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Inhibitive Influence of Carica Papaya and AzadirachtaIndica Leaves Extracts on the Corrosion of Mild Steel in H_2SO_4 Environment.

J.C. Ugwuoke[1] and N. I. Amalu[2]
[1]*Department of Metallurgical and Materials Engineering, Enugu State University of Science and Technology, Enugu, Nigeria.*
[2]*Engineering Research, Development and Production Department, Projects Development Institute (PRODA), Enugu.*
Corresponding Author: J.C. Ugwuoke

Abstract:- *The inhibitive influence of pawpaw (carica papaya) and neem (azadirachtaindica) leaf extracts on the corrosion of mild steel in H_2S0_4 environment at normal temperature has been investigated. The study was carried out using the weight loss technique. The results obtained show carica papaya and azadirachtaindica leaves extracts as potential inhibitors of mild steel corrosion in H_2S0_4 environment. The result revealed that the rate of corrosion of mild steel in H_2S0_4 increases with increase in the concentration of the acid and that the leaves extracts inhibits the corrosion of mild steel in H_2S0_4 via adsorption of the inhibitor molecules on the metal surface. The inhibition efficiency of the extracts increases with increase in the concentration of the extracts. The best result was obtained with 60ml of (CP+AI) leaves extracts as inhibitors with an inhibition efficiency of 92.20%. The poorest inhibition efficiency (11.71%) came from the inhibition with 10ml AI leaves extracts. The inhibition efficiency of the leaves extracts follows the trend (CP+AI) > CP > AI.*

Keywords: *Azadirachtaindica, Carica papaya, Corrosion, Inhibitors, Weight loss techniques.*

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I. INTRODUCTION

Corrosion may be described as the deterioration of a material, (usually metals) and their properties arising from its interaction with its environment. Corrosion impairs materials usefulness by deterioration of its mechanical properties such as ductility and strength [1].

Corrosion commonly occurs at the metal surface in the presence of oxygen and moisture, involving two electrochemical reactions. Oxidation takes place at the anodic site and reduction occurs at the cathodic sites. Corrosion problems have received considerable amount of attention because of their economic and safety consequences [2]. The corrosion behavior of carbon steel in acidic solution is a subject of pronounced practical significance considering its wide application mainly in the manufacture of pipeline for petroleum industries. Mild steel finds a variety of application industrially, in mechanical and structural purposes, like bridge work, building, boiler plates, steam engine parts and automobile. These applications occur under severe corrosion in aggressive environment, and needs to be protected [3].

The corrosion of metals in many industries, constructions, installations and civil services such as electricity, water and sewage supplies is a serious problem. In order to prevent or minimize corrosion, inhibitors are usually used especially in flow cooling system. Organic, inorganic or a mixture of both inhibitors can inhibit corrosion by either chemisorption on the surface or reacting with metal ions and forming barrier type precipitate on its surface. [4,5,6,7]

II. EXPERIMENTAL PROCEDURE

2.1 Equipment

The equipment used in this work include beakers(1200ml), volumetric flask(250ml), funnels, round bottom flask(1000ml), measuring cylinder (1000ml), nylon thread, hacksaw, metre rule, caliper, metalwork vice, electronic weighing machine, emery paper, mortar and pestle, filter papers, pH meter.

2.2 Materials and Methods

The experiments were performed with a flat mild steel bar from Aladja steel company, Delta State, Nigeria. The compositional specification of the mild steel (in wt%) are as follows: 0.35 C, 0.90 Mn, 0.40 P, 0.20 Si, 0.04 S, 0.25Cu, 0.10 Ni, 0.20 N, and the remainder iron. The mild steel bar was machined into coupons of thickness 0.5mm and dimension 3cm x 4cm with the geometric surface area of $12cm^2$. Small grooves of 1mm were made on each sides of the dimension for suspension. A fine grade of emery paper was used to abrade the specimen before washing in distilled water, then rinsed with acetone and spread on a clean glass for drying. The dried coupons were weighed and the initial weight was recorded, consequently, stored in an air – tight desiccators prior to use.

Inhibitors

The two plant extracts used as inhibitors in this study were.

a. Neem (Azadirachtaindica leaves extracts)

b. Pawpaw (Carica papaya leaves extracts)

Fresh leaves of the above different plants were harvested and washed with cold tap water and ground using a manual grinding machine, squeezed to obtain corresponding extracts without the addition of water, then filtered. 10ml, 20ml, 30ml, 40ml, 50ml, 60ml set of the filtered different plants extracts were weighed with an electronic weighing machine.The aggressive solution used was of analytical grade with percentage assay of 98%. Acetone $(CH_3)_2CO$ from BDH with 99.5% assay. The appropriate concentration of acid was prepared using distilled water. Different concentrations were preparedfrom concentrated H_2SO_4 acid, the volume of diluted acid per cm^3 was worked out using the following relation:

V_c = $M V_D Z / 10PS$

V_c = Volume of concentrated acid to be diluted

M = Molarity of diluted acid

V_D = Volume of distilled water which dilution is to be made ($1dm^3 = 1000cm^3$)

Z = The molar mass of the substance ($H_2SO_4 = 98$)

P = Percentage assay of solute (98%)

S = Specific gravity of $H_2SO_4 = 1.84$

The prepared coupons were labeled and immersed into aggressive solutions with and without inhibitors and the pH measurement of the solutions were taken and recorded. After the withdrawal of the coupons, they were rinsed in distilled water, swabbed in acetone, air dried, and weighed. The difference in weight was recorded as the weight loss.

III. RESULTS AND DISCUSSIONS.

The corrosion of mild steel in different concentration of H_2SO_4 (1M and 2M) in the presence of an inhibitive plant extracts of carica papaya or azadirachtaindica at room temperature were investigated and the weight loss per day for seven days were summarized together with the media pH in tables 1 and 2 and figures 3 to 10. The result obtained from this experiment showed that the weight loss of mild steel coupons in H_2SO_4 solution increases with increase in acid concentration and pH decreases. The weight loss for 2M of H_2SO_4 is several times more than those obtained for either 1M of H_2SO_4. This could be due to the increased concentration of sulphate ions in the acid solution which readily destroy the passive nature of the mild steel surface.

Table 1: Corrosion rate and inhibition efficiency data obtained from weight loss measurements for mild steel in 1M H_2SO_4 with various concentrations of inhibitors for7 days.

Inhibitor concentration (ml)	Corrosion rate (mm/y)	Inhibition efficiency (%)	Surface coverage (θ)
0.0	9.1344	—	—
10 CP	8.8853	2.73	0.0273
20 CP	8.6086	5.76	0.0576
30 CP	8.3561	8.52	0.0852
40 CP	7.7227	15.45	0.1545
50 CP	7.7329	15.34	0.1534
60 CP	7.4804	18.11	0.1811
10 AI	8.9783	1.71	0.0171
20 AI	8.8012	3.65	0.0365
30 AI	8.5521	6.37	0.0637
40 AI	8.2997	9.14	0.0914
50 AI	8.0473	11.90	0.1190
60 AI	7.6044	16.75	0.1675
10 (CP+AI)	5.5248	39.52	0.3952
20 (CP+AI)	1.7160	81.21	0.8121
30 (CP+AI)	4.9768	45.52	0.4552
40 (CP+AI)	1.2178	86.67	0.8667
50 (CP+AI)	1.6473	81.97	0.8197

60 (CP+AI)	1.2798	85.99	0.8599

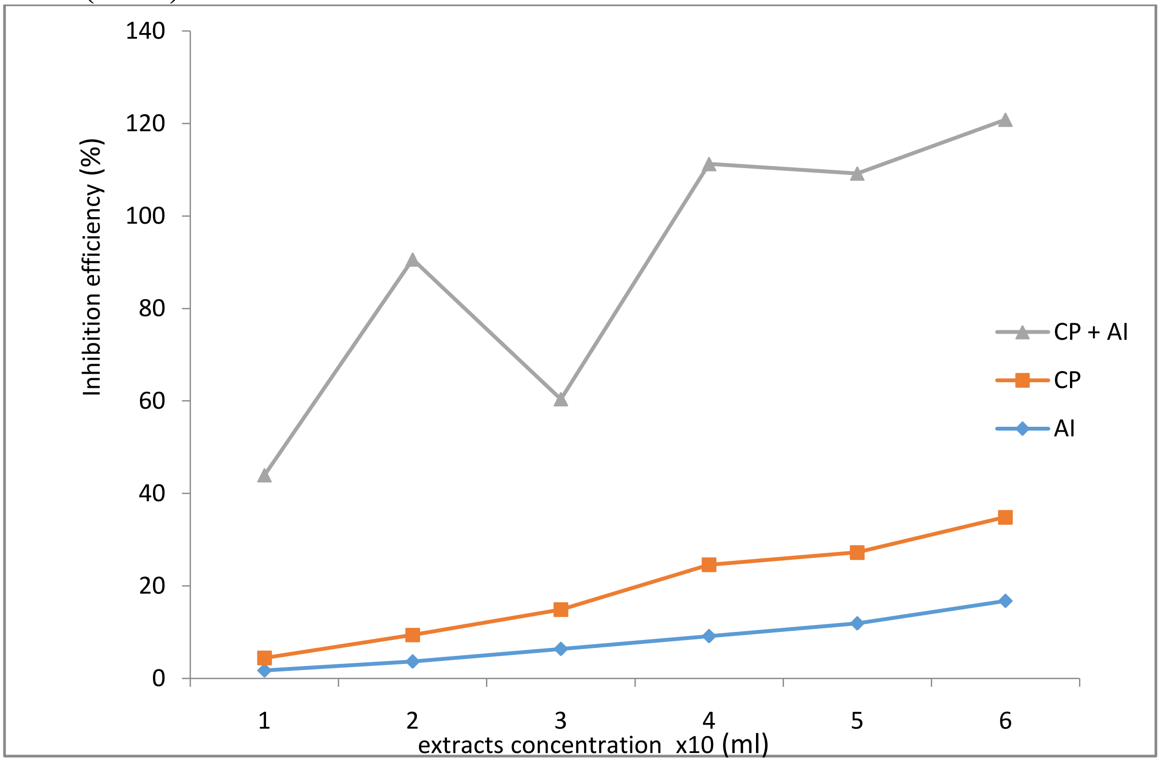

Figure 1: Variation of inhibition efficiency with extracts concentration for mild steel coupons in 1M H_2SO_4 solution.

Table 2: Corrosion rate and inhibition efficiency data obtained from weight loss measurements for mild steel in 2M H_2SO_4 with various inhibitors concentrations for 7 days.

Inhibition concentration (ml)	Corrosion rates (mm/y)	Inhibition efficiency (%)	surface coverage (θ)
0.0	22.1585	—	—
10 CP	11.0341	50.20	0.5020
20 CP	10.5138	52.55	0.5255
30 CP	9.3481	57.81	0.5781
40 CP	8.0008	63.89	0.6389
50 CP	5.8248	73.71	0.7371
60 CP	4.4349	79.99	0.7999
10 AI	12.2447	44.74	0.4474
20 AI	10.7784	51.36	0.5136
30 AI	10.4989	52.62	0.5262
40 AI	8.8687	59.98	0.5998
50 AI	7.2026	67.50	0.6750
60AI	5.4307	75.49	0.7549
10 (CP+AI)	19.3737	52.59	0.1257
20 (CP+AI)	17.7186	55.62	0.2004
30 (CP+AI)	4.7122	78.73	0.7873
40 (CP+AI)	9.4217	70.48	0.5748
50 (CP+AI)	3.3898	84.70	0.8470
60 (CP+AI)	1.7287	92.20	0.9220

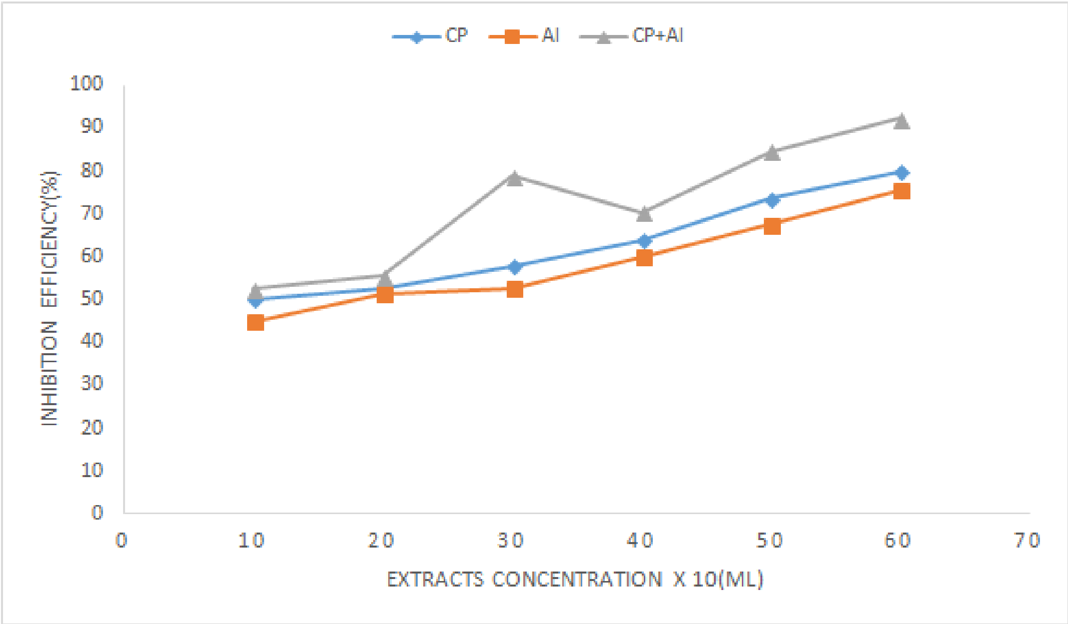

Figure 2: Variation of inhibition efficiency with extracts concentration for mild steel coupons in 2M H_2SO_4.

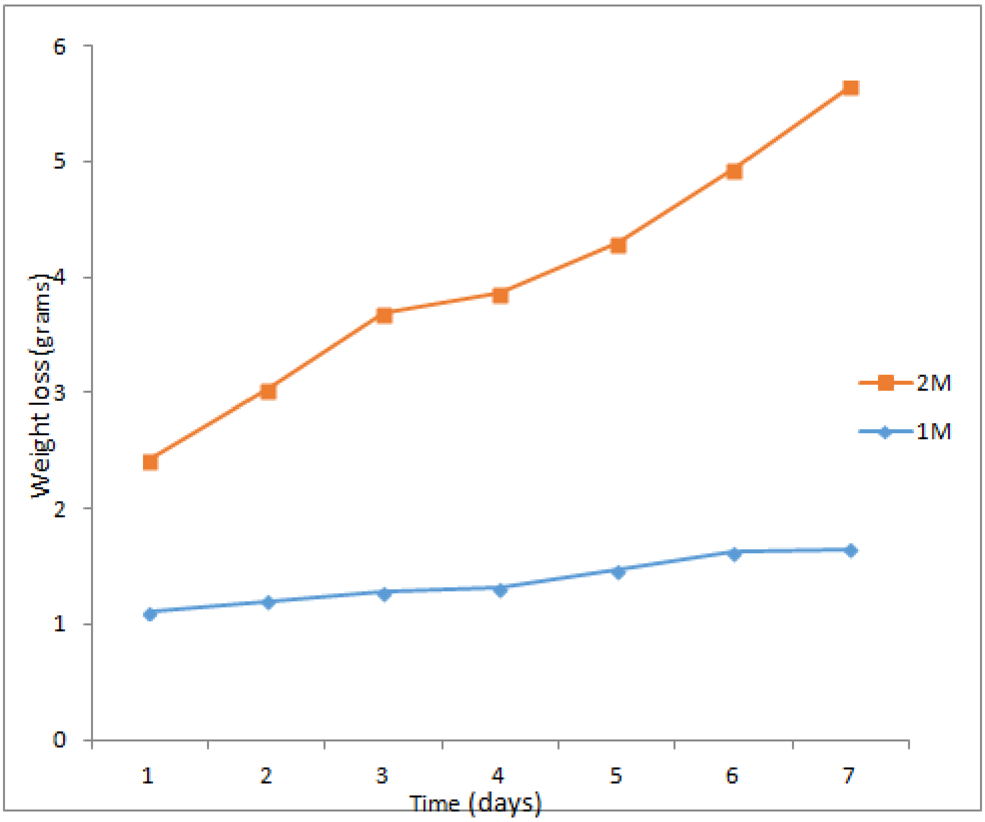

Figure 3: Variation of weight loss with time for the corrosion of mild steel in different concentration of H_2SO_4solution without inhibitor

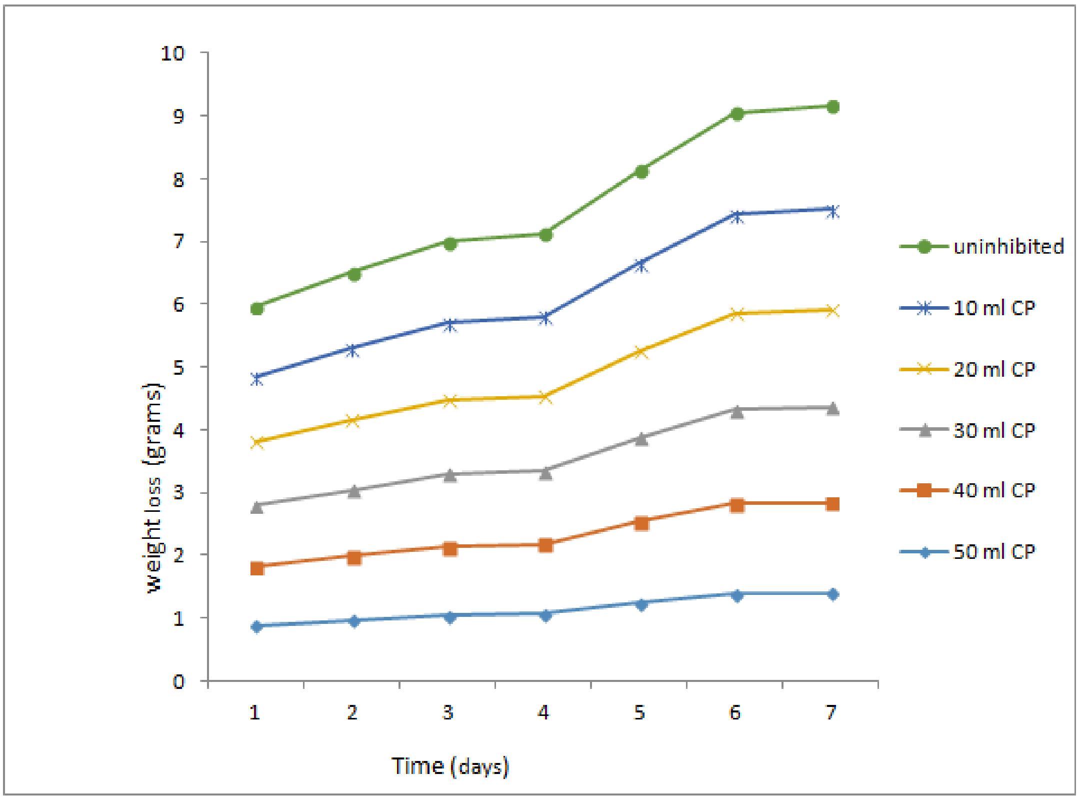

Figure 4: Variation of weight loss with time for the corrosion of mild steel in different concentrations of CP inhibitors in 1M H_2SO_4

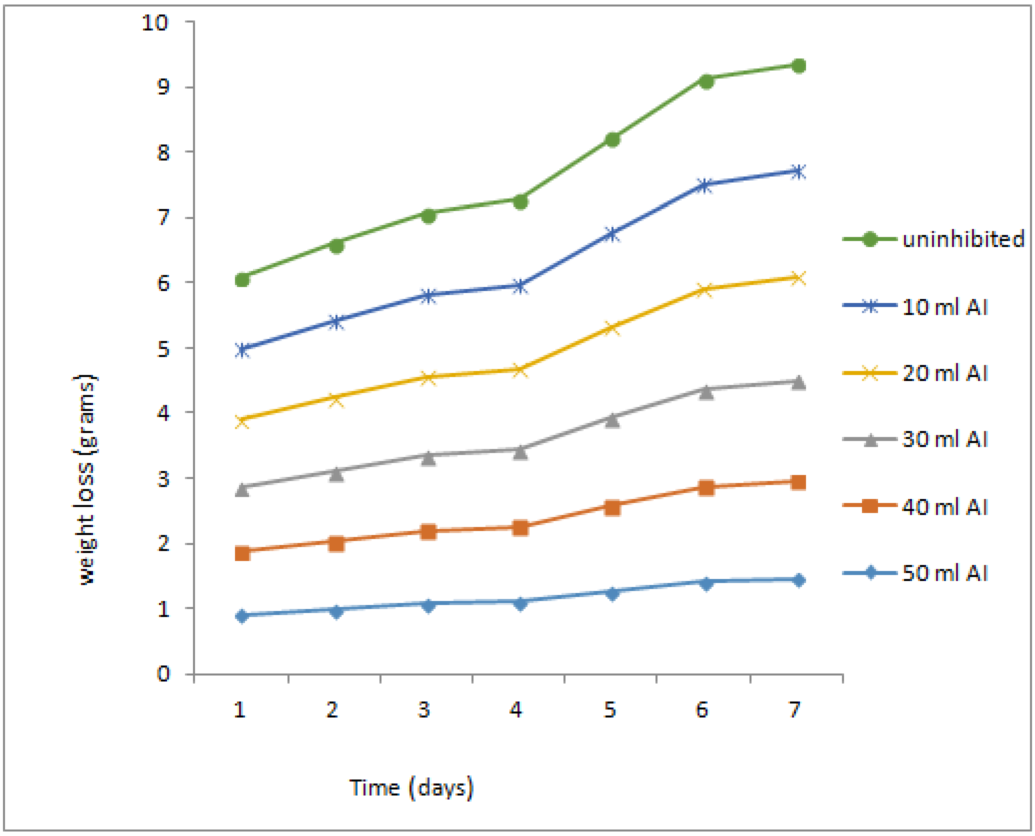

Figure 5: Variation of weight loss with time for the corrosion of mild steel in different concentrations of AI inhibitors in 1M H_2SO_4

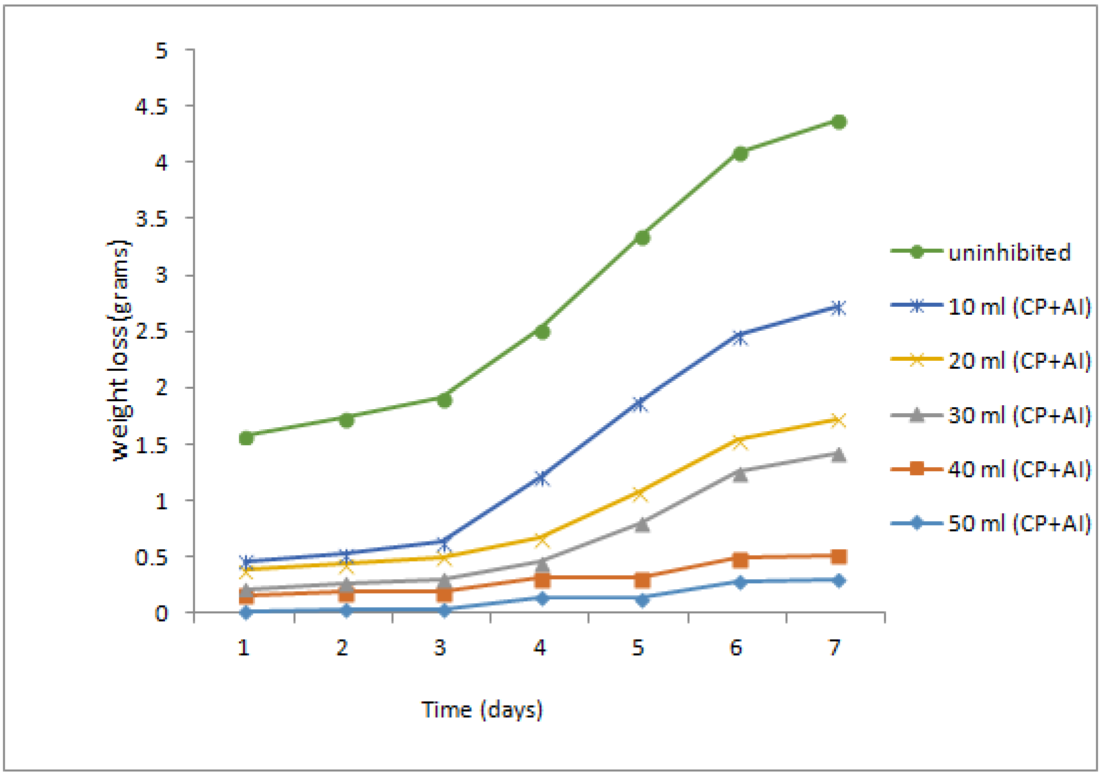

Figure 6: variation of weight loss with time for the corrosion of mild steel in different concentrations of (CP+AI) inhibitors in 1M H_2SO_4

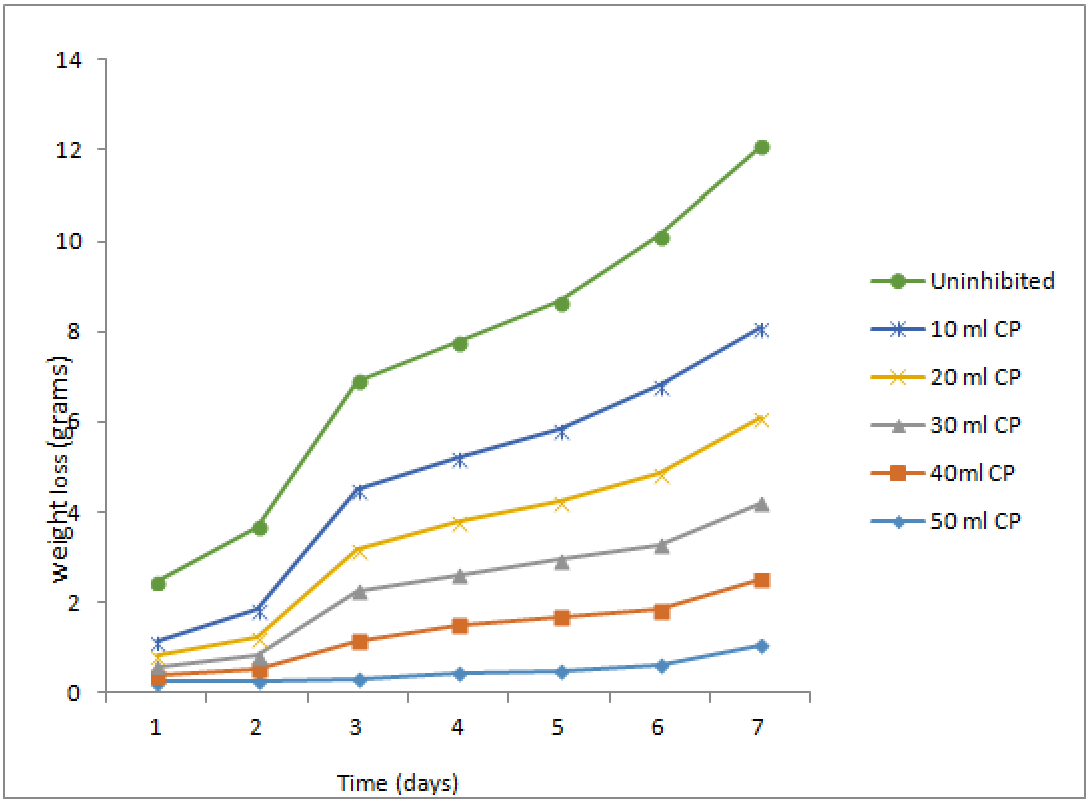

Figure 7: Variation of weight loss with time for the corrosion of mild steel in different concentrations of CP inhibitors in 2M H_2SO_4

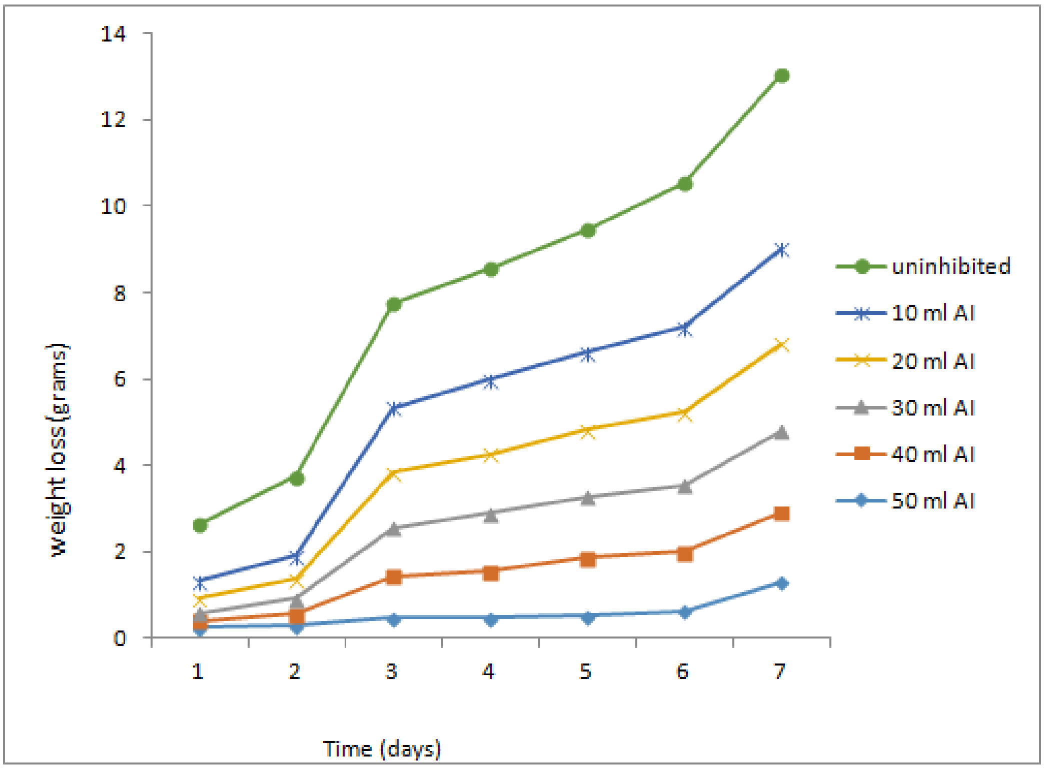

Figure 8: Variation of weight loss with time for the corrosion of mild steel in different concentrations of AI inhibitors in 2M H_2SO_4

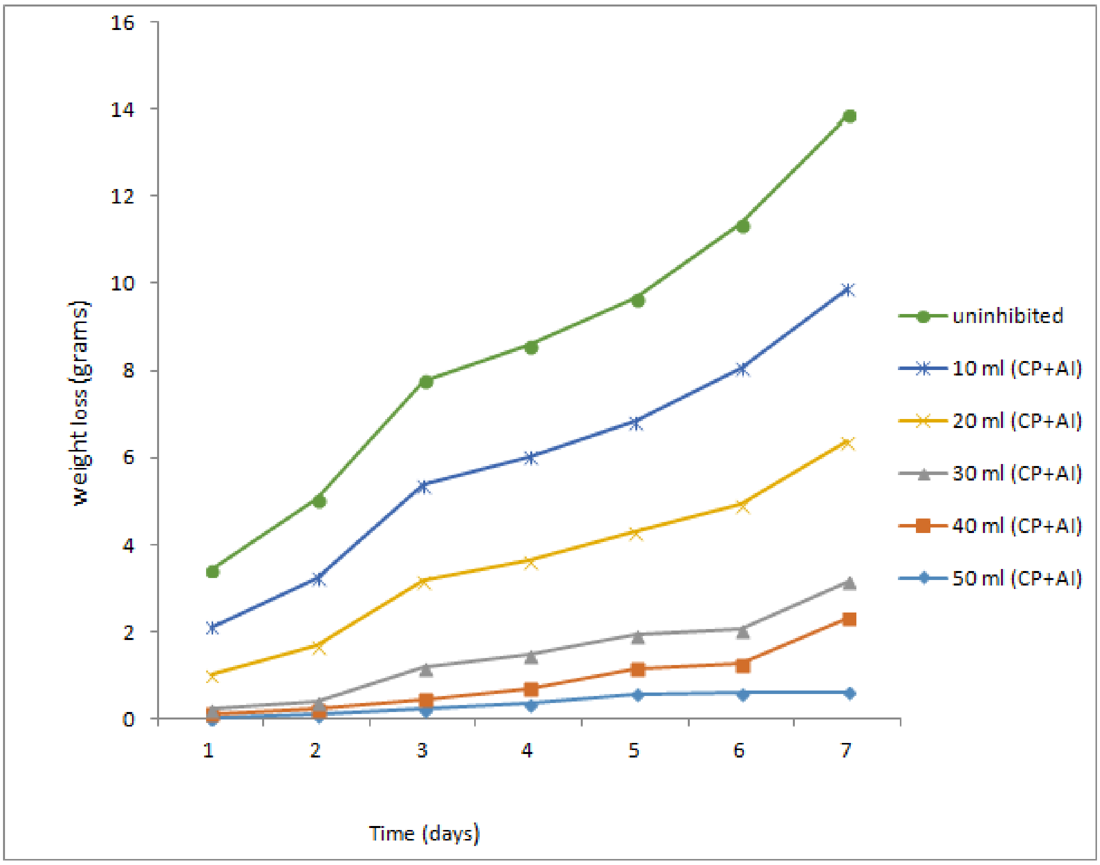

Figure 9: Variation of weight loss with time for the corrosion of mild steel in different concentrations of (CP+AI) inhibitor in 2M H_2SO_4

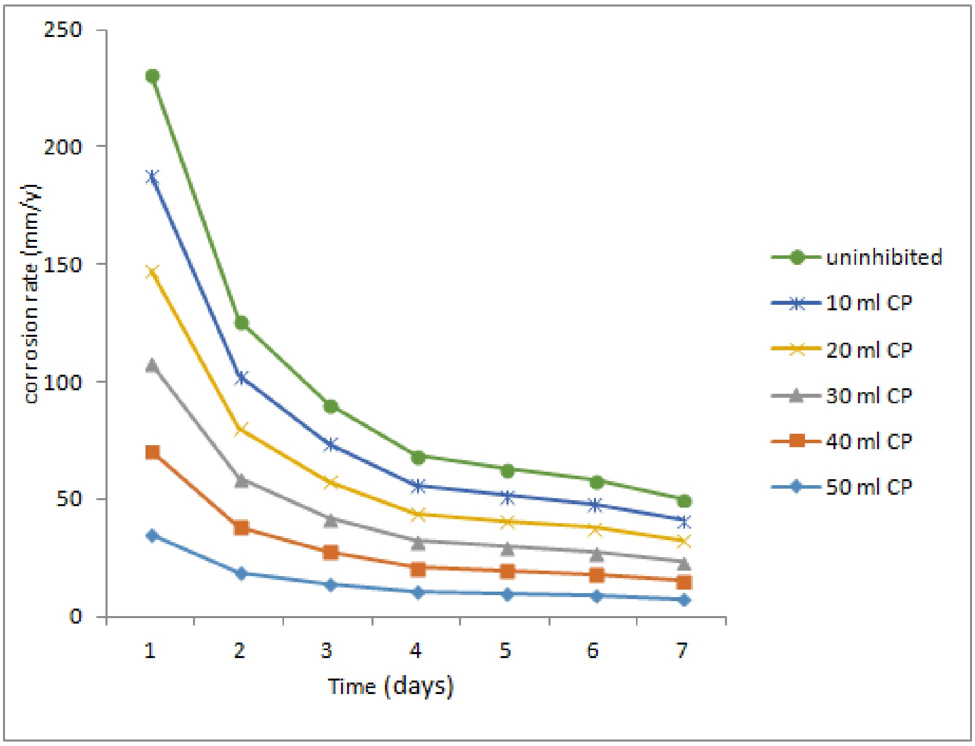

Figure 10: Variation of corrosion rate with time for the corrosion of mild steel in different concentrations of CP inhibitors in 1M H_2SO_4

Figure 3 shows variation of weight loss of mild steel with time in 1M H_2S0_4 solution without inhibitor and weight loss of mild steel with time in 2M H_2S0_4 solution without inhibitor. It can be seen that the corrosion of mild steel increases as the concentration of the corrodent increases. Several authors have also reported that the increase in corrosion rate with concentration may be attributed to the increase in concentration of the active ion in the corrosion reaction.[5,6,7,8]

At the initial period when the coupons were immersed into the beakers containing corrodent, it was observed that the coupons were rapidly attacked by the corrodent, which afterwards maintain its uniform attack throughout the coupon. The reason is that when the coupons were immersed, immediately the active sites of the corrodent attacked them greatly but with time the corrodent was uniformly distributed throughout the coupons thereby making them move from active sites to passive sites in the media. As these happen, the corrosion rate decreases in the media.With 2M H_2SO_4, all the mild steel coupons were attacked severely compared with that of 1M H_2SO_4 because moresulphuric acid which deteriorate the arrangement of the compositions of mild steel coupons was introduced. This increases the corrosion rate of the mild steel coupons immersed in the media.

Figure 10 shows variation of corrosion rate of mild steel with time in 1M H_2SO_4 solution with 10ml carica papaya as inhibitor. The corrosion rate with 10ml pawpaw extract is lower compared to corrosion rate of mild steel with time in 1M H_2SO_4 solution without inhibitor. This is also true and likewise at 2M H_2SO_4.

The results obtained from this study clearly showed that the inhibition efficiency increases with concentration of the extracts which indicated that the inhibition mechanism is due to chemical adsorption of the molecular components of carica papaya and azadirachtaindica leaves extracts on the surface of the metal.

Also, combination of the two leaves extracts as inhibitor produced a superior inhibition efficiency greater than the sum of their separate inhibition efficiency.The highest inhibitor concentration that is 60ml of carica papaya, azadirachtaindica and (carica papaya + azadirachtaindica) leaves extracts for 1M of H_2SO_4 has inhibition efficiency of 18.11%, 16.75% and 85.99% respectively.

The highest inhibitor concentration that is 60ml of carica papaya, azadirachtaindica and (carica papaya + azadirachtaindica) leaves extracts for 2M of H_2SO_4 has inhibition efficiency of 79.99%, 75.49% and 92.20% respectively.The lowest inhibitor concentration that is 10ml of carica papaya, azadirachtaindica and (carica papaya + azadirachtaindica) leaves extracts for 1M of H_2SO_4 has inhibition efficiency of 2.73%, 1.71% and 39.52% respectively.The lowest inhibitor concentration that is 10ml of carica papaya, azadirachtaindica and (carica papaya + azadirachtaindica) leaves extracts for 2M of H_2SO_4 has inhibition efficiency of 50.20%, 44.74% and 52.59% respectively.

The inhibition efficiency of carica papaya is higher than the inhibition efficiency of azadirachtaindica, whereas the inhibition efficiency of the leaves extracts synergy that is (carica papaya + azadirachtaindica) is higher than the inhibition efficiency of carica papaya leaves extracts.
Hence, the inhibition efficiency of the studied plants leaves extracts follows the trend AI < CP < (CP + AI).

IV. CONCLUSION

Acids are used for drilling operations, pickling baths and in descaling process and other process where mild steels are involved. Mild steel suffers from severe corrosion in aggressive environment and it has to be protected.
An environmentally acceptable, inexpensive, readily available, renewable source of materials and ecological acceptable inhibitors has been considered as good inhibitors.
The inhibitor efficiency of all the extracts increased with increase in extract concentration.

1. The best result was obtained with 60ml of (CP+AI), that is 30ml each of carica papaya and azadirachtaindicaleaves extracts as inhibitors with an inhibition efficiency of 92.20%.
   The poorest inhibitor efficiency 44.74% came from the inhibition with 10ml of AI (azadirachtaindica) leaves extracts.
2. Saponins, Tannins, Flavonoids, Alkaloids, Glycosides present in carica papaya and azadirachtaindica are responsible for the reduction of the corrosion rate of mild steel in H_2S0_4.
3. The inhibitor efficiency of all the extracts increased with increase in extract concentration until maximum inhibitor efficiency was obtained.
4. The inhibitive performance of the organic inhibitors could be enhanced in synergism.

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