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The study of Corrosion inhibition of Mild Steel in 2.0 M Hydrochloric acid by avocado pear leaf extract.

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Abstract

Corrosion inhibition of mild steel in 2.0M HCl solution by extract from avocado pear leaf was investigated using weight loss method. It has been found that the extract acts as an effective corrosion inhibitor of mild-steel in hydrochloric acid as a corrodent. The inhibition process is attributed to the formation of an adsorbed film of inhibition on the metal surface which protects the metal against corrosion. The inhibition efficiency and surface coverage (Θ) of extract from avocado pear leaf increased with increase in inhibitor concentration. The adsorption of extract of avocado pear leaf on mild steel surface was found to obey Langmuir's adsorption isotherm. The negative free energy value (-ΔGads) indicates that the adsorption of inhibitor molecule was of physical adsorption and the reaction was spontaneous extract from avocado pear leaf could serve as an excellent corrosion inhibitor owing to the fact that it is eco-friendly, cheap, biodegradable and highly acceptable by environmental regulation.

Keywords: Avocado leaf, Corrosion Inhibition, temperature, Weight loss method.

Introduction

Mild steel is an alloy of iron which includes the following elements and their percentages: Carbon (0.05 – 0.15%), Silicon (0.18%), Phosphorous (0.04%), Sulphur (0.02%), Manganese (0.70 – 0.48%), and Iron, the rest of the composition (about 98.9%) (Emmanuel et al,2013). Mild steel remains one of the alloys that is heavily sort for in the industry because of its essential use. One of the most challenging and difficult task for industries are the protection of mild steel from corrosion. Corrosion of metals is a natural phenomenon which proceeds until inhibited. Since metals are used in different technological structures and in various environments, protection of metallic structures is pertinent (Karim et al, 2016). The use of mild steel as construction material in industrial sectors has become a great challenge for corrosion engineers or scientists nowadays. In practice, most of the acidic industrial applications such as refining crude oil, acid pickling, industrial cleaning, acid descaling, oil–well acid in oil recovery and petrochemical processes use mild steel as their material. Hydrochloric acid is one of the most widely used agents in the industrial sector (Hussin *et al*, 2016). Due to the aggressiveness of acid solution to mild steel, the use of inhibitor to prevent the metal dissolution process will be inevitable (Ostovari et al., 2009). Recent researches on corrosion inhibition had centred on natural inhibitors which are non toxic, eco friendly and readily available obtained from plants. Some of the evidences where bio-renewable green chemical were used for corrosion inhibitors are Carica papaya (Okoafor and Ebenso 2010) water hyacinth (Oloruntoba et al2012), bread food peel, Tinospora crispa (Hussin *et al*, 2016) Citrus aurantium leaves (Hassan *et al* 2016), Folic Acid (lawson et al, 2015), extract of red onion skin (James and Akarenta 2002), Karanj (Pongama pinnate) seed, (Singh *et al* 2011). Extracts of plant are used with variety of organic compounds containing heteroatoms like phosphorus, nitrogen, sulphur and oxygen have been investigated on their green corrosion inhibition properties. These atoms coordinate with the corroding metal atom (their ion) through their electron and prevent corrosion by formation of protective layer on the metal surface. The purpose of the study is to reveal the use of extract from avocado pear leaf to inhibit the corrosion of mild steel in hydrochloric acid.

Preparation of Mild Steel Coupon

Mild steel sheets with composition, (C, 0.16-18%, Mn 0.7-0.9%, P 0.0 4%, Si 0.40% and S, 0.04%) were obtained from the Engineering workshop of the university of Port Harcourt Choba Rivers State Nigeria. They were cut into 4cm/3cm sizes of 1.0mm thickness. The coupons were perforated at the top centre with holes of diameter 2.0mm to allow passage of thread. They were mechanically cleaned and scrubbed with sandpaper to expose shining surfaces, degreased in absolute ethanol and dipped in acetone and finally dried in an oven at 40^{o}C. Dried coupons were stored in desiccators before use. The initial weight of the coupons was taken, using an analytical weighing balance. Each weight was an average of three replicate measurements

Preparation of the extract

The avocado pear leaves were collected from a farm sun dried and grinded into powdery form, the grinded dried leaves were put into the conical flask and soaked in ethanol for 24 hours. The pure extract was obtained using a sieve.

Weight loss measurement

The rectangular mild steel specimens of dimension 4cm/3cm sizes of 1.0mm thickness were immersed (complete immersion) in 100 mL of deaerated electrolyte in the absence and presence of different concentrations of the extract at different temperature of 303 K, 303K and 323K. The weight loss of mild steel specimens was determined after 24 hours of immersion for the duration of 7 days. The following formulas were used to calculate some essential parameters to aid decision on the level of inhibitions.

$$\text{Inhibition Efficiency (IE\%)} = \frac{W_B - W_i}{W_B} \times \frac{100}{1} \quad (1)$$

$$1\text{- Surface coverage } (\theta) = \frac{W_i}{W_B} \quad (2)$$

$$\text{Longmuir adsorption isotherm, } \frac{C}{\theta} = \frac{1}{K_{ads}} + C \quad (3)$$

$$\text{Freundlich adsorption isotherm, } \theta = K_{ads.}\, C^{-n} \quad (4)$$

$$\text{Gibbs free energy, } K_{ads} = 1/55.5\, e^{(-dG/RT)} \quad (5)$$

Where θ is the surface coverage, IE is the inhibitor efficiency, C is the inhibitor concentration, W_i & W_b, weight of coupon in presence and absence of inhibitors, K_{ads}

Results

	Concentration/ Days	1	2	3	4
i	20ml HCl	114.0g	113.8g	113.6g	113.3g
ii	10ml extract +5ml HCl	109.2g	103.1g	101.0g	100.0g
iii	20ml extract +10ml HCl	106.7g	102.5g	99.3g	97.2g
iv	30ml extract +15ml HCl	100.5g	96.1g	94.4g	93.3g
v	40ml extract + 30ml HCl	98.4g	98.0g	97.0g	94.1g

Discussion

The result shown above indicates the inhibition efficiency of the extract from avocado pear leaf based on concentration of the extract and the acid solution which serves as a corrodant with the use of a mild-steel. The results generally showed that the extract from avocado pear leaf is a corrosion inhibitor for mild steel in Hydrochloric acid solution since there was a general decrease in weight loss with increase in the concentration of the extract. The decreasing weight loss from day one to day four is correspondent to the increase or volume of the extract that is, increase in the volume of the extract per day showed an observable trend of decrease in the weight of the mild steel. However, weight loss of the mild steel is an indication that corrosion is being checked.

Extract from avocado pear leaf can be considered as a source of relatively cheap, eco-friendly, biodegradable and effective acid corrosion inhibitor**.**

Conclusion

Avocado pear leaf extract has been found to be an effective inhibitor for mild steel in 2.0M HCl. This research exploited the weight loss method and the maximum inhibition efficiency, as the increase in the volume of the extract resulted to the reduction of weight of the mild steel in the acidic medium. This is otherwise known as green corrosion inhibitor.

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