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Pineapple Crown Extract As Green Inhibitor for Steel 39 in Acidic Media

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Abstract - The development of green corrosion inhibitors are highly demanded because of the increasing demand of green chemistry in the area of science and technology. Use of plant extracts as corrosion inhibitors has attracted significantly attention. The present study investigates corrosion inhibition of pineapple crown extract for steel 39 in 1M H_2SO_4 and 1M HCl. The weight loss method is used for inhibitor efficiency testing. The inhibition efficiency of inhibitor increases with the increases of concentration of inhibitor. Use of this inhibitor in concentration 3g/L present protection efficiency 82.88 % for steel 39 in aggressive media. The results present that pineapple crown extract is a good choice for steel 39 and environment, too.

Keyword: pineapple crown extract, corrosion inhibitor, steel 39, weight loss method

1. Introduction

Carbon steel due to its mechanical properties and low cost is the preferred material for constructions. Amongst the various ways of mitigating corrosion, the use of chemical compounds as green corrosion inhibitors is one of the most cost-effective corrosion mitigation strategies for carbon steel [1]. The non-toxic nature of the majority of the plants and their extracts makes them a viable replacement option for toxic organic inhibitors. Many known inhibitors contain heteroatoms such as O, N and S, and multiple bonds in their molecular structures. These chemicals are adsorbed onto the metal surface, thus forming a protective layer that prevents corrosive agents from contacting with the metal [2, 3]. In this paper, organic inhibitor extracted from the crown of pineapple was chosen to investigate the inhibition performances for the mild steel 39 in 1M H_2SO_4 and 1M HCl solution, using weight loss method.

2. Experimental

Corrosion tests were performed on steel 39, manufactured in Elbasan, intending for concrete armor with the following percentage composition:

Table 1: Composition of low alloy carbon steel tested

Elements %	C	Si	Mn	Cr	Ni	Cu	P	S
Steel 39	0.37	0.17	0.51	0.60	0.60	0.30	0.040	0.040

2.1 The environment

The aggressive solutions (1M H_2SO_4 + 1M HCl) were prepared from 96% sulfuric acid and 37% HCl, with a density of 1.83 g/cm^3; taking 5.4 ml H_2SO_4 and 8.3 ml HCl. The environment in which we will experiment steel 39, in addition to 1M H_2SO_4, also contains 1M HCl. The extract used is pineapple crown extract and the concentrations used are: 1g/L; 2g/L; 3g/L.

2.2 Preparation of the extract

To prepare the extract, we first dried the pineapple crown in a thermostat at 40ºC, grinding it finely to increase the contact surface. For the preparation of the alcoholic extract, 20 g of pineapple crown was taken and we poured 3 times into it 200 ml of 70 % ethyl alcohol, then we put it in a magnetic mixer for 6 hours and filtered the extract. The extract was then left for the alcohol to evaporate up until 1/4 of the amount and was placed for storage in the refrigerator, as it should be stored at 4°C and in the dark.

$$C_{ekstr} = \frac{A-B}{C} = \frac{20-15.23}{0,1025} = 46,536\ g/l \qquad (1)$$

Corrosive acid solutions for steel 39 were prepared while keeping in mind this concentration of the extract.

2.3 Weight loss measurements:

This is a simple method through which the weight loss of the material under study is estimated by calculating its corrosion rate in mm/year and inhibition efficiency according to the relevant formulas [4, 5]:

$$V_{(mm/vit)} = \frac{87.6 \cdot \Delta m}{d \cdot A \cdot t} \qquad (2)$$

Where: Δm - the difference of weight in mg;
d- the density in g/cm^3;
A - the surface of sample in cm^2;
t - the time of exposure of the sample in hours

The percentage of inhibition efficiency (IE %) was calculated as follows [6]:

Inhibitor Efficiency (%) = [(CR uninhibited – CR inhibited)/ CR uninhibited] x 100 (3)

Cylindrical samples of iron B500 and steel 39 were prepared on a lathe, with a length of 38 ± 4 mm and a diameter of 7 ± 1mm. On the top of them we drilled a hole with a diameter of 3 mm as shown in Figure 1.

Figure1: Preparing of the sample for the weight loss measurements

The samples were polished with P200-P1200 polishing paper and labelled by creating a pair for each concentration of the extract.

Their further purification was done with urotropin, distilled water and acetone in an ultrasonic bath for 5 minutes and then they were weighed on electronic scales with an accuracy of up to 4 digits after the comma.

After purification the samples were placed in chemical beakers with and without the presence of the inhibitor. The samples were removed from the corrosive environment after 3 hours.

The cleaning of corrosion products is done in an ultrasonic bath with the solution prepared from the mixture with a ratio 1: 1 HCl and water in which we have dissolved 1g urotropin, then via distilled water and acetone for 5 minutes.

Table 2: Composition of solution for weight loss measurements

Nr.	Blank	Concentration of pineapple crown extract (g/L)			
		1	2	3	4
1	+				
2	+	+			
3	+		+		
4	+			+	
5	+				+

3. Results And Discussions

Inhibition efficiency of the mild steel 39 was determined in the presence and absence of the pineapple crown extract and the results are shown in Table 3:

Table 3: Corrosion rate, surface coverage and protection efficiency of pineapple crown extract in 1M H_2SO_4 and 1M HCl solution for steel 39.

Sample	Media	Corrosion rate (mm/vit)	θ (surface coverage)	Inhibition Efficiency (%)
1	Blank (1M H_2SO_4/1M HCl)	1.363	0	0
2	1g/L	0.456	0.665	66.5
3	2g/L	0.303	0.777	77.7
4	3g/L	0.316	0.768	76.8
5	4g/L	0.33	0.758	75.8

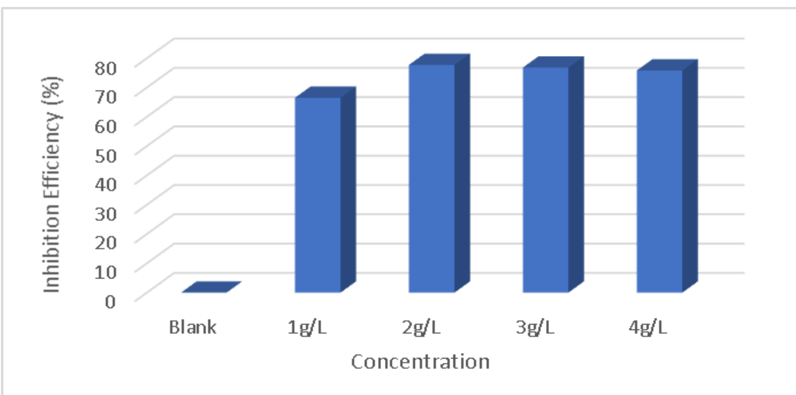

Figure 2: Inhibition efficiency in varius concentration of inhibitor

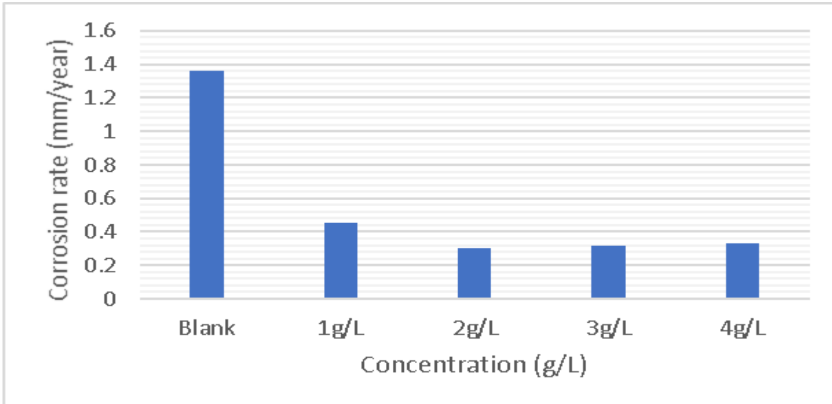

Figure 3. Corrosion rate in various concentration of inhibitor

From the weight loss results, it was observed that the corrosion rate of the mild steel decreases on increasing the concentration of the extracts up to 3 g/L as is shown in Figure 3. The best inhibitor efficiency for steel 39 in 1M H2SO4 and 1M HCl at 3 hours was 76.8 % which corresponding 3 g/L pineapple crown extract, Figure 2. The presence of diverse phytochemical, polyphenols, constituents in the extracts is also responsible for the inhibitive effects of the pineapple crown extract [7]. The inhibitory performance of the pineapple crown extract dependent from the increase of concentration of extract, more polyphenol molecules are being adsorbed on to the surface of steel 39, enhancing more uniform surface coverage, which decreases the surface area that is available for direct attack on the metal surface and consequently reduced the corrosion rate [8, 9, 10].

4. Conclusions

For steel 39 it can be seen that up to the concentration of 3 g/L we have an increase of inhibition efficiency, while in higher concentrations we have an oversupply of the surface with inhibitor and as a result we do not have an increase of inhibition efficiency.

According to the weight loss method the corrosion rate for steel 39 decreases from 1.363 mm/year to 0.33 mm/year. Steel 39 in a H_2SO_4 1 M and HCl 1 M solution for an extract concentration of 3 g/L has an effectiveness of 76.8%.

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