Effect of Temperature on Inhibitory Efficacy of *Azadirachta indica* Fruit on Acid Corrosion of Aluminium

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Abstract: *Azadirachta indica* (Neem) is one of the most versatile medicinal plants having wide spectrum of biological activity. The *Azadirachta indica* fruit is rich nimbin, nimbinin, nimbidin, metiantriol (triterpenoid), azadirone, epoxyazadiradione etc. The inhibitory efficacy of ethanolic extract of *Azadirachta indica* fruit (EE*Ai*F) has been investigated at room as well as elevated temperatures and the IE % has been observed significantly high (92.37 %) at room temperature at concentration 1.052g/L. The experimentations has been carried out on acid corrosion of Aluminium using weight loss measurement. The high inhibitive effect is attributed due to these photochemical present in the extract. Efficiency of the inhibitor increases with the increasing concentration of inhibitor. The thermodynamic parameters for *Azadirachta indica* fruit extract indicate that the process was spontaneous and the active constituents have been physically adsorbed onto the metal surface. The adsorptive behavior of the inhibitor at room and higher temperatures has been further endorsed by carrying out FT-IR spectroscopy.

Keywords: Aluminium, *Azadirachta indica*, Acid corrosion, FT-IR Spectroscopy, Kinetic and Thermodynamic Parameters

I. INTRODUCTION

Aluminium is an active metal i.e. its nature is to oxidize very quickly. This particular quality is actually the key to its ability to resist corrosion. Aluminium's oxide film is tenacious, hard, and instantly self-renewing, but it is not always completely impervious to corrosion. This layer can become unstable when exposed to extreme pH levels. When the environment is highly acidic or basic, breakdown of the protective layer can occur, and its automatic renewal may not be fast enough to prevent corrosion [1-2].

Corrosion inhibitors are the substances added to the corrosive medium to reduce the rate of its attack on the metal or alloy [3] and these may be inorganic or organic compounds [4-9]. The inorganic compounds such as chromates inhibit the corrosion process via formation of passive oxide film on the metal surface and thus prevent the corrosive medium to attack the bar metal. On the other hand, the organic compounds adsorb on the metal surface forming a barrier between the metal and the corrosive environment. Inhibition of metallic corrosion, now-a-days is mainly focused to cater the environmental regulations as well as economic. Unfortunately, most of the effective corrosion inhibitors are costly synthetic chemicals. The natural resources are the greatest chemicals' supplying factory to inhibit the corrosion process. Most of the naturally occurrence substances are safe and can be extracted by simple and cheap procedures. Many of the natural resources, such as, henna, natural honey, *Trigonella foenum graceums*, tulsi, opuntia, oils extracted from different parts of different plants have proved their inhibitive ability towards metal corrosion in different aggressive media [10-20].

The *Azadirachta indica* fruits extract is non-toxic and biodegradable, hence, its usages would help to reduce the economic cost of corrosion control as well as decrease the subsequent environmental threats. The chemical constituents of *Azadirachta indica* fruit mainly are nimbin, nimbinin, nimbidin, metiantriol (triterpenoid), azadirone, azadiradionolide, meliacinin, limocin, epoxyazadiradione and the inhibitive effect is attributed due to these photochemical present in the extract [21-25].
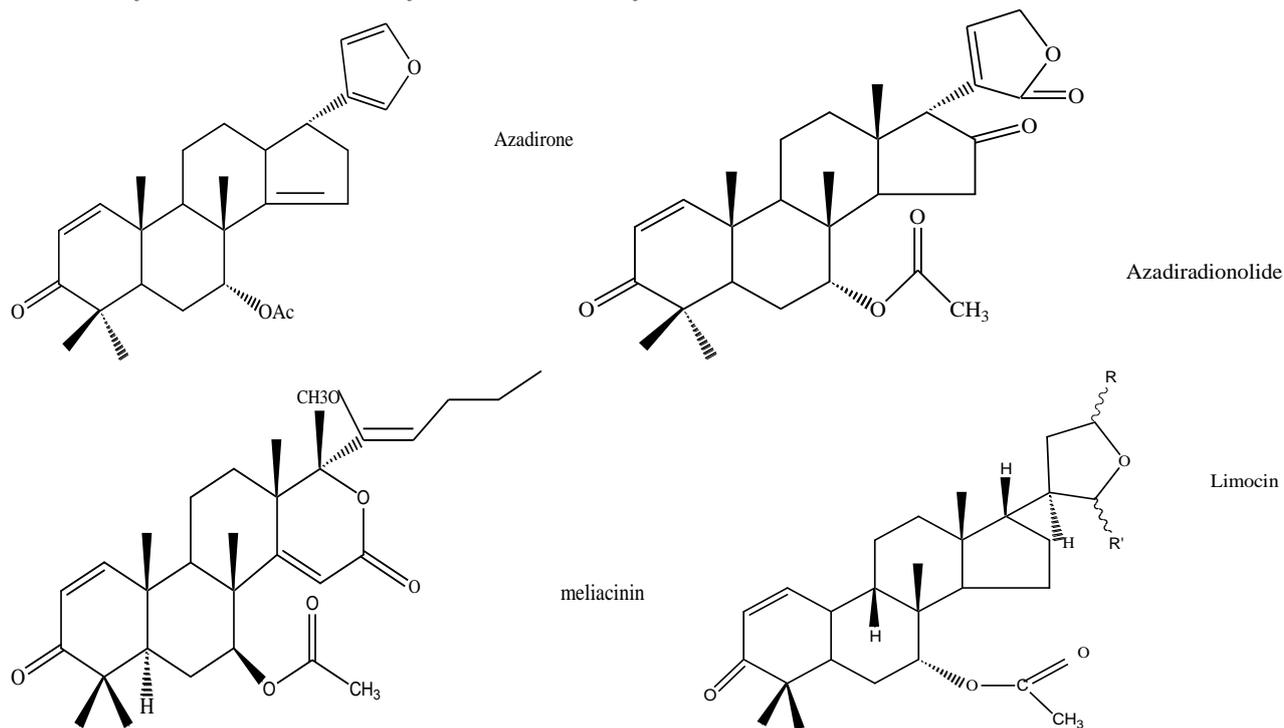
In the present work, the effect of elevation in temperature on inhibitory efficacy of *Azadirachta indica* fruit for acid corrosion of aluminium has been investigated at different immersion periods i.e. 6 and 72 h.

Structures of the active constituents of Azadirachta indica fruit

Azadirone

Azadiradionolide

Limocin

meliacinin

II. EXPERIMENTATION

Preparation of Test Coupons:
Commercially available aluminium was used for specimen preparation with 98 % purity. The specimens were prepared by cutting the aluminium sheet into rectangular shaped pieces having dimension 3.0 x 2.0 x 0.16cm containing a small hole of about 0.12mm diameter near the upper edge. Specimens were polished to mirror finish by using emery paper.

Test Solutions & Experimentation:
Solutions of HCl were prepared by using bi-distilled water. All chemicals used were of AnalR grade. Ethanolic extraction of *Azadirachta indica* fruits (EE*Ai*F) was obtained by refluxing the dried fruits in soxhlet extractor (as procedure adopted earlier [14-20]. Each specimen was suspended by the glass hook and plunge into a beaker containing 50 mL of the test solution and different concentrations of the inhibitor (EE*Ai*F). The investigation has been carried out at different elevated temperatures (303K to 353K). After fixed intervals of exposure time period, test specimens were washed with running water and dried by hanging the washed specimens in desiccators for sufficient time period.

Surface morphological analysis:
Fourier- Transform infrared (FTIR) spectroscopy: The spectra were recorded with the 8400s Shimadzu, Japan spectrometer. The samples were prepared using KBr and the analysis was done by scanning the samples through a wave number range of 400 to 4000 cm^{-1}.

Chemical (Weight Loss) Measurement:
To get more information about the performance of the inhibitor and the nature of adsorption isotherm which can be used to explain the adsorption and activation processes, the experimentations have been carried at various elevated temperatures, in the range 303-353K, in absence and presence of inhibitor at various concentrations at 6 and 72 h immersion periods. Various corrosion and adsorptive parameters, viz., corrosion rate (ρ_{corr}) (mmy^{-1}), percentage inhibition efficiency (IE %), fractional surface coverage (Θ), adsorption equilibrium constant (K_{ad}) etc. have been evaluated using following equations and the results have been tabulated in table 1.

$$\%IE = [\,(\Delta W_u - \Delta W_i)\,/\,\Delta W_u\,]\,x\,100 \qquad (1)$$

where ΔW_u is weight loss without inhibitor and ΔW_i is weight loss with inhibitor.

The degree of surface coverage (θ) has been calculated as:

$$(\theta) = ((\Delta W_u - \Delta W_i) / \Delta W_u) \tag{2}$$

The corrosion rate (ρ_{corr}) (mmy^{-1}) has been obtained by following equation

$$\text{Corrosion rate } (mmy^{-1}) = (\Delta W \times 87.6) / \text{area} \times \text{time} \times \text{metal density} \tag{3}$$

where ΔW weight loss expressed in mg, area expressed in cm^2 of metal surface exposed, time expressed in hours of exposure and metal density expressed in g/cm^3.

TABLE- I

Corrosion Parameters of EE*Ai*F for Acid Corrosion of Aluminium at 6 and 72h Immersions at Elevated Temperatures

Temp. ($\pm$1K)	EE*Ai*F Concentration (g/L)	6h				72h			
		Weight loss (mg)	Corrosion rate (ρ_{corr}) (mmy^{-1})	Inhibition Efficiency (% IE)	Adsorption Equilibrium Constant (K_{ad})	Weight loss (mg)	Corrosion rate (ρ_{corr}) (mmy^{-1})	Inhibition Efficiency (% IE)	Adsorption Equilibrium Constant (K_{ad})
303	A0	15	5.03			131	3.66		
	A1 0.0526	13	4.36	13.33	2.92	91	2.54	30.53	8.36
	A2 0.1052	12	4.02	20.00	2.38	68	1.90	48.09	8.81
	A3 0.2630	10	3.35	33.33	1.90	42	1.17	67.94	8.06
	A4 0.5260	9	3.02	40.00	1.27	28	0.78	78.63	6.99
	A5 0.7890	7	2.35	53.33	1.45	16	0.45	87.79	9.11
	A6 1.0520	**6**	**2.01**	**60.00**	**1.43**	10	**0.28**	92.37	**11.50**
313	A0	20	6.71	-	-	160	4.47	-	-
	A1 0.0526	17	5.70	15.00	3.35	130	3.63	18.75	4.39
	A2 0.1052	15	5.03	25.00	3.17	100	2.79	37.50	5.70
	A3 0.2630	13	4.36	35.00	2.05	75	2.10	53.12	4.31
	A4 0.5260	11	3.69	45.00	1.56	60	1.68	62.50	3.17
	A5 0.7890	9	3.02	55.00	1.55	43	1.20	73.12	3.45
	A6 1.0520	**7**	**2.35**	**65.00**	**1.77**	31	**0.87**	**80.62**	**3.96**
323	A0	27	9.05	-	-	27	6.99	-	-
	A1 0.0526	24	8.05	11.11	2.38	24	5.84	16.40	3.73
	A2 0.1052	22	7.38	18.52	2.16	22	5.11	26.80	3.48
	A3 0.2630	19	6.37	29.63	1.60	19	3.91	44.00	2.99
	A4 0.5260	16	5.36	40.74	1.31	16	2.93	58.00	2.63
	A5 0.7890	13	4.36	51.85	1.37	13	2.29	67.20	2.60
	A6 1.0520	10	**3.36**	**62.96**	**1.62**	10	**1.68**	**76.00**	**3.01**
333	A0	35	11.73	-	-	405	11.32	-	-
	A1 0.0526	32	10.73	08.57	1.78	358	10.00	11.60	2.50
	A2 0.1052	29	9.72	17.14	1.97	310	8.66	23.45	2.91
	A3 0.2630	25	8.38	28.57	1.52	250	6.99	38.27	2.36
	A4 0.5260	22	7.38	37.14	1.12	190	5.31	53.09	2.15
	A5 0.7890	18	6.04	48.57	1.20	150	4.19	62.96	2.15
	A6 1.0520	14	**4.69**	**60.00**	**1.43**	108	**3.02**	**73.33**	**2.61**
343	A0	50	16.76	-	-	600	16.76	-	-
	A1 0.0526	47	15.76	6.00	1.21	544	15.20	9.33	1.96
	A2 0.1052	42	14.08	16.00	1.81	490	13.69	18.33	2.13
	A3 0.2630	38	12.74	24.00	1.20	430	12.01	28.33	1.50
	A4 0.5260	32	10.73	36.00	1.07	320	8.94	46.67	1.66
	A5 0.7890	28	9.39	44.00	1.00	240	6.71	60.00	1.90
	A6 1.0520	22	**7.38**	**56.00**	**1.21**	**190**	**5.31**	**68.33**	**2.05**
353	A0	60	20.12	-	-	940	26.26	-	-
	A1 0.0526	57	19.11	5.00	1.00	870	24.31	7.45	1.53
	A2 0.1052	53	17.77	11.67	1.26	830	23.19	11.70	1.26
	A3 0.2630	48	16.09	20.00	0.95	760	21.23	19.15	0.90
	A4 0.5260	45	15.09	25.00	0.63	700	19.56	25.53	0.65
	A5 0.7890	41	13.75	31.67	0.59	600	16.76	36.17	0.72

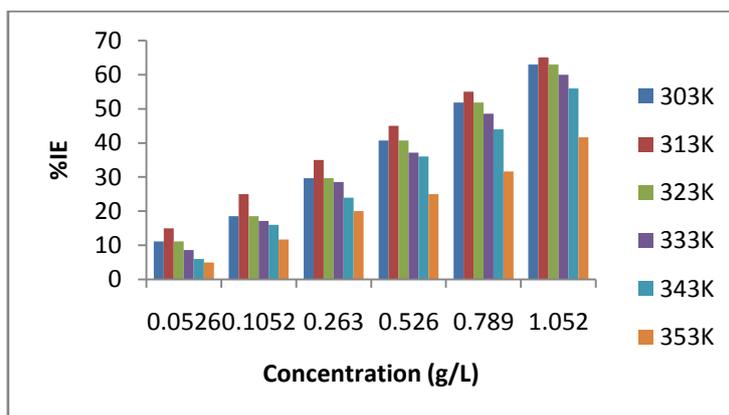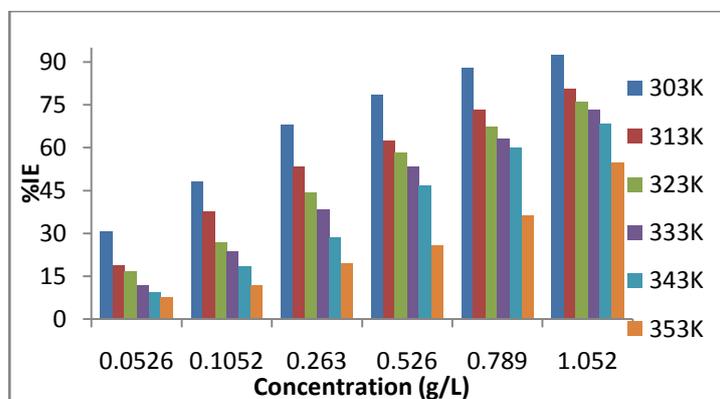| A6	1.0520	35	11.73	41.67		0.68	425	11.87	54.79	1.15

Fig: 1(a). IE (%) vs concentration of EE*Ai*F (g/L) at different temperatures (303-353K) at 6h immersion period.

Figures 1(a) and (b) clearly indicate an increase in inhibition efficiency with increasing concentration of the inhibitor. The maximum efficiency (92.37%) has been observed at highest inhibitor concentration (1.052g/L) at 72 h at room temperature (303 K). At elevated temperature (353 K), IE % reduces to 41.67%. With an elevation in temperature, due to the thermal aggitaion, the desorption process of the adsorbed constituents of the inhibitor increases, leading to a decrease in the inhibition efficacy of EE*Ai*F (table I).

Fig: 1(b). IE (%) vs concentrations of EE*Ai*F (g/L) at different temperatures (303-353K) at 72h immersion period.
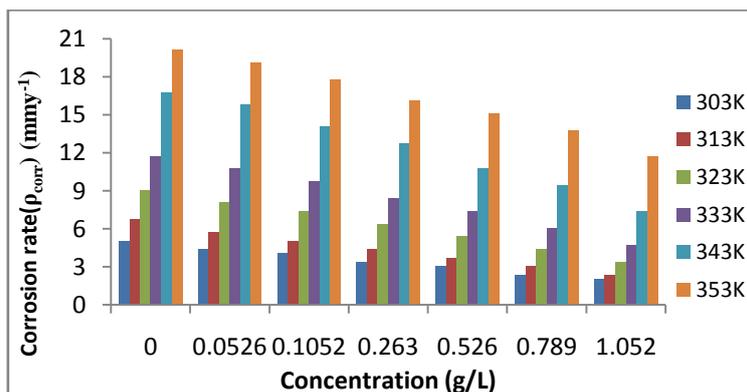

Fig:2(a). Corrosion rate vs concentrations of EE*Ai*F (g/L) at different temperature (303-353K) at 6h immersion period.
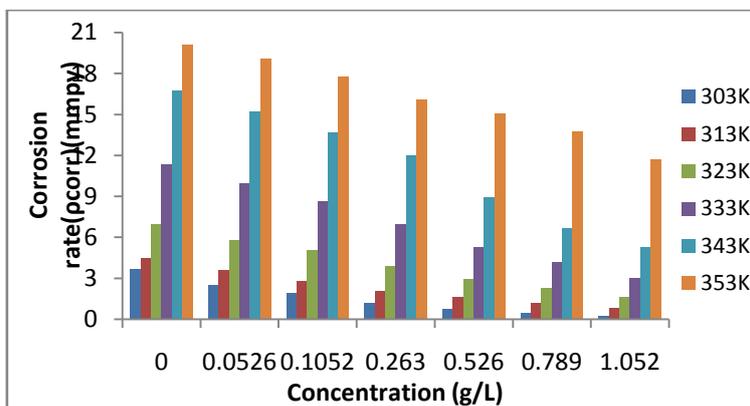
Fig:2 (b). Corrosion rate vs concentrations of EE*Ai*F at different temperature (303-353K) at 72h immersion period.

Figures 2(a) and (b) indicate an increase in the corrosion rate with an increase in temperature. A decrease in the degree of surface coverage has been observed with increasing temperature owing to the desorption of the inhibitor molecules onto the aluminium surface.

Kinetic /thermodynamic Treatment of Weight Loss Results:
Assuming that the corrosion rate of aluminium and the concentration of the EE*Ai*F obey the kinetic relationship, expressed by the equation:

$$\log \rho_{corr} = \log k + B \log C \qquad\qquad (4)$$

where k is the rate constant and equals to ρ_{corr} at inhibitor concentration of unity; B is the reaction constant which, in the present case, is a measure for the inhibition effectives and C is the concentration of EE*Ai*F in g/L.

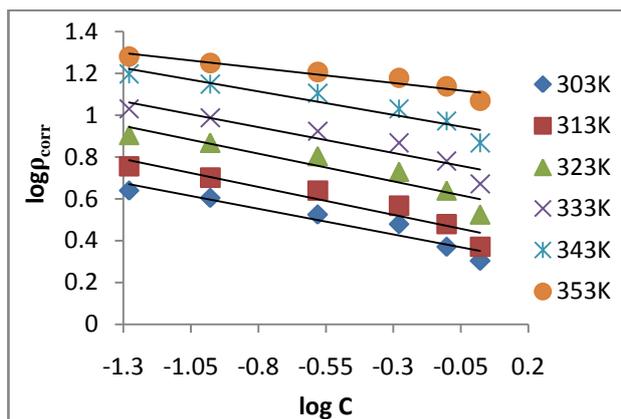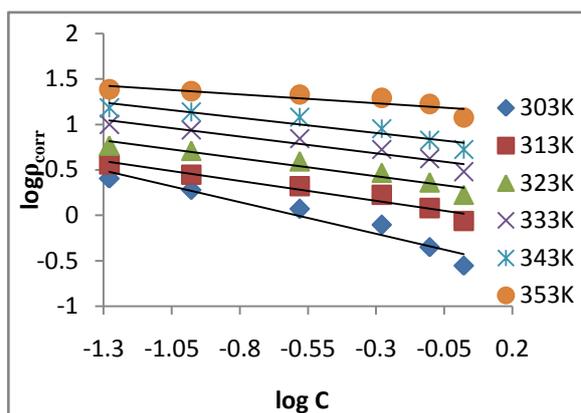Fig. 3 (a). log ρ_{corr} vs log C at 6h immersion periods.

Fig. 3 (b). log ρ_{corr} vs log C at 72h immersion periods.

The plot of log ρ_{corr} vs. log C at various temperature for 6 and 72 h immersions resulted in straight lines (Figs-3 a & b). The kinetic parameters (k and B) have been calculated using equation 4 and the results have been tabulated in table-II. The straight lines with negative slopes were obtained, indicative that the rate of corrosion process is inversely proportional to EE*Ai*F concentration, i.e. EE*Ai*F becomes more effective as its concentration is increased. At each temperature a linear variation was observed, confirming the first order kinetics. At elevated temperature, with an

increase in the concentration of the inhibitor, the decrease in corrosion rate is very low (also low values of B), indicating that the desorption process is swift.

TABLE – II
The kinetic parameters (k and B) for EE*Ai*E at 6 and 72 h immersions at different temperatures

Temperature (K)	6h			72h		
	B	K	R^2	B	k	R^2
303	-0.244	2.269	0.917	-0.695	0.386	0.941
313	-0.266	2.773	0.907	-0.437	1.066	0.945
323	-0.265	4.018	0.888	-0.393	2.042	0.937
333	-0.246	5.559	0.89	-0.369	3.724	0.922
343	-0.225	9.840	0.9	-0.334	6.383	0.894
353	-0.142	12.912	0.907	-0.193	14.962	0.743

Energy of Activation:

The weight loss measurements were conducted in the temperature range of 303-353K in the absence and presence of different concentrations of EE*Ai*F in 0.5N HCl for aluminium. The dependence of corrosion rate on temperature can be expressed by Arrhenius equation [14-20]:

log CR = log A - E_a/2.303RT   (5)

where CR is the corrosion rate, A is Arrhenius constant, R is a molar gas constant and T is temperature(K).

A plot of log CR (ρ_{corr}) against 1/T resulted straight lines (figs. 4 a & b) in 0.5N HCl in absence and presence of different concentrations of EE*Ai*F. Activation energy values, Ea were calculated from the slope of the plots of figure 4 and are summarized in table III.
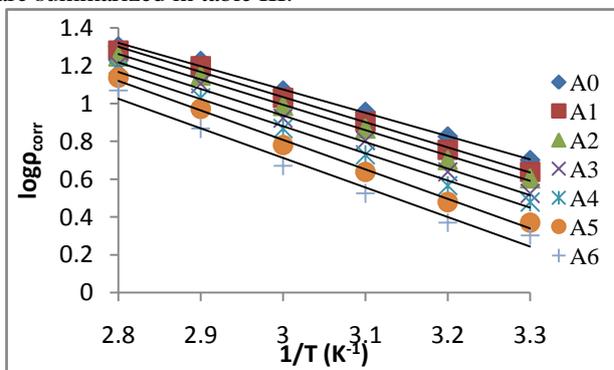

Fig: 4(a). log ρ_{corr} vs 1/T (K) at 6h immersion period.
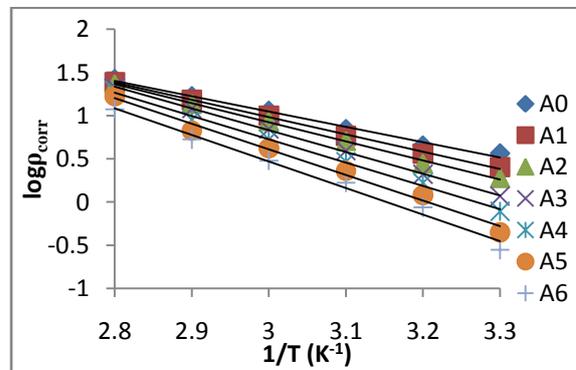

Fig: 4(b). log ρ_{corr} vs 1/T (K) at 72h immersion period.

TABLE – III
Thermodynamic Parameters at 6 and 72 h immersion periods

Concentration (g/L)		6h			72h		
		(Ea) (kJ mol^{-1})	ΔH (kJ mol^{-1})	ΔS (J/mol k)	(Ea) (kJ mol^{-1})	ΔH (kJ mol^{-1})	ΔS (J/mol k)
	A0	23.61	-21.06	-162.08	33.92	-31.42	-131.52
A1	0.0526	25.49	-22.94	-157.22	38.30	-35.75	-119.79
A2	0.1052	25.64	-23.09	-157.56	42.30	-39.75	-108.95
A3	0.2630	26.92	-24.37	-154.77	48.22	-45.67	-92.92
A4	0.5260	27.48	-24.93	-154.19	51.57	-49.04	-84.86
A5	0.7890	29.85	-27.32	-148.45	56.74	-54.21	-71.63
A6	**1.0520**	29.91	-27.36	-150.13	58.57	-56.31	-67.97

The enthalpy, ΔH and entropy of adsorption, ΔS were obtained from the Transition state equation:

log ρ_{corr} / T = [log (R/Nh) + (ΔS/ 2.303R)] − ΔH / 2.303 RT   (6)

where h is Planck's constant, N is the Avogadro's number.

Figure 5 illustrates the plot of log (CR/T) as a function of 1/T for aluminium (a) at 6 h and (b) 72 h immersion periods. Straight lines were obtained with a slope of (-ΔH/R) and an intercept of log (R/Nh) + (ΔS/2.303R) from which the values of ΔH and ΔS were calculated.

The calculated values have been presented in Table III for aluminium in 0.5N HCl without and with varying concentration of EEAiF. The value of E_a increases in the presence of the inhibitor as compared to the free acid solution for aluminium corrosion. The increase in E_a in the presence of inhibitor has been associated with physisorption of the adsorptive film onto the metal surface.
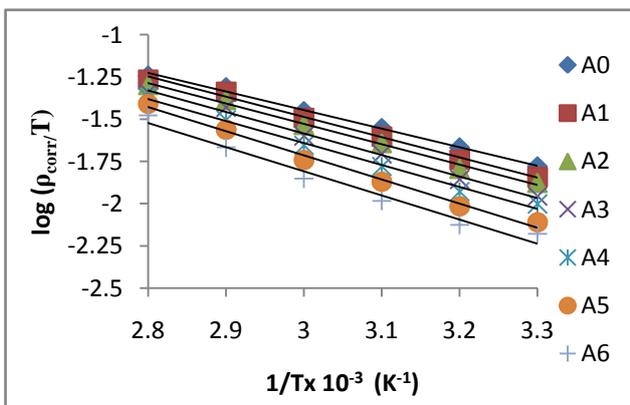

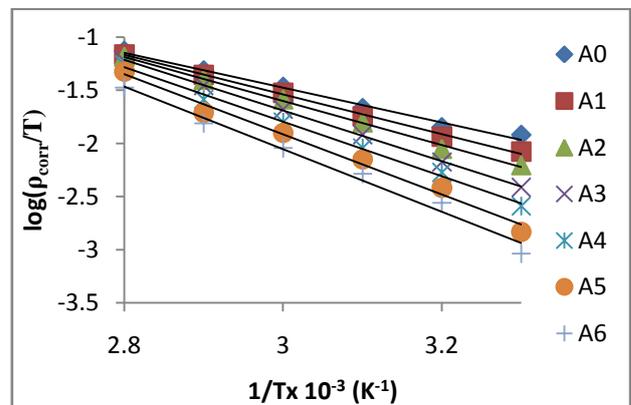Fig: 5 (a) log(ρ_{corr}/T) vs 1/T at 6h immersion period.

Fig: 5 (b) log(ρ_{corr}/T) vs 1/T at 72 h immersion period.

Thermodynamic Parameters:

With the expression: **K = 1/55.5 exp [-ΔG$^o_{ads}$/RT]**   (7)

the free energy of adsorption values, ΔG$^o_{ads}$ were obtained and the results have been tabulated in Table- IV (a & b).

Results presented in the Tables indicate that the values of ΔG$^o_{ads}$ are negative in all cases. The negative values indicate a spontaneous adsorption of the inhibitor molecules. Generally, values of ΔG$^o_{ads}$ up to -20 kJ mol^{-1} are consistent with electrostatic interaction between charged molecules and a charged metal (which indicates physical adsorption) while those more negative than -40 kJ mol^{-1} involves charge sharing or transfer from the inhibitor components to the metal surface to form a coordinate type of bond (which indicate chemisorption).

The thermodynamic parameters ΔH and ΔS for adsorption of EEAiF on aluminium can be calculated from the following equation: **ΔG^o = ΔH^o - TΔS^o**   (8)

where ΔH and ΔS are the enthalpy and entropy of adsorption process.

The calculated values are given in Table IV (a & b).

TABLE – IV (a)
Thermodynamic Parameters (ΔH$^o_{ads}$, ΔG$^o_{ads}$, ΔS$^o_{ads}$) for 6 h immersion at different temperature

Concen.(g/L)	ΔG$^o_{ads}$ kJ mol^{-1}						ΔH$^o_{ads}$ kJmol^{-1}	ΔS$^o_{ads}$ Jmol^{-1}K^{-1}
	303K	313K	323K	333K	343K	353K		
A0	-	-	-	-	-	-		
A1 0.0526	-12.82	-13.60	-13.11	-12.72	-12.01	-11.79	-22.36	0.029
A2 0.1052	-12.30	-13.45	-12.85	-12.99	-13.15	-12.46	-12.86	0.060
A3 0.2630	-11.74	-12.32	-12.05	-12.28	-11.98	-11.64	-13.20	0.003
A4 0.5260	-10.72	-11.60	-11.51	-11.44	-11.64	-10.45	-12.41	0.003
A5 0.7890	-11.05	-11.59	-11.62	-11.62	-11.44	-10.23	-15.55	0.013
A6 1.0520	-11.01	-11.93	-12.07	-12.10	-12.00	-10.65	-27.36	0.004

TABLE – IV (b)
Thermodynamic Parameters (ΔH$^o_{ads}$, ΔG$^o_{ads}$, ΔS$^o_{ads}$) for 72 h immersion at different temperature

Concn. (g/L)	ΔG$^o_{ads}$ kJ mol^{-1}						ΔH$^o_{ads}$ kJ mol^{-1}	ΔS$^o_{ads}$ Jmol^{-1}K^{-1}
	303K	313K	323K	333K	343K	353K		
A0	-	-	-	-	-	-		
A1 0.0526	-15.47	-14.30	-14.32	-13.65	-13.37	-13.04	-28.66	0.044
A2 0.1052	-15.60	-14.98	-14.14	-14.08	-13.62	-12.47	-32.72	0.056

A3	0.2630	-15.38	-14.25	-13.73	-13.49	-12.62	-11.48	-36.56	0.070
A4	0.5260	-15.02	-13.45	-13.38	-13.24	-12.91	-10.53	-35.78	0.069
A5	0.7890	-15.69	-13.67	-13.35	-13.25	-13.29	-10.82	-37.34	0.073
A6	1.0520	-16.27	-14.03	-13.75	-13.78	-13.50	-12.20	-34.44	0.062

Adsorption Isotherm

Adsorption isotherm provides useful insights into the mechanism of corrosion inhibition. The adsorption equilibrium constant, K_{ad}, is expressed as:

$$K_{ad} \, C = \theta / (1-\theta) \tag{9}$$

where C is the concentration of EE*Ai*F in g/L; θ the fractional surface coverage and K_{ad} is the adsorption equilibrium constant. The fractional surface coverage, θ, was evaluated. The fractional surface coverage θ, and the adsorption equilibrium constant K_{ad}, was found large at higher concentration of EE*Ai*F, hence it is concluded that higher concentration of EE*Ai*F is essential for maximum adsorption over aluminium metal surface. It is essential to determine empirically which adsorption isotherm fits best to the surface coverage data in order to use the corrosion rate measurements to calculate the thermodynamic parameters pertaining to inhibitor adsorption. Different adsorption models were considered for the best fit of experimental data. The best fitted straight line was obtained for the plot of C_{inh}/θ versus C_{inh} with slopes around unity. This suggests that the adsorption of EE*Ai*F on the metal surface obeyed Langmuir adsorption isotherm, mathematically expressed as:

$$(C / \theta) = C + 1/ K_{ad} \tag{10}$$

where, C is the concentration of the inhibitor (EE*Ai*F), θ is the fractional surface coverage, and K_{ad} is the adsorption equilibrium constant. From the intercepts of the straight line C_{inh}/θ-axis, K value was calculated and from graph the value came can be justify by theoretical value. It is based on the assumption that the adsorbed molecule decreases the surface area available for the corrosion reactions to occur.
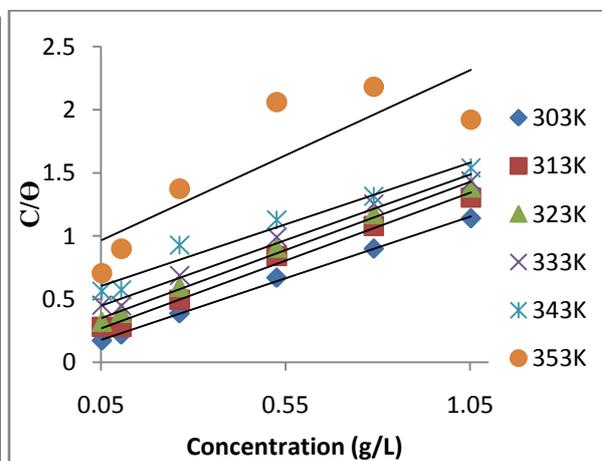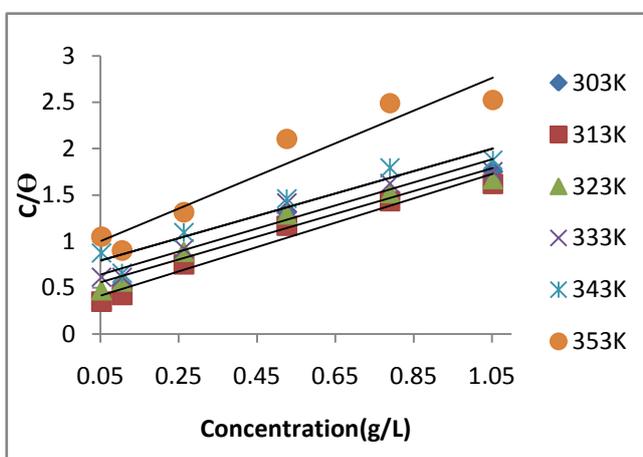

Fig: 6(a). Plot of C/Ө vs C at different temperature at 6h immersion period.   Fig: 6(b)Plot of C/Ө vs C at different temperature at 72 h immersions.

TABLE- V

The correlation coefficient and slopes from Langmuir adsorption isotherm at different temperature

Temperature (K)	6h		72h	
	Correlation coefficient (R^2)	K (adsorption coefficient)	Correlation coefficient (R^2)	K (adsorption coefficient)
303	0.965	2.439	0.998	7.874
313	0.968	2.873	0.991	4.673
323	0.956	2.012	0.993	3.389
333	0.948	1.724	0.988	2.532
343	0.931	1.362	0.964	1.805
353	0.922	1.095	0.737	1.116

The degree of linearity of Langmuir adsorption isotherm as measured by value of R^2 in the range ($0.999 \geq r^2 \geq 0.737$) is nearly equal to one and slope is almost unity, monolayer of the inhibitor species must have been attached to aluminium surface without lateral interaction between the adsorbed species.

Surface Morphological Analysis:

FT-IR Spectroscopy: The formation of the adsorbed protective film over the surface of copper coupon was further established by carrying out FT-IR spectroscopic investigations. FT-IR was conducted on 8400 Shimadzu, Japan FT-IR spectrometer in the IR range from 4000 to 400 cm^{-1}. The FT-IR spectrum of the protective film was recorded by carefully removing the film, mixing it with KBr & making the pellet.
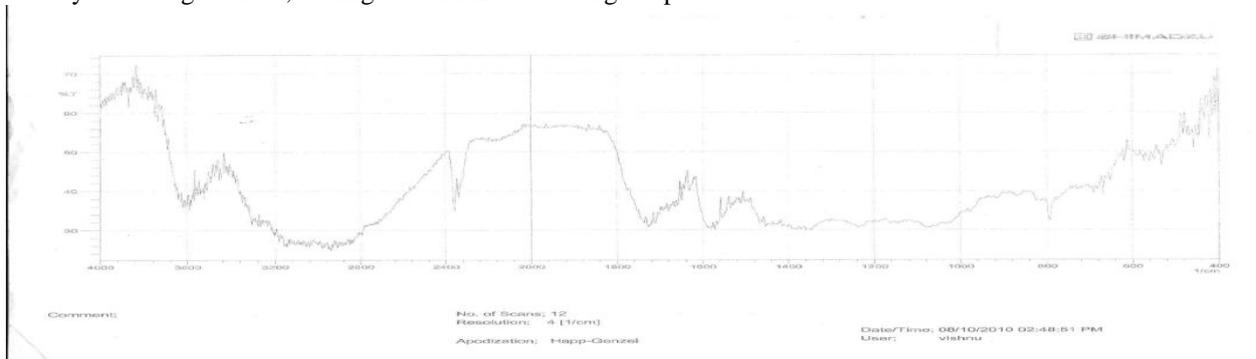

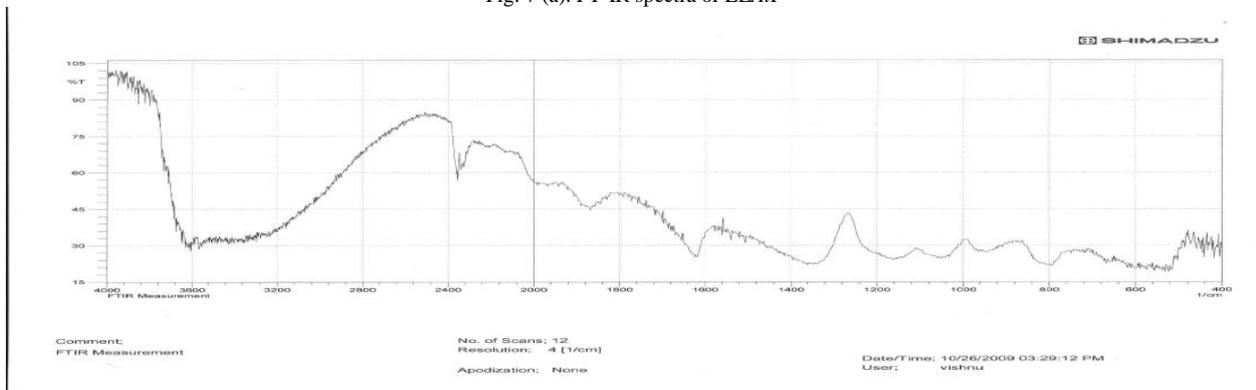Fig: 7 (a). FT-IR spectra of EE*Ai*F

Fig: 7 (b). FTIR spectra of adsorbed film of EE*Ai*F onto Aluminium surface in 0.5 N HCl containing 1.052g/L EE*Ai*F

Fig. 7 (b) shows the changes in the spectrum of EE*Fg*F after its adsorption onto the metal surface and undoubtedly illustrates that some of the peaks have disappeared completely while some have shifted to higher frequencies region, justifying the adsorption phenomenon taking place over the solid metal surface.

Proposed Mechanism for Inhibition by EEAiF

Corrosion of aluminium in 0.5N HCl is retarded in presence of different concentrations of the *Azadirachta indica* extract. The results clearly showed that the inhibition mechanism involves blocking of aluminium surface by inhibitor molecules via adsorption. In general, the phenomenon of adsorption is influenced by the nature of metal and chemical structure of inhibitor. The values of thermodynamic parameters for the adsorption of inhibitors provide valuable information about the mechanism of corrosion inhibition. The adsorption mechanism of extract on aluminium surface involves a physisorption. It means that the extract is able to electrostatically adsorb on the metal surface. The temperature study (303-353K) shows that at higher temperature desorption of the inhibitor from the metal surface occur. The Kinetic and thermodynamic parameters also confirm that there is electrostatic kind of interaction between the extract and metal surface. *Azadirachta indica* fruit extracts contain significant high concentrations of alkaloids, fatty acids, and nitrogen and oxygen-containing compounds. Chemical constituents of *Azadirachta indica* fruit mainly are

nimbin, nimbinin, nimbidin, metiantriol (triterpenoid), azadirone, epoxyazadiradione and the inhibitive effect is attributed due to these photochemical present in the extract. The adsorption of these organic molecules occurred due to the formation of a links between aluminium atoms, involving the displacement of water molecules from metal surface, and the lone pairs present on N- and O- atoms of the heterocyclic rings. It can be concluded that, due to the suitable inhibitive characteristics of compounds present in *Azadirachta indica* extract it is effective inhibitor for aluminium corrosion.

III. CONCLUSION

From the study, it was concluded that ethanol extract of *Azadirachta indica* fruit has good adsorptive propensity for the metal (aluminium) surface. The inhibition of the corrosion of aluminium by ethanol extract of the fruits of *Azadirachta indica* is due to the phytochemical constituents of the extract. Analyses of the temperature effect on inhibition efficiency as well as comparison of corrosion activation energies in absence and presence of inhibitor give some insight into the possible mechanism of inhibitor adsorption. Decrease in inhibition efficiency with rise in temperature, with correspondingly increase in corrosion activation energy in the presence of inhibitor compared to its absence, is ascribed to physical adsorption mechanism. The adsorption of ethanol extract of the fruits of *Azadirachta indica* is spontaneous and occurred according to the mechanism of physical adsorption. The experimental data fit into the Langmuir adsorption isotherm. The formation of monolayer of adsorption as described by Langmuir adsorption isotherm also supported this assertion. The FT-IR spectra confirm that the extract inhibit the corrosion of aluminium by being adsorbed on the surface of aluminium and that there is interaction between the inhibitor and the surface. In view of the findings, it may be concluded that the ethanolic extract of *Azadirachta indica* fruit can be considered as a source of relatively cheap, eco-friendly and effective acid corrosion inhibitor to a certain elevation in temperature.

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