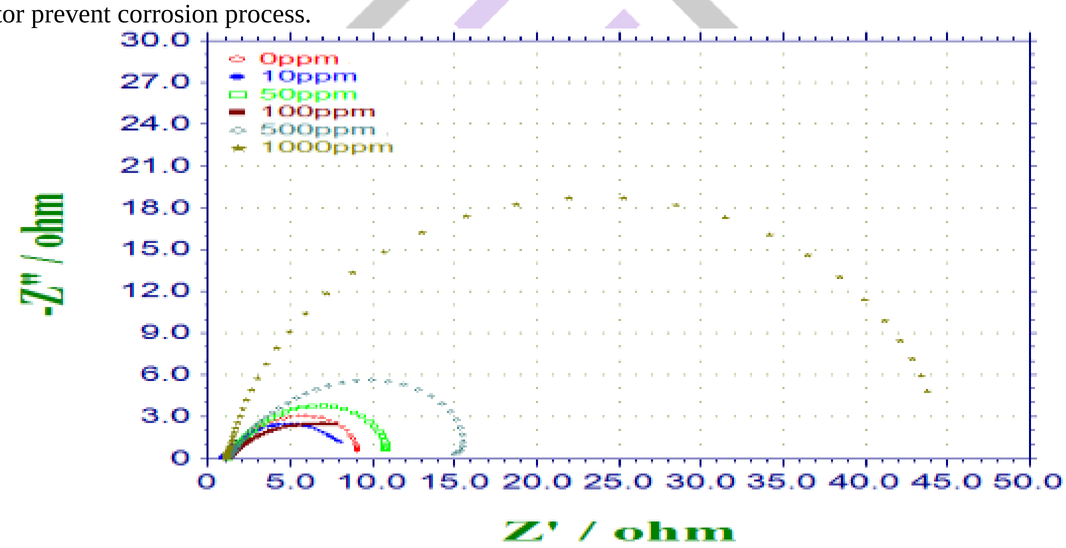
3.1.2. Electrochemical impedance (EIS) studies

Fig.2 (a-c) shows that typical set of complex planes plot of mild steel in 1.0N Hydrochloric acid in the absence and presence of various concentration of ASL inhibitor at room temperature. It was obvious that the addition of inhibitor results in an increase of the diameter of the semicircle capacitive loop (Fig.2(a)), the maximum phase angle (Fig.2(c)). Careful inspection of this data revealed that the value of charge transfer resistance (R_{ct}) increased from 7.989 to 44.432Ω cm^2 of mild steel in 1.0N Hydrochloric acid with increase of inhibitor concentrations. The inhibition efficiency increased from 2.24 to 82.01% with increase of inhibitor concentration. It ensures that the formation of protective film on the metal surface. Double layer capacitance (C_{dl}) decreased as the increase of inhibitor concentration may be due to the adsorption of the active compounds on the metal surface to a film formation. It can be noticed that a perfect semi-circle clearly indicates that the charge transfer process may controlling the dissolution of the specimen. This data was also fitted with the values obtained from the previous data as described earlier.

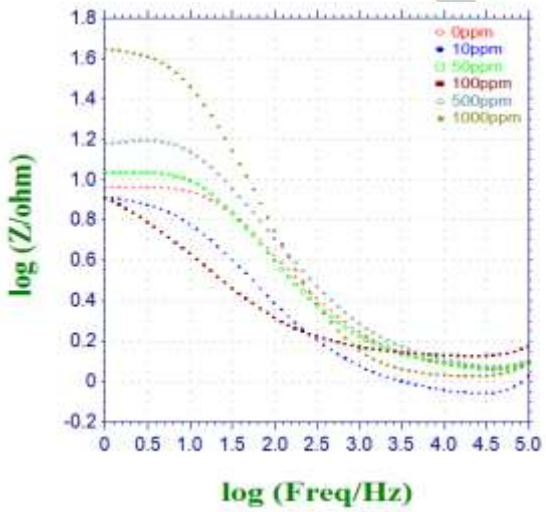
Table- 1 Parameters derived from electrochemical measurements of mild steel in 1.0N Hydrochloric acid containing various concentration of ASL inhibitor.

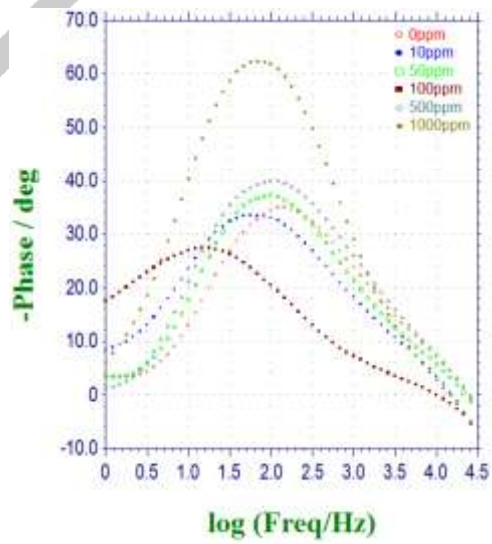
Conc. (ppm)	Polarisation studies					Impedance studies		
	$-E_{corr}$ V/dec	b_a (mV/ decade)	b_c (mV/ decade)	I_{corr} mA cm^{-2}	I.E (%)	R_{ct} (Ω cm^2)	C_{dl} x10^{4} Fcm^2	I.E (%)
Blank	494	95.02	99.43	58.56	---	7.98	0.00356	---
10	488	100.21	105.95	51.24	12.5	8.17	0.00405	2.24
50	493	98.63	103.55	49.96	14.68	9.77	0.00254	18.29
100	491	99.87	98.87	43.11	26.38	10.63	0.00232	24.84
500	459	91.43	97.85	26.47	54.79	13.85	0.00115	42.31
1000	477	87.68	97.27	12.9	77.97	44.43	0.00015	82.01

In the Bode impedance plots and Bode phase plot are shown in Fig.2 (b) and (c). It observed that increasing the inhibitor concentration of extract results in an increased in the impedance of the interface and in the maximum phase angle which indicates that the inhibitor prevent corrosion process.



(a)





(b) (c)

Fig.2 (a-c). Electrochemical impedance plots, (a) Nyquist, (b) Bode plot, (c) phase angle plot for mild steel in 1.0N Hydrochloric acid containing various concentration of ASL inhibitor.

4. Conclusion:

The corrosion behaviour of mild steel in 1.0N Hydrochloric acid was studied in the presence and absence of an eco-friendly inhibitor, The inhibition efficiency was found to be 82.01% by impedance studies and 77.97% of polarisation studies. The study also showed that ASL functioned as a Cathodic-type corrosion inhibitor in the acid environments studied and therefore presents it as a long –term inhibitor for the corrosion of mild steel.

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