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INVESTIGATION OF THE INHIBITIVE EFFECT OF AQUEOUS EXTRACT OF *EUCALYPTUS* LEAVES ON MILD STEEL IN ACIDIC MEDIA

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ABSTRACT
The corrosion inhibition of mild steel in 0.5M H_2SO_4 and 1M HCl by leave extract of eucalyptus was studied using gravimetric (weight loss) method at various temperature. The results obtained showed that the efficiency of inhibition increases with increase in the extract concentrations and decreases with rise in temperature. The adsorption of plant extract on the mild steels was found to obey Longmuir adsorption isotherm. This could be due to physical adsorption of cation species on the metal surface.

INTRODUCTION
Corrosion of metal is due to chemical or electro-chemical reaction when it comes in contact with matter in the environment. [1, 2] Corrosion can cause economic consequences in terms of repair, replacement, products losses, safety and environmental pollution. Due to the various applications of metals and it's alloys, its protection against corrosion has attracted much attention [3]. There are various methods of corrosion control, one of the methods of protecting the metal is by adding inhibitors to the solution in contact with the surface in order to inhibit the corrosion reaction and reduce corrosion rate [4]. However most of the inhibitor used are of inorganic or organic source and are toxic and non-biodegradable. The toxic effect of these synthesis inhibitors have lead to search for an alternative source that can be used as an inhibitor. The aim of this paper is to evaluate the inhibitor properties of Eucalyptus leave extract on mild steel in acidic media.

Eucalyptus is a fast growing evergreen tree native to Australia. The plant was first described by a French botanist Jacques. The most common name for Eucalyptus tree is gum tree. This is because Eucalyptus tree exude a sticky resin or gum. Its generic name is derived from the Greek word eu "well" and Kalyptos "covered", meaning "well covered". The uses of Eucalyptus are very vast and widely range because there are so many species that have medicinal properties [7].

Traditionally, Eucalyptus species have been used for insect repellent, respiratory infections and mouth washes. The Australian Aborigines have used the leaves to disinfect wounds and treat infections for thousands of years [8].

EXPERIMENTAL
The mild steel was obtained from a mechanical workshop of the Federal Polytechnic Nekede. It was in coupons of $30 \times 30mm$ dimension, thickness 0.5mm. A hole of 2.5mm diameter was drilled at the top center of each coupon to make it easy for suspending into the corrosive liquid. The surface of the coupons were polished with wire brush, degreased into ethanol, dried in acetone and store in moisture free desiccators before using it for the corrosion studies. The acids used for the medium are all of an analytical grade.

Reagent Preparation
1M HCl and 0.5M H_2SO_4 solutions were prepared for the experiment using analytical grade reagents and distilled water. The blank was prepared without the addition of the extract.

Preparation of the Plant Extract
The plant extract was prepared by boiling weighted quantity of dried and ground plant leaves and extracted with ethanol in soxhlet extractor. The resulting solution was allowed to cool and the ethanol was evaporated to dryness. From the respective stock solution, inhibitor test solution was prepared in the concentration range of 50-1200mg/l.

Metal Spacemen
The mild steel sheets were obtained from the material and metallurgical engineering

workshop Federal University of Technology Owerri (FUTO). The sheets were cut into coupons of $30 \times 30mm$ dimension, thickness 0.5mm. a hole 2.5mm the steel surface were degreased in ethanol and cleaned with acetone and air dried.

Weight Loss (Gravimetric) Procedure

Two coupons A and B were marked for each corrodent solution and their individual initial weights were taken and recorded after proper polishing cleaning. After the specified duration in the corroding solutions, it was removed washed in running water with bristle brush, cleaned with acetone and air dried with hot air from the air blower and reweighted. The experiment was repeated twice and average was calculated.

Weight loss measurements were carried out in 1.0M HCl and 0.5M H_2SO_4. This process is an index of measurement of the effectiveness of corrosiveness environment as it affects the test samples and also shows the average corrosion rate. The corrosion rate of the mild steel coupons was computed from the weight loss method using the formula below

$$C_r = \frac{\Delta W}{At}$$

$$\mathrm{C_r} = \text{corrosion rate}$$
$$\Delta \mathrm{W} = \text{change in weight}$$
$$\mathrm{A} = \text{total surface area of specimen } (\mathrm{md}^2)$$
$$\mathrm{t} = \text{time of immersion (days)}$$
$$\mathrm{A} = 2\mathrm{LW} + 4\mathrm{tL} - 2\pi \mathrm{r}^2 + 2\pi \mathrm{rt}$$

Where L= length
W = width
t = thickness (0.5mm)
r = radius of hole on coupon (1.25mm)

The inhibition efficiency (I.E %) and surface area (θ) of the specimen were computed following the equation shown below

$$\mathrm{I.E\%} = 1 - \frac{\mathrm{W_i}}{\mathrm{W_b}} \times 100$$

$$\theta = 1 - \frac{\mathrm{W_b} - \mathrm{W_i}}{\mathrm{W_o}}$$

Where

$$\mathrm{W_i} = \text{weight in inhibitor}$$
$$\mathrm{W_b} = \text{weight in blank}$$

RESULTS AND DISCUSSION

Table 1.0: Variation of inhibition efficiency (%) with concentration (mg/L) of 0.5M H_2SO_4

Concentration (mg/L)	Average weight loss (g)	Inhibition efficiency (I.E%)
Blank	0.0597	-
25	0.0502	15.91
50	0.0496	16.92
100	0.0477	20.10
200	0.0389	34.84
300	0.0235	60.64
400	0.0221	62.98
500	0.0184	69.18
600	0.0181	69.68
700	0.0179	70.02
800	0.0170	71.52
900	0.0159	73.37
1000	0.0142	76.21

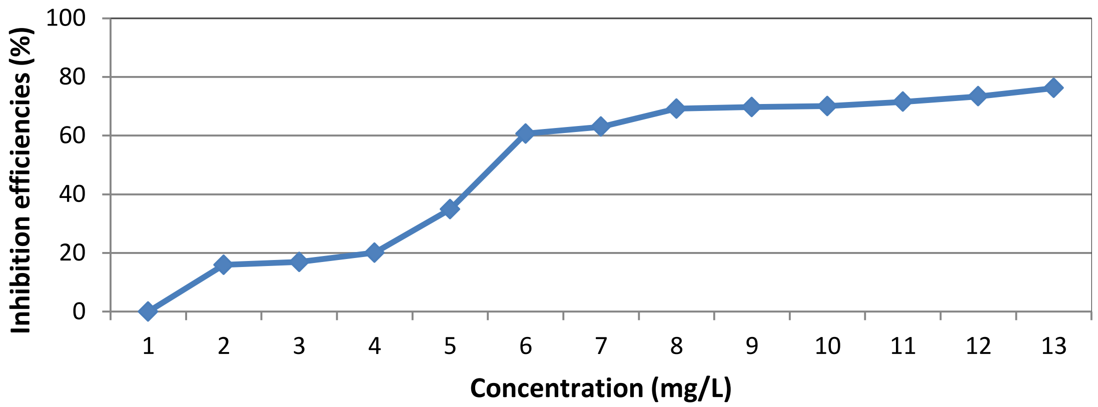

Figure 1.0: inhibition efficiency (%) against concentration (mg/L) of mild steel.

Table 2.0: Variation of inhibition efficiency (I.E) with concentration (mg/L) of 0.1M HCl

Concentration (mg/L)	Average weight loss (g)	Inhibition efficiency (I.E)
Blank	0.0106	-
25	0.0089	15.17
50	0.0061	42.18
100	0.0055	47.87
200	0.0049	54.03
300	0.0038	64.45
400	0.0030	71.56
500	0.0027	74.41
600	0.0022	79.15
700	0.0020	81.04
800	0.0017	83.89
900	0.00165	84.36
1000	0.0015	86.26

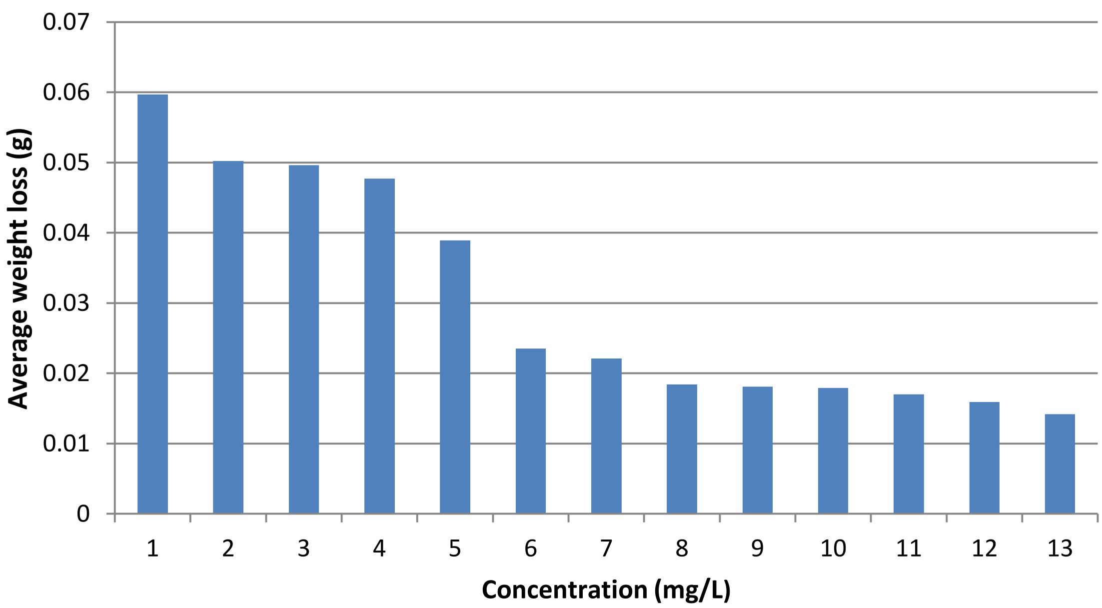

Figure 2.0: weight loss against concentration (mg/L) of extract.

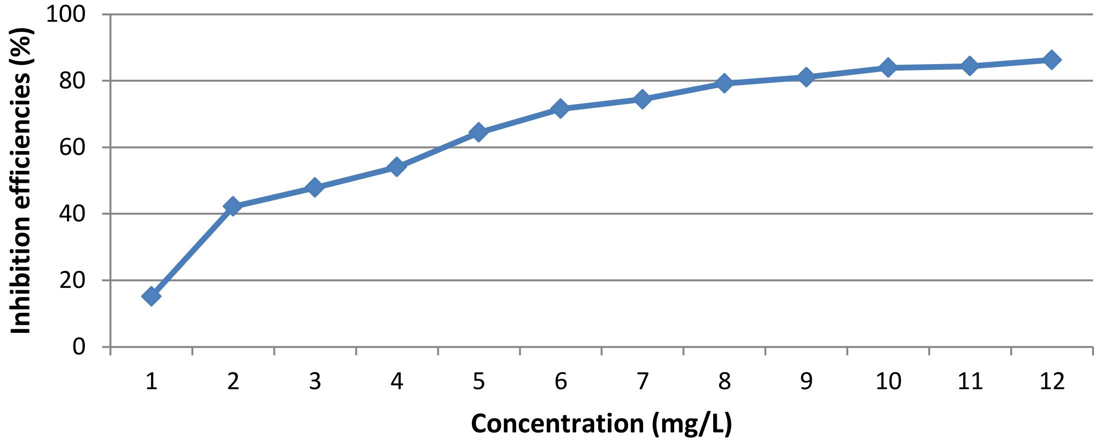

Figure 3.0: inhibition efficiency (%) against concentration (mg/L) of mild steel corrosion in 1.0M HCl

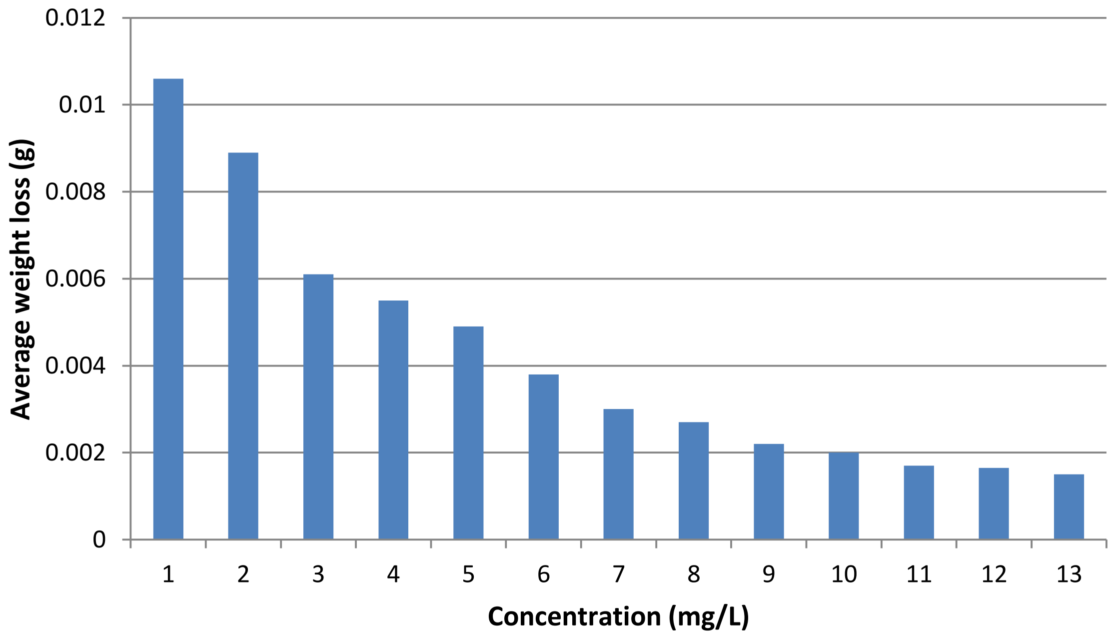

Figure 4.0: Average weight loss against concentration of mild steel corrosion in 1.0M HCl

Table 3.0: Variation of inhibition efficiency (I.E) with temperature (˚C) of 0.5M H_2SO_4

Temperature	30^oC	35^oC	40^oC	45^oC	50^oC	55^oC
Concentration (mg/L)	0.0295	0.0516	0.0520	0.0711	0.1006	0.1079
25	0.0284	0.0373	0.0400	0.0823	0.1177	0.1193
800	0.0105	0.0086	0.0094	0.0266	0.0448	0.0564
1000	0.0080	0.0022	0.0040	0.0239	0.0423	0.0459

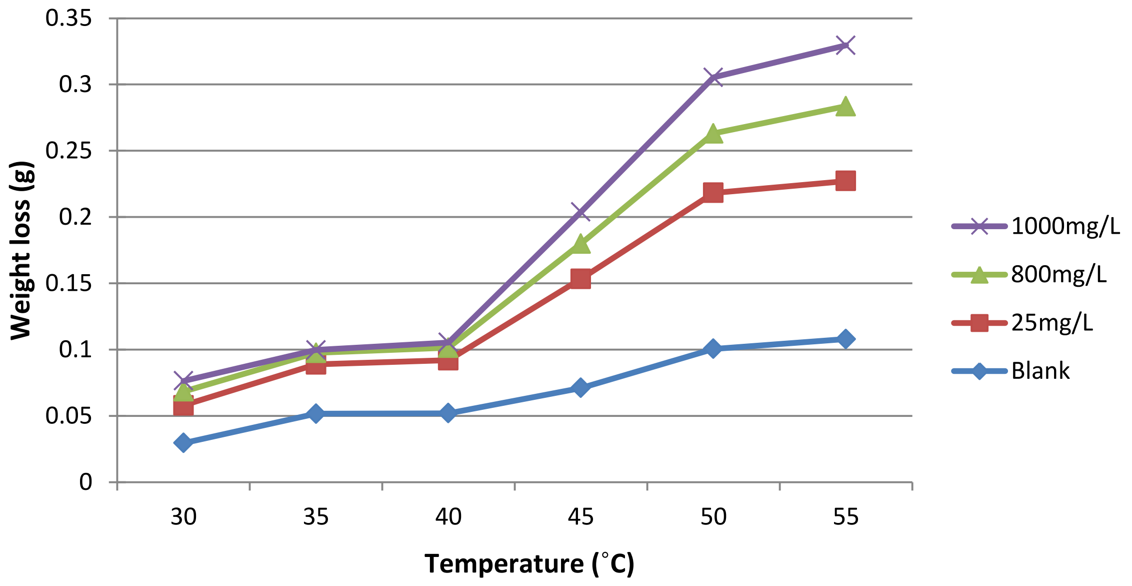

Figure 5.0: weight loss (g) against temperature (˚C) of mild steel.

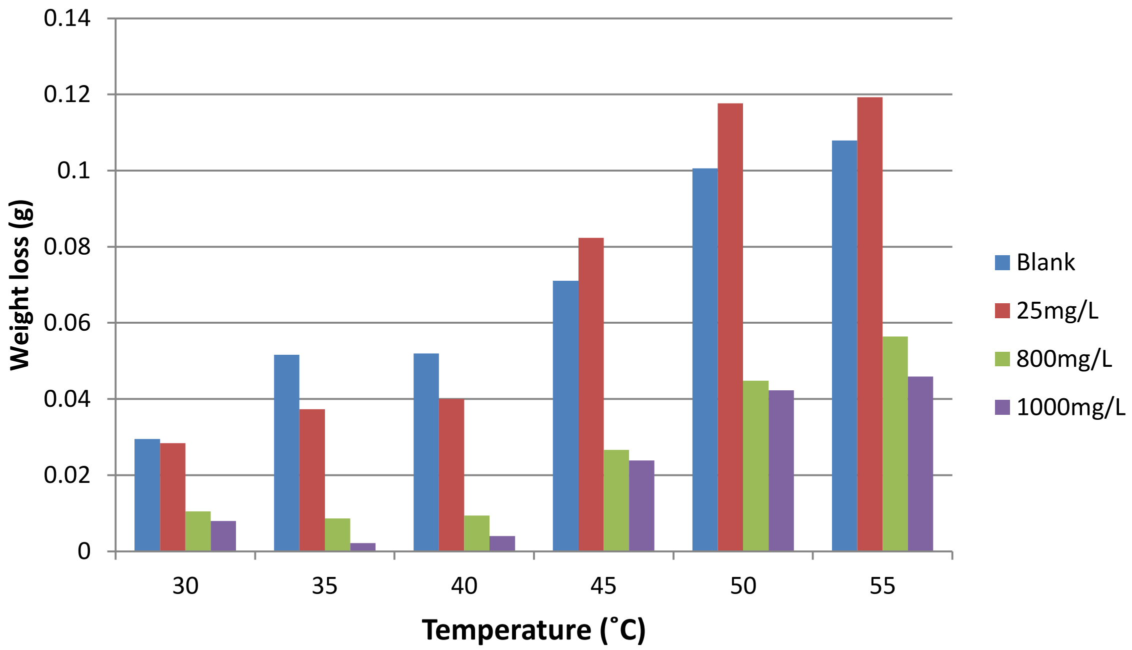

Figure 6.0: weight loss (g) against temperature (˚C) of mild steel corrosion inhibition

Table 4.0: Variation of inhibition efficiency (I.E) with temperature (˚C) of 1.0M HCl

Temperature	30°C	35°C	40°C	45°C	50°C	55°C
Concentration (mg/L)	0.0306	0.0306	0.0369	0.0451	0.0620	0.0526
25	0.0120	0.0236	0.0261	0.0346	0.0572	0.0623
800	0.0069	0.0104	0.0106	0.0127	0.0166	0.0245
1000	0.0055	0.0039	0.0096	0.0103	0.0155	0.0192

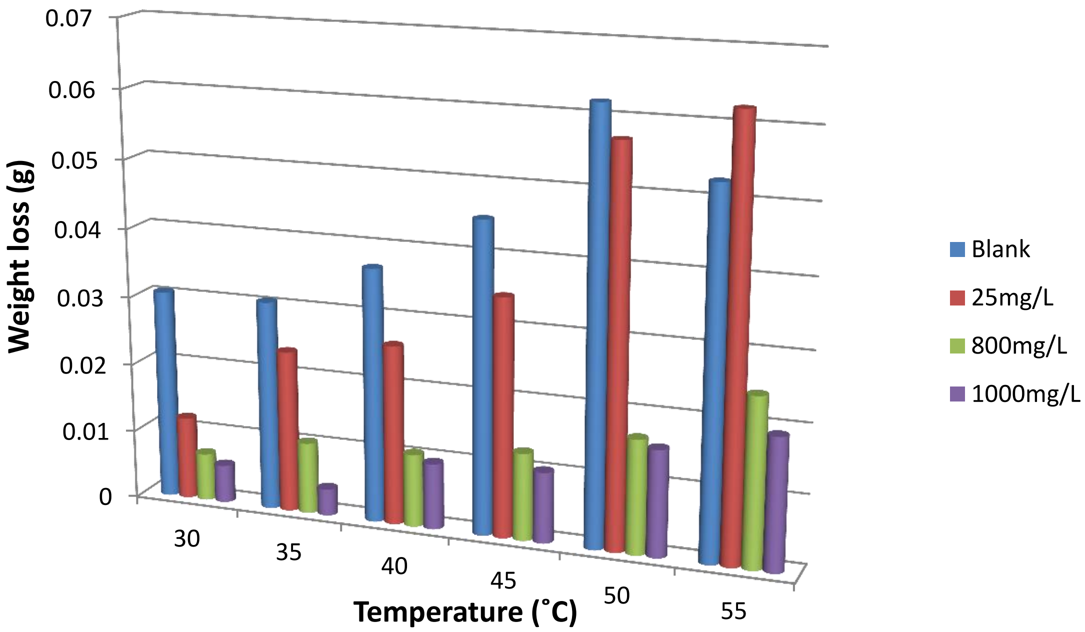

Figure 7.0: Weight loss (g) against temperature (˚C) of mild steel corrosion using 1.0M HCl

Table 5: Temperature increase with decrease in Inhibition efficient (IE)

Temperature (T)	Inhibition efficiencies (IE)	Activation Energy (Ea)
30	4.150	21.20
35	2.010	22.54
40	0.092	23.60
45	0.060	24.20
50	0.038	25.30
55	0.24	26.17

DISCUSSION

Figure 1.0 to 4.0 shows the variation of the concentration (mg/L) against inhibition efficiencies (I.E) in 0.5M H_2SO_4 and 1.0M HCl. The result indicates that increase in concentration (mg/L) lead to an increase in the inhibition efficiency (I.E). The inhibition efficiency was seen to be higher in 0.5M H_2SO_4 than in 1.0M HCl because of the presence of synergistic effect of the sulphate anion in H_2SO_4.

While the effect of temperature on corrosion rate as seen in figure 5.0 to 7.0 for 0.5M $H_2SO_4$and 1.0M HCl showed an increase in the inhibition efficiency as the temperature increases but decreases at a point, this could be as a result of a shift in adsorption-desorption equilibrium towards desorption at higher temperature. While at sufficiently higher temperature the inhibition efficiency of the higher. While correspondingly 800mg/L and 100mg/L increase with increase in temperature. Increase in temperature as recorded in 0.5M H_2SO_4shows an indication of physical adsorption of inhibitor species into the surface of corroding metals. A similar trend was observed in 0.1M HCl at low concentration of the plant extract. The inhibition efficiency increase with increasing temperature which shows higher chemisorptions in 1.0M HCl.

The activation (Ea) showed an increase as the temperature increase while the inhibition efficiencies (IE) decrease as temperature increase. These could be due to physical

adsorption that occurs which cause decrease in the adsorption of the inhibitor on the mild steel as the temperature increase.
The enthalpy activation (ΔH *) and entropy of activation (ΔS*) for the corrosion of mild steel in the acid media was used as an index of the protection efficiency of the plant extract.

CONCLUSION

The plant extract of Eucalptus leave acts as a good corrosion inhibitor for mild steel in an acidic media. The highest value for the corrosion performance was achieved at higher concentration of 0.7g/l at a temperature of 55^0c.
The adsorption of the plant extract obeyed Longmuir absorption Isotherm.

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