EFFECTS OF *VERNONIA AMYGDALINA LEAF EXTRACT* ON THE CORROSION INHIBITION OF MILD STEEL IN DIL. *TETRAOXOSULPHATE* (VI) ACID (H_2SO_4)

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Abstract

Effects of *vernonia amygdalina* (bitter) leaf extract on the corrosion inhibition of mild steel in dil. Tetraoxosulphate (vi) acid has been studied. Weight loss method was used in which the test coupons, with known weight, were immersed in the test media; leaves extract of vernonia *amygdalina*, and dilute H_2SO_4, for a total exposure time of five days. The weight loss was measured at an interval of 24hours i.e. a day, and the corrosion penetration rate was determined. The result revealed that the rate of corrosion of mild steel in dilute H_2SO_4 increases with increase in the concentration of the acid and that the extract of leaves of *vernonia amygdalina* inhibits the corrosion of mild steel in dilute H_2SO_4. The inhibition efficiency of the extract increases with increase in the concentration of the extract. The inhibition was assumed to occur via adsorption of the inhibitor molecules on the metal surface.

Keywords: Corrosion inhibition, Mild steel, *Tetraoxosulphate* (vi) acid, Vernonia amygdalina.

INTRODUCTION

The environmental consequences of corrosion are enormous and its inhibition has been deeply investigated. It has been found that one of the best methods of protecting metals against corrosion involves the use of inhibitors; which are substances that slow down the rate of corrosion. (Abdallah, 2002,2004), Acharya and Upadyay, (2004); Abiola, etal, (2007); Eddy and Odemelam, (2009); Eddy, etal, (2009). Bendadou, etal (2009), Odeongenyi, etal (2009), Abdallah, (2004a). An inhibitor is usually added in small quantity in order to slow down the rate of corrosion through the mechanism of adsorption (Boyanzer and Hamonti, 2004).

Mild steel corrosion phenomenon has become important particularly in acidic media because of the increased industrial applications of acid solution, Ambrish, et al (2002, 2005). In order to reduce the corrosion of metals, several techniques have been applied. The use of inhibitors during acid pickling procedure is one of the most practical methods for protection against corrosion in acidic environment; Umoren et al, (2001).

Organic inhibitors are the most effective, cheap, available and affordable inhibitors. Most of the effective and efficient organic inhibitors are those compounds containing hetero-atoms in their aromatic or long carbon chain; Edddy and Manza (2009). To be effective, an inhibitor must displace water from the metal surface, interact with anodic or cathodic reaction sites to retard the oxidation and reduction corrosion reaction, and prevent transportation of water and corrosion active species. (Umoren etal, 2011). However, in the application of these inhibitors for corrosion control, factors such as cost, toxicity, availability and environmental friendliness are very important. (Nnabuk,2009); Okafor, Ebenso and Udofot, (2010); Arockia, Susai, Ganga, Amairaj and Naraynasamy, (2008). According to Ebenso et al, (2009), the last class of inhibitors (green inhibitors) are significant because they are non-toxic and do not contain heavy metals. Hence they are environmental friendly.

Experimental

Material preparation

The materials used for the study were mild steel sheet of composition (wt. %) C (0.4), Mn (0.9), P (0.04), Si (0.2), S (0.4), Cu (0.3), Cr (0.1), and Ni (0.11) and the rest Fe. The sheet was mechanically pressed-cut to form different coupons, each of dimension, 5x2x0.10cm. Each coupon was polished with different grades of emery paper of grit size 220 and above. The specimens were washed thoroughly with distilled water and dried to a temperature of 100^0C using heat treatment furnace; and was finally degreased with acetone. The specimens were allowed to cool before weighing using digital weighing machine to get the initial weight. The acid used for the study was dilute H_2SO_4 with molar concentrations of 0.5mole to 2.0moles. The molar concentration of the acid was calculated using the formula below:

$$Vc = \frac{MVZ}{10PS} \quad (1)$$

Where

Vc = volume of the concentrated acid to be diluted.

M = molarity of the diluted solution

Z = molar mass of the acid

V = volume of the container (beaker)

P = percentage composition of the solution

S = specific gravity

Preparation of Plant Extracts

Samples of *vernonia amygdalina* extracts used was obtained locally from Onweonwiya Izzi Local Government Area of Ebonyi State. The leaves were collected and used fresh that is not dried, sunned or allowed to undergo any other process. The leaves were plucked and ground immediately using manual grinding machine. To obtain the extract, the ground leaves which already contained some water were then placed in a sieve cloth and squeezed to discharge the extract laden solution into a container. This became the stock inhibitor solution from which measured volumes were purposely introduced into the acid solutions for experimentation. Inhibitor volumes of 20mls, 30mls, 40mls and 50mls were used in 0.5M, 1.0M, 1.5M and 2.0M concentrations of acid solution together with a control for 0.5M to 2.0M.

Chemical Analysis of Plant Extract

Samples of vernonia amygdalina extract used were analyzed and the following results obtained (wt. %): Cu (0.7), Zn (0.3), Cr (0.3), Fe (9.5), Mn (1.0), Na (12.40), S (0.67), and p (0.73). The aim of this analysis is to ascertain the elements contained in the extract that aid in preventing corrosion. It was discovered that some elements such as S, P and Cr react to form organic compounds such as glycoside-vernoniside, vernonium, sesquiterpes lactones that contributed to corrosion inhibition.

Weight-loss method

Each beaker represents environmental set up. The beaker was allowed for five days which is 120hrs. The specimens were cleaned with acetone and weighed, the difference in weight from the initial weight (before immersion in environment) noted. The difference between the initial and final weight is called weight loss W. The weight loss in the coupons removed after 24hrs, 48hrs, 72hrs, 96hrs, and 120hrs from each of the beakers were calculated using

$W = W_1 - W_2$

Where

W = weight loss

W_1 = initial weight

W_2 = final weight

The procedure was repeated for five days.

The corrosion penetration rate for each specimen was calculated using the formula below:

$$CPR = \frac{KW}{\rho At}(mpy) \qquad (2)$$

Where

K = 534 (constant)

W = weight loss (mg)

t = time (hr.)

A = area of the specimen (inch)

ρ = density (for Fe = 7.969(g/cm^3)

Results and Discussion

In figure 5.0 to 8.0 there are graphic illustrations of the corrosion rate of mild steel in different concentrations of H_2SO_4 containing various volumes of leaves extract of vernonia amygdalina and control. The plots of the corrosion rate with time revealed that the leaves extract of vernonia *amygdalina* exhibited much lower corrosion rate than the control (uninhibited) on mild steel coupons.

From fig. 5.0, variation of Corrosion Penetration Rate (CPR) with time for the corrosion of mild steel in various volumes of vernonia amygdalina leaves extract and 0.5M; it can be seen that in control the corrosion penetration rate of mild steel increases with increase in time. This is an indication that corrosion penetration rate of mild steel increases with time of contact. It was also observed that the addition of leaves extract of *vernonia amygdalina* to the corrodent brought about reduction in the corrosion penetration rate when compared to the control. This is an evidence of inhibition efficiency of the leaves extract of *vernonia amygdalina*. Fig. 5.0 equally showed that the best inhibition efficiency occurred when 50mls of leaves extract of *vernonia amygdalina* was introduced to the environment. This is an evidence that the corrosion penetration rate decreases with an increase in the concentration of the extract.

Fig. 6.0 variation of corrosion penetration rate(CPR) with time for the corrosion of mild steel in various volumes of *vernonia amygdalina* leaves extract and 1.0M H_2SO_4.

From fig. 6.0 it can be seen from the control that the increase in the concentration penetration rate of mild steel with time is more pronounced here than in fig. 5.0. This implies that increase in the concentration of the acid led to the increase in the corrosion penetration rate of mild steel. It was equally observed in fig. 6.0 that there was a reduction of corrosion penetration rate of mild steel when leaves extract of *vernonia amygdalina* was introduced. This shows that leaves extract of vernonia amygdalina inhibit corrosion irrespective of the increase in the concentration of the acid.

Figures 7.0 and 8.0 show the variations of corrosion penetration rate (CPR) with time for the corrosion of mild steel in various volumes of *vernonia amygdalina* leaves extract and 1.5M, 2.0M of H_2SO_4 respectively.

From the figures, it was observed that in the control, the corrosion penetration rate of mild steel continues to increase with the period of contact respectively. This indicate that the increase in the concentration of the acid led to the increase in the corrosion penetration rate with time.

From the figures, it was also observed that the addition of leaves extract of vernonia amygdalina to the corrodent still brought about decrease in the corrosion penetration rate of mild steel with time. This shows that the increase in the concentration of the acid does not stop corrosion inhibition of leaves extract of *vernonia amygdalina*, rather the efficiency of corrosion inhibition of the extract reduces with increase in time of contact and the concentration of the acid as was observed in all the graphs plotted.

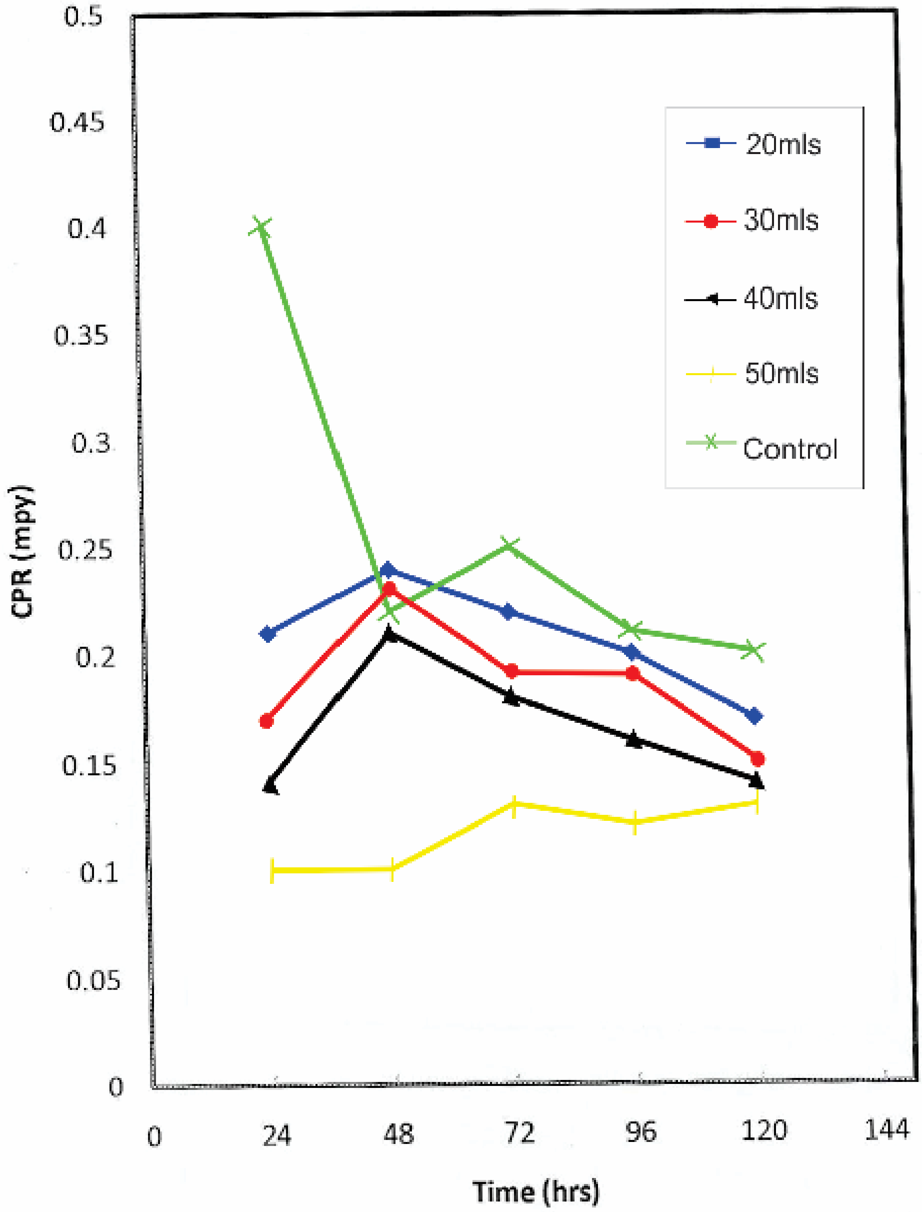

Fig. 5.0 Variation of CPR with time for the corrosion of mild steel in various volumes of vernonia amygdalina leaves extract and 0.5M H_2SO_4

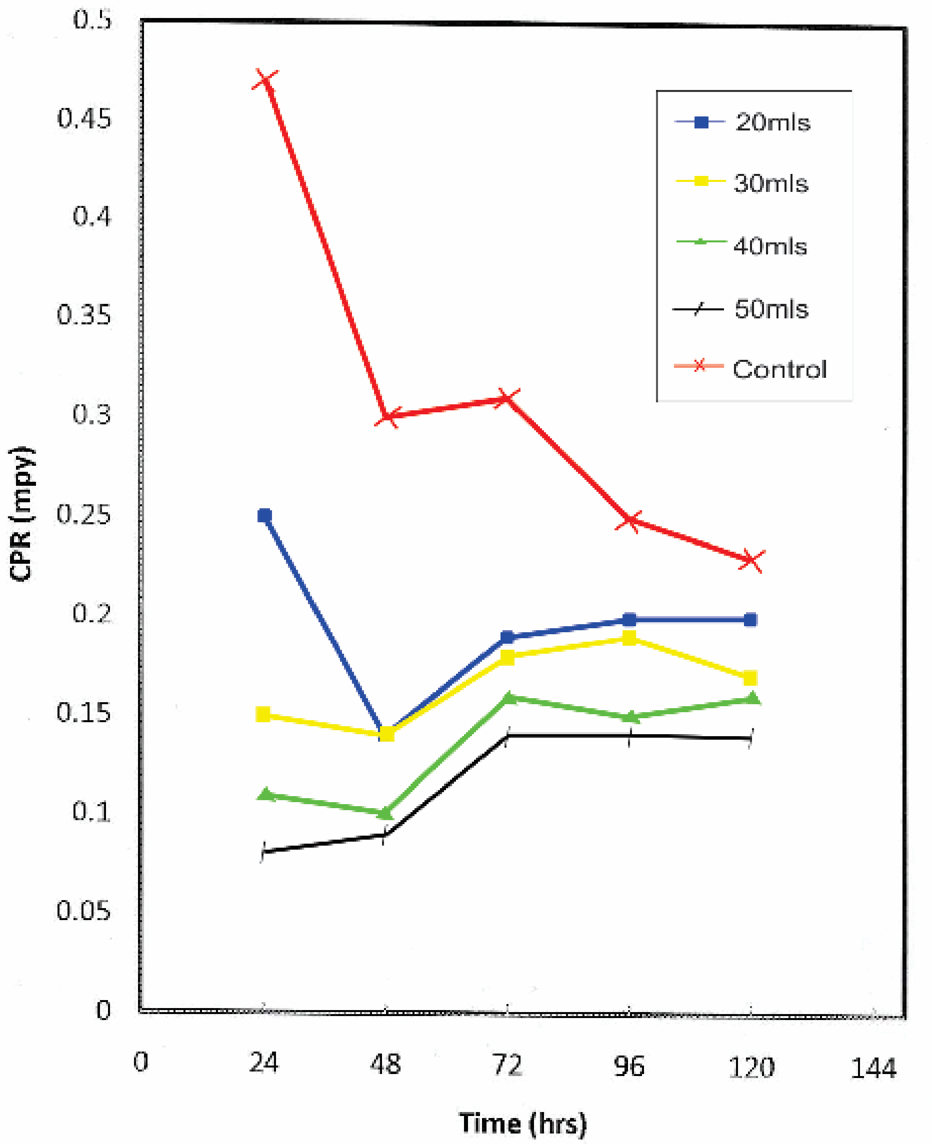

Fig. 6.0 Variation of CPR with time for the corrosion of mild steel in various volumes of vernonia amygdalina leaves extract and 1.0M H_2SO_4

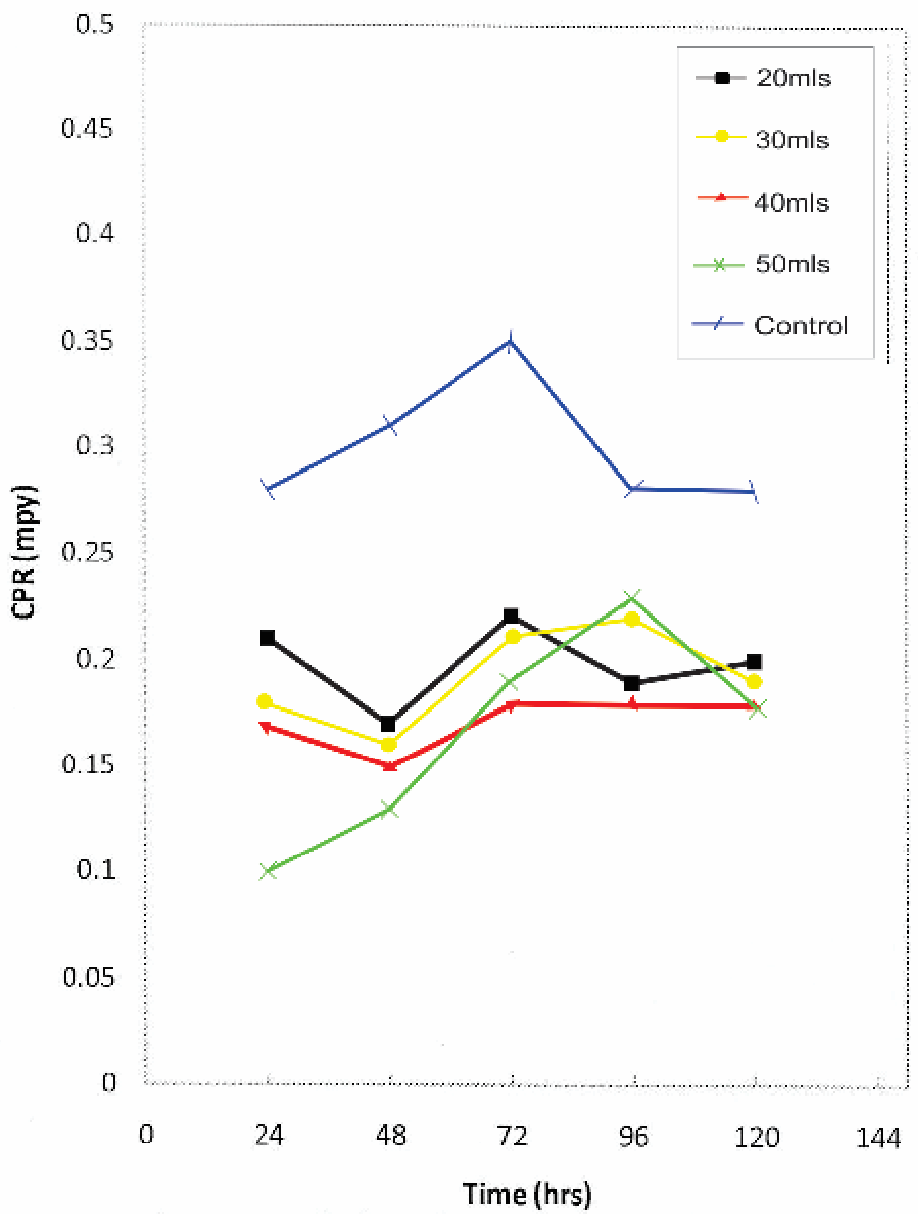

Fig. 7.0 Variation of CPR with time for the corrosion of mild steel in various volumes of vernonia amygdalina leaves extract and 1.5M H_2SO_4

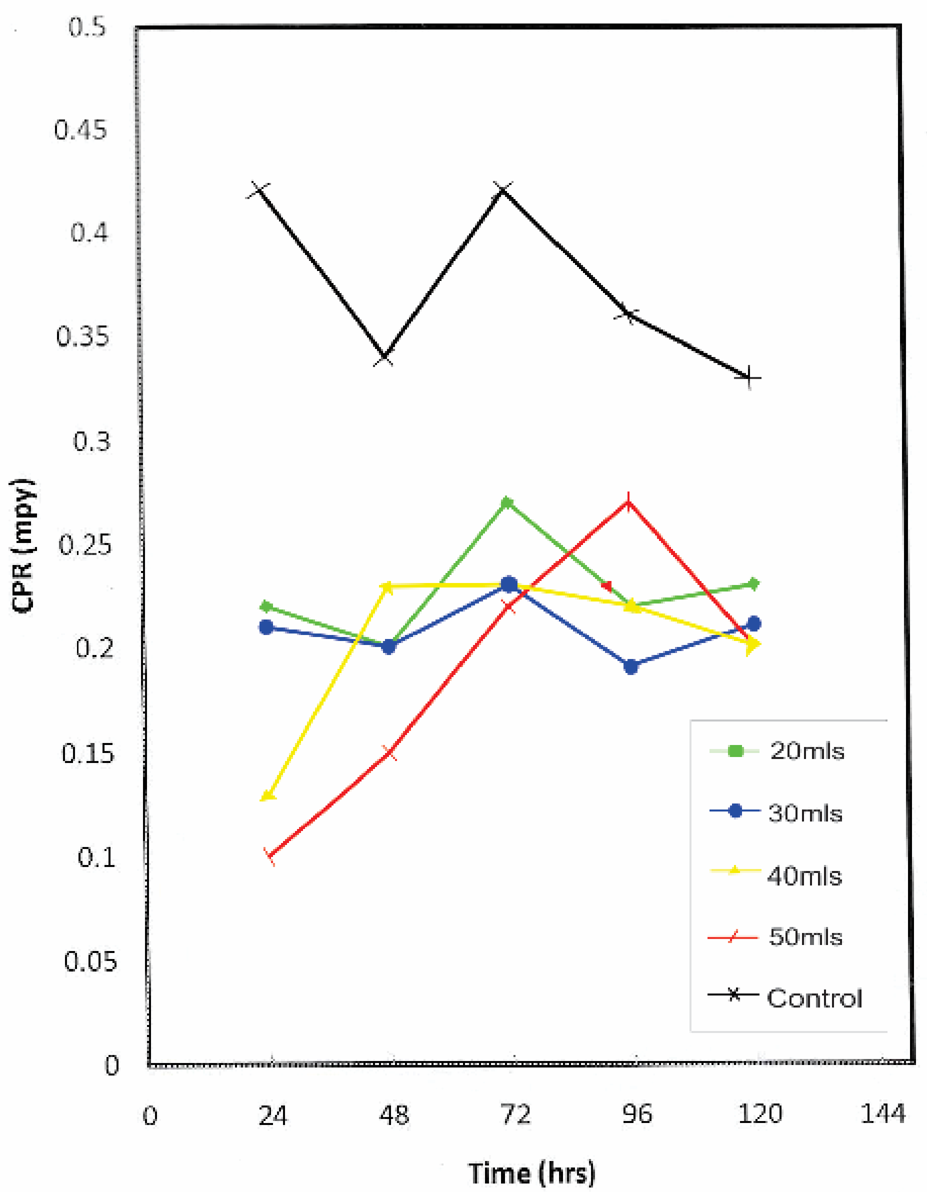

Fig. 8.0 Variation of CPR with time for the corrosion of mild steel in various volumes of vernonia amygdalina leaves extract and 2.0M H_2SO_4

CONCLUSIONS

In summary, the plots of the corrosion penetration rate with time revealed that the leaves extract of *vernonia amygdalina* exhibited much lower corrosion rate than the control (uninhibited) on the mild steel coupons.

It can be reasonably concluded that corrosion penetration rate of mild steel in dilute H_2SO_4 increases with time of contact but decreases with the increase in the concentration of the extract of *vernonia amygdalina*; an indication that the extract is a good adsorption inhibitor for mild steel in *tetraoxosulphate* (vi) acid.

In general, the best result was obtained when 50ml of leaves extract of *vernonia amygdalina* was introduced to the corrodent. This buttress the point that the inhibition efficiency of the extract increases with the increase in the concentration of the extract.

The research also shows that the inhibition of mild steel with the leaves extract of *vernonia* a*mygdalina* could afford a reasonable protection at the right dosage.

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