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Corrosion Inhibition Efficiency of Mixture of Rubber (*Hevea Brasiliensis)* Leaf and Corn Cob (*Zea Mays*) Extracts on Mild Steel in Sulphuric Acid Solution

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Abstract: *The inhibition efficiency of the mixtures of rubber leaf and corn cob extracts on the corrosion of mild steel in 1M H_2SO_4 acid solution was studied at room temperature using weight loss, AAS method and FTIR methods. The mixture of Rubber leaf and corn cob extracts inhibited the corrosion of mild steel in 1M H_2SO_4 solution and the inhibition efficiency was found to increase with increasing concentration of the extract. The results also showed that at 0.1g, 0.2g, 0.3g, 0.4g, 0.5g plant extract concentrations, 89.5%, 95.2%, 96.4%, 96.8% and 98.2% inhibition efficiency was obtained respectively. The weight loss analysis showed an increase of 1.94g in the absence of the extract but in the presence of 0.5g of the extract it decreases the mild steel to 0.04g. The AAS analysis showed an Iron ion (Fe^{2+}, Fe^{3+}) concentration of 1427.04mg in the absence of the extract concentration but in 0.5g of the extract the concentration, it decreases to 384.56mg. The mixture of rubber leaf and corncob was found to be a good inhibitor of mild steel corrosion in acidic medium.*
It was recommended that the mixed extract should be used to test inhibitory effect on different metals and in higher concentrations of sulphuric acid.

Keywords: *Corrosion, Rubber leaves, Corn cob, Inhibition, Mild Steel, Metal coupon*

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I. Introduction

Corrosion is a spontaneous deterioration of the physical and chemical state of a material or metal due to the reaction with its environment (Osarolube *et.al.,*2004). The deterioration of metal by chemical attack or reaction with the environment called corrosion, is a constant and continues problem often difficult to eliminate completely (Eddy *et. al.*, 2009). This is because corrosion processes develops fast after disruption of the protective barrier of the corroding material and are accompanied by a number of reactions that changes the composition and properties of both the metal surface and the local environment. For example formation of oxides, diffusion of metal cations into the coating matrix and the local pH changes (Cao *et. al.,* 2000). Nowadays, most important considerations in the industries are reduction of overall costs of protection and maintenance of material used.

Metallic oxidation is the most prevalent most researched and most taught form of corrosion. Corrosion by oxidation involves a process in which a metallic material reacts with oxygen and followed by water to form a thermodynamically more stable compound. With respect to corrosion, this process is colloquially called rusting. Deterioration of materials can also occur through reactions with other species in the environment including sulphur, hydrogen, and light. (Anthony, 2015).

Corrosion inhibitors are compounds that are added in small quantities to an environment to prevent corrosion of metal (Sathiyanarayanan *et. al.*, 2005). Recent interest on corrosion inhibition focuses on non toxic and environmental friendly inhibitors due to their quality requirement (Eddy and Ebenso, 2008). Several inorganic and organic compounds have been utilized commercially for corrosion protection with high inhibition efficiencies recorded. Plant based inhibitors are cheaply processed, non toxic and biodegradable, often constitute waste and are readily available (Ji *et. al.*, 2015). Several research works on the potential of plants based material as corrosion are well documented in the literature. Plants that have been reported to have inhibitory properties in acidic medium are *Tithonia diverstifolia* (Alamene and Olusegun, 2012), *Murraya umbellate* (Alamene *et. al.*, 2015), *Psidium quajava* (Noyel *et al*, 2015), *Sida acuta* (Eduok *et. al.*, 2012), *Hibiscus sabdariffa calyx* (Nnabuk *et. al.*, 2012). Among several others are plant sourced inhibitors which have recorded varied levels of success. There are still continued interests in this subject, particularly the investigation of plant sources with less competitive alternative uses such in chemical and pharmaceutical application (Alamene et. al., 2015).

Awe *et. al.* (2015). investigated the inhibitive ability of bitter leaf (*vernonia amygdalina*) root extract on corrosion of mild steel in 1.5M Sulphuric acid solution using weight loss, hydrogen evolution and thermometric measurements at temperature ranges of 30-60^{o}C. The result showed the extracts contained some organic compounds which are responsible for the inhibitive ability. The corrosion rate of the mild steel in the presence of the inhibitor decreases with increase in the temperature. The inhibitor exhibit excellent inhibition efficiency on mild steel corrosion in H_2SO_4 solution as 90%, 84.82 %,79.65 % and 76.90 % of inhibition efficiency achieved with addition of 0.5 g/l concentration of the bitter leaf root extract at 30^{0}C, 40^{o}C, 50^{o}C and 60^{o}C temperatures respectively.

The inhibition of mild steel in 0.5 M H_2SO_4 solution by *Achyranthes aspera* L. leaves was also investigated at room temperature. The results revealed that corrosion inhibition efficiency increases with increase in inhibitor concentration in the order of 85.8 % < 86.9 % < 89.1 % < 91.2 % < 92.4 %. The result obtained also showed that mass loss increases with increase in plant extract concentration as follows: 0.029 g, 0.034 g, 0.039 g, 0.041 g and 0.050 g. (Francis *et. al.*, 2013). Shitu *et. al.* (2014) investigated the effect of polystyrene on the corrosive behaviour of HCl and H_2SO_4 on mild steel using weight loss technique. The result revealed that corrosion of mild steel decreased with increase in concentration of polystyrene as 36.7, 25.1, 24.8, 23.5, and 19.5 for HCl and 17.1, 15.2, 13.8, 12.2 and 11.9 for H_2SO_4. The result also shows that corrosion inhibition efficiency increases with inhibitors concentration as 90.0%, 85.1%, 74.0%, 59.1% and 46.0% for HCl and 84.1%, 78.0%, 68.3%, 55.2% and 36.1% for H_2SO_4. The aim of this study is to determine the corrosion inhibition efficiency of mixture of rubber leaf (*Hevea brasiliensis*) and corn cob (*Zea mays*) extract on mild steel in acidic environment at room temperature using weight loss, AAS and FTIR analysis.

II. Materials And Methods

Materials: The materials used in this study include: Weighing balance (electronic compact scale SF- 4000), Ethanol (BDH Analar product of absolute 99% purity), Sulfuric acid (H_2SO_4) (DIC ANALAR product of specific gravity 1.84 and 98% purity), Methanol (50%), 2% HCl, 20% sodium carbonate (Na_2CO_3), 0.3% ammonium thiocyanate, Rubber thread, Mild steel coupon, AAS (C:/Program FileGBC Avanta ver. 2.02 analyst1 anl) Acetone (BDH.AnalaR product of 99.5% purity), Sample (dried grounded leaf of rubber tree and corn cob).

Sample Collection: Fresh leaves of rubber tree (*Hevea brasiliensis)* and corn cob (*Zea mays)* were collected from Bera village in Gokhana Local Government area of Rivers State, Nigeria.

Preparation of Sample Extract: The fresh leaves of rubber tree (*Hevea brasiliensis*) and corn cob (*Zea mays*) were washed with enough water, sun dried for few days and ground into powdered form using a grinding machine. About 400g of the pulverized sample were measured and soaked in 800ml of ethanol in a beaker and stirred for complete dissolution and allowed for 48hrs (2days). The mixture was then filtered using filter paper and funnel, the extracts of rubber tree and corn cob were then mixed together and the mixture was further subjected to evaporation in order to make the extract free of ethanol. The stock of the extract obtained was used in preparing different concentrations of the extract by dissolving 0.1 g, 0.2 g, 0.3 g, 0.4 g, 0.5 g of the extract in 1M H_2SO_4 respectively.

Mild Steel: Mild steel of composition: Iron (Fe) = 98.3%, Carbon(C) = 0.133%, Phosphorous (P) = 0.0061%, Manganese (Mn) = 0.82%, and Chromium (Cr) = 0.08% was used for this study (Alamene, *et. al.*, 2016).

Preparation of Metal Coupon: Mild steel of 0.2cm thickness used for the study were cut into 2cm by 2cm coupon size for weight loss analysis. The coupons were polished and brushed with silicon carbide paper (sand paper) and a hole was made at the center of each coupon with 2inches nail. The coupons were soaked in ethanol solution for 5 minutes for degreasing and rinsed with distilled water and acetone and were finally allowed to dry. This was necessary to prevent contamination before corrosion studies.

Preparation of 1M H_2SO_4: 1M H_2SO_4 was prepared by diluting 54.3 ml of stock H_2SO_4 with distilled water in 1000 ml volumetric flask and made up to the mark on the flask.

Preparation of Test Solution: The extract obtained were weighed and used to prepare different concentrations of the extract by diluting 0.1g, 0.2 g, 0.3 g, 0.4 g, and 0.5 g of the extract in 100ml of 1M H_2SO_4 respectively. Another 100ml of the 1 M H_2SO_4 was used as blank for preliminary test. The test solution was prepared as shown in Table 1 below.

Table.1. Percentage Extract of the Test Solution in 100ml 1M H_2SO_4

Weight (g)	**%Extract (w/v)**
Blank	0
0.1	0.1
0.2	0.2
0.3	0.3
0.4	0.4
0.5	0.5

Weight Loss Analysis: The mild steel coupons were weighed first using a weighing balance to get its initial weight and their respective grams were recorded. Each of the mild steel coupon were placed in different beakers containing different concentration of the test solution (0.1% w/v, 0.2% w/v, 0.3% w/v, 0.4% w/v and 0.5% w/v), rubber thread was used to suspend the mild steel into the test solution respectively at room temperature for 7days (168hrs). The coupons were retrieved from the test solution for every 24hrs interval by scrubbing the coupons with silicon carbide paper(sand paper) under running water, dipped in ethanol and acetone and allowed to dry, then the coupons were reweighed to determine the weight loss. The differences in the weight of the coupons were used as the weight loss. The essence of the scrubbing was to remove the films (coat) of inhibitor from the mild steel surface. The scrubbing was done with care to avoid wearing off of the metal.

Atomic Absorption Spectrometric (AAS) Analysis: Atomic absorption spectrophotometric analysis to determine the concentration of Iron ion in the acidic solution after gravimetric measurements was performed using atomic adsorption spectrometer model: GBC Avanta ver. 2.02\Analysis\anl. This was required to determine the concentration of Iron ion in the acidic solution after gravimetric measurements. The calibration curve of iron ions was drawn before analyzing the electrolyte solution. All samples containing iron ions were diluted with distilled water to ensure that the concentrations of metal ions are within the range of the calibration curve.

Fourier Transform Infrared Spectroscopy (FTIR) Analysis: The structural organization of the rubber leaf and corn cob extract was investigated to identify the functional group present using FTIR – Perkins Elmer Spectrum BX II model.

III. Results

Weight Loss Analysis: The results of the weight loss analysis obtained from different concentrations of mixture of Rubber leaf (*Hevea Brasiliensis*) and corn cob (*Zea Mays*) extracts at room temperature are presented in the Tables below. The results obtained from the corrosion of mild steel in 1M H_2SO_4 solution containing the extracts of the mixture of rubber leaf *(Hevea brasiliensis*) and corn cob (*Zea mays*) with the concentration range of 0.1-0.5 g/m from the weight loss measurement are presented in the Tables 7 to 12. Table 12 shows the summary table of inhibition efficiency of the extract on mild steel in 1 M H_2SO_4 at room temperature. Tables 2- 5 show the results from preliminary test.

Table 2: Mild steel coupon in water at room temperature

Time (hrs.)	Initial weight (W_I)	Final weight (W_F)	Weight loss(ΔW) $=W_I-W_F$	Change in weight $W_I-\Delta W$	Log of ($W_I-\Delta W$)	% inhibition efficiency	Surface coverage (ɵ)	Rate constant (K)(hr^{-1})
24	2.69	2.69	0	2.69	0.429			0.01533
48	2.69	2.66	0.03	2.66	0.425			0.00764
72	2.69	2.66	0.03	2.66	0.424			0.00517
96	2.69	2.66	0.03	2.66	0.424			0.00388
120	2.69	2.64	0.05	2.64	0.423			0.00312
144	2.69	2.63	0.06	2.63	0.419			0.00261
168	2.69	2.62	0.07	2.62	0.418			0.00225
Average	2.69	2.65	0.04	2.65	0.423			0.00571

Table 3: Mild steel coupon in ethanol at room temperature

Time (hrs.)	Initial weight (W_I)	Final weight (W_F)	Weight loss(ΔW) $=W_I-W_F$	Change in weight $W_I-\Delta W$	Log of ($W_I-\Delta W$)	% inhibition efficiency	Surface coverage (ɵ)	Rate constant (K)(hr^{-1})
24	2.68	2.61	0.07	2.61	0.4166			0.01574
48	2.68	2.59	0.09	2.59	0.4133			0.00793
72	2.68	2.58	0.1	2.58	0.4116			0.00531
96	2.68	2.56	0.12	2.56	0.4082			0.00401
120	2.68	2.56	0.12	2.56	0.4082			0.00401

144	2.68	2.54	0.14	2.54	0.4048			0.00696
168	2.68	2.52	0.16	2.52	0.4014			0.00233
Average	2.68	2.56	0.11	2.56	0.4092			0.00661

Table 4: Mild steel coupon in 2M H_2SO_4 at room temperature

Time (hrs.)	Initial weight (W_I)	Final weight (W_F)	Weight loss(ΔW) $=W_I-W_F$	Change in weight $W_I-\Delta W$	Log of ($W_I-\Delta W$)	% inhibition efficiency	Surface coverage (ɵ)	Rate constant (K)(hr^{-1})
24	2.89	2.17	0.72	2.17	0.3365			0.02038
48	2.89	1.54	1.35	1.54	0.1875			0.01435
72	2.89	0.96	1.93	0.96	-0.0177			0.01536
96	2.89	0.42	2.49	0.42	-0.3979			0.01152
120	2.89	0	2.89	0	-			-
144	2.89	0	2.89	0	-			-
168	2.89	0	2.89	0	-			-
Average	2.89	0.72	2.17	0.72	0.0155			0.00880

Table 5: Mild steel coupon in 3M H_2SO_4 at room temperature

Time (hours)	Initial weight (W_I)	Final weight (W_F)	Weight loss(ΔW) $=W_I-W_F$	Change in weight $W_I-\Delta W$	Log of ($W_I-\Delta W$)	% inhibition efficiency	Surface coverage (ɵ)	Rate constant (K)(hr^{-1})
24	2.76	1.84	0.92	1.84	0.2648			0.01689
48	2.76	1.02	1.74	1.02	0.0086			0.02071
72	2.76	0.28	2.48	0.28	-0.5528			0.03179
96	2.76	0	2.76	0	-			-
120	2.76	0	2.76	0	-			-
144	2.76	0	2.76	0	-			-
168	2.76	0	2.76	0	-			-
Average	2.76	0.45	2.31	0.45	-0.0399			0.00993

Table 6: Mild steel coupon in 4M H_2SO_4 at room temperature

Time (hrs.)	Initial weight (W_I)	Final weight (W_F)	Weight loss(ΔW) $=W_I-W_F$	Change in weight $W_I-\Delta W$	Log of ($W_I-\Delta W$)	% inhibition efficiency	Surface coverage (ɵ)	Rate constant (K)(hr^{-1})
24	2.85	1.30	1.55	1.30	0.1139			0.03269
48	2.85	0.12	2.73	0.12	-0.9208			0.08171
72	2.85	0	2.85	0	-			-
96	2.85	0	2.85	0	-			-
120	2.85	0	2.85	0	-			-
144	2.85	0	2.85	0	-			-
168	2.85	0	2.85	0	-			-
Average	2.85	0.20	2.65	0.20	-0.1153			0.01634

Table 7: Mild steel coupon in 1M H_2SO_4 without inhibitor at room temperature

Time (hrs.)	Initial Weight (W_I)	Final Weight (W_F)	Weight loss(ΔW) $=W_I-W_F$	Change in Weight $W_I-\Delta W$	Log of ($W_I-\Delta W$)	% Inhibition efficiency	Surface Coverage (ɵ)	Rate Constant (K)(hr^{-1})
24	2.86	2.27	0.59	2.27	0.3560			0.009632
48	2.86	1.75	1.11	1.75	0.2430			0.01024
72	2.86	1.28	1.58	1.28	0.1072			0.01117
96	2.86	0.77	2.09	0.77	-0.1135			0.01368
120	2.86	0.37	2.49	0.37	-0.4318			0.01705
144	2.86	0.00	2.86	0.00	-			-
168	2.86	0.00	2.86	0.00	-			-
Average	2.86	0.92	1.94	0.92	0.0230			0.00882

Table 8: Mild steel coupon in 1M H_2SO_4 with 0.1g inhibitor

Time (hrs.)	Initial Weight (W_I)	Final Weight (W_F)	Weight loss(ΔW) =W_I-W_F	Change in Weight W_I-ΔW	Log of (W_I-ΔW)	% Inhibition efficiency	Surface Coverage (ɵ)	Rate Constant (K)(hr^{-1})
24	2.72	2.69	0.03	2.69	0.4298	94.9	0.9495	0.0004622
48	2.72	2.63	0.09	2.63	0.4199	91.9	0.9189	0.0006999
72	2.72	2.57	0.15	2.57	0.4044	90.5	0.9051	0.0007859
96	2.72	2.49	0.23	2.49	0.3962	88.1	0.8891	0.0009171
120	2.72	2.41	0.31	2.41	0.3820	87.6	0.8755	0.001009
144	2.72	2.34	0.37	2.34	0.3711	87.1	0.8706	0.001001
168	2.72	2.30	0.42	2.30	0.3617	85.3	0.8531	0.0009979
Average	2.72	2.49	0.23	2.49	0.3958	89.5	0.8945	0.000839

Table 9: Mild steel coupon in 1M H_2SO_4 with 0.2 g inhibitor

Time (hrs.)	Initial Weight (W_I)	Final Weight (W_F)	Weight loss(ΔW) =W_I-W_F	Change in Weight W_I-ΔW	Log of (W_I-ΔW)	% Inhibition efficiency	Surface Coverage (ɵ)	Rate Constant (K)(hr^{-1})
24	2.63	2.60	0.03	2.60	0.4149	94.9	0.9492	0.0004781
48	2.63	2.58	0.05	2.58	0.4116	95.5	0.9541	0.0003993
72	2.63	2.56	0.07	2.56	0.4082	95.6	0.9561	0.0003737
96	2.63	2.54	0.09	2.54	0.4048	95.5	0.9559	0.0003614
120	2.63	2.52	0.11	2.52	0.4014	95.6	0.9558	0.0003563
144	2.63	2.49	0.14	2.44	0.3962	95.1	0.9510	0.0003777
168	2.63	2.47	0.16	2.47	0.3927	94.4	0.9440	0.0003735
Averag e	2.63	2.54	0.09	2.54	0.4043	95.2	0.9523	0.0003886

Table 10: Mild steel coupon in 1M H_2SO_4 with 0.3 g inhibitor

Time (hrs.)	Initial Weight (W_I)	Final Weight (W_F)	Weight loss(ΔW) =W_I-W_F	Change in Weight W_I-ΔW	Log of (W_I-ΔW)	% Inhibition efficiency	Surface Coverage (ɵ)	Rate Constant (K)(hr^{-1})
24	2.68	2.66	0.02	2.66	0.4248	96.6	0.9661	0.0003122
48	2.68	2.64	0.04	2.64	0.4216	96.3	0.9631	0.0003128
72	2.68	2.63	0.05	2.63	0.4199	96.8	0.9684	0.0001955
96	2.68	2.61	0.07	2.61	0.4166	96.6	0.9761	0.0002747
120	2.68	2.54	0.04	2.54	0.4133	96.4	0.9639	0.0002848
144	2.68	2.57	0.11	2.57	0.4099	96.2	0.9615	0.0002894
168	2.68	2.54	0.14	2.54	0.4048	95.1	0.9510	0.0003192
Average	2.68	2.54	0.07	2.61	0.4157	96.4	0.9643	0.0002434

Table 11: Mild steel coupon in 1M H_2SO_4 with 0.4 g inhibitor

Time (hrs.)	Initial Weight (W_I)	Final Weight (W_F)	Weight loss(ΔW) =W_I-W_F	Change in Weight W_I-ΔW	Log of (W_I-ΔW)	% Inhibition efficiency	Surface Coverage (ɵ)	Rate Constant (K)(hr^{-1})
24	2.61	2.59	0.02	2.59	0.4133	96.6	0.9661	0.0003206
48	2.61	2.57	0.04	2.57	0.4099	96.3	0.9634	0.0003213
72	2.61	2.56	0.05	2.56	0.4082	96.8	0.9683	0.0002670
96	2.61	2.55	0.06	2.55	0.4065	97.1	0.9712	0.0002414
120	2.61	2.54	0.07	2.54	0.4048	97.2	0.9719	0.0002267
144	2.61	2.53	0.08	2.53	0.4031	97.2	0.9720	0.0002150
168	2.61	2.51	0.10	2.51	0.3997	96.6	0.9650	0.0002324
Average	2.61	2.55	0.06	2.55	0.4065	96.8	0.9683	0.0002606

Table 12: Mild steel coupon in 1M H_2SO_4 with 0.5 g inhibitor

Time (hrs.)	Initial Weight (W_I)	Final Weight (W_F)	Weight loss(ΔW) =W_I-W_F	Change in Weight W_I-ΔW	Log of (W_I-ΔW)	% Inhibition efficiency	Surface Coverage (ɵ)	Rate Constant (K)(hr^{-1})
24	2.85	2.84	0.01	2.84	0.4533	98.3	0.9831	0.0001465
48	2.85	2.83	0.02	2.83	0.4518	98.2	0.9810	0.0001465
72	2.85	2.82	0.03	2.82	0.4502	98,1	0.9810	0.0001466
96	2.85	2.82	0.03	2.82	0.4502	98.6	0.9856	0.0001098
120	2.85	2.81	0.04	2.81	0.4487	98.3	0.9834	0.0001179
144	2.85	2.80	0.05	2.80	0.4472	98.3	0.9825	0.0001222

168	2.85	2.78	0.07	2.78	0.4440	97.6	0.9755	0.0001480
Average	2.85	2.81	0.04	2.81	0.3915	98.2	0.9817	0.0001339

Table 13: Iron ions (Fe^{2+}, Fe^{3+}) concentrations in 1M H_2SO_4 at different concentrations of Rubber leaf extract from AAS analysis.

Acid medium	**Extract concentration (g)**	**Concentration of iron ion (Fe^{2+}, Fe^{3+})(mg)**
1 M H_2SO_4	Blank	1427.04
	0.1	1317.41
	0.2	575.11
	0.3	501.06
	0.4	390.50
	0.5	384.56

Table 14: Levels of various parameters measured at different concentrations of rubber leaf and corn cob extracts on mild steel in 1 M H_2SO_4 at room temperature.

Acid medium	Extract Concentration	Weight loss(ΔW) $=W_I-W_F$	Log of ($W_I-\Delta W$)	(%) Inhibition efficiency.	Surface coverage (ɵ)	Concentration Of Iron ion(Fe^{2+},Fe^{3+})(mg)
1M H_2SO_4	Blank	1.94	0.0230			1427.04
	0.1% g	0.23	0.3958	89.5	0.8945	1317.41
	0.2% g	0.09	0.4043	95.2	0.9523	575.11
	0.3% g	0.07	0.4157	96.4	0.9643	501.06
	0.4% g	0.06	0.4065	96.8	0.9683	390.50
	0.5% g	0.04	0.3915	98.2	0.9817	384.56

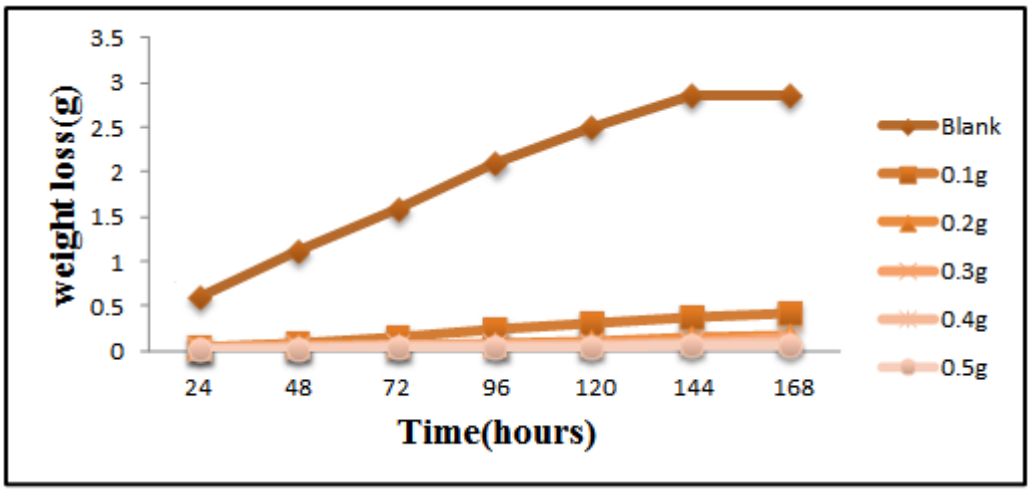

Fig. 1: Variation of weight loss with time for mild steel in 1M H_2SO_4 at different concentrations of extracts.

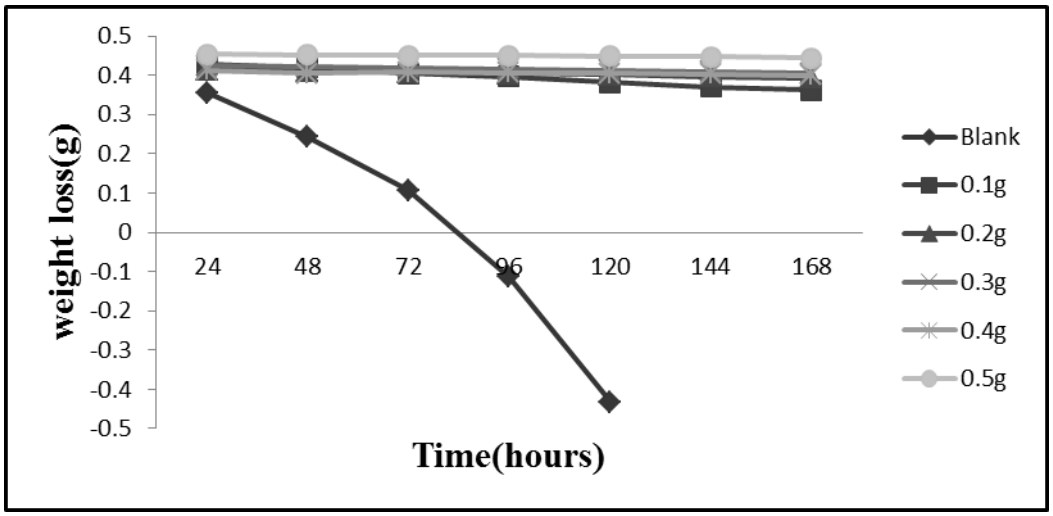

Fig. 2: Variation of Log (W_I–ΔW) with time for mild steel in 1M H_2SO_4 at different concentrations of extracts.

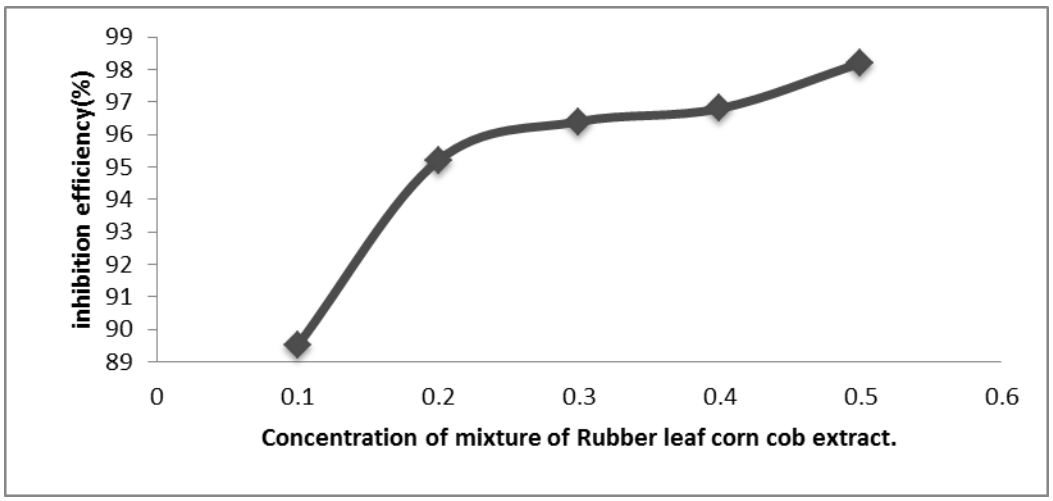

Fig. 3: Variation of inhibition efficiency with concentrations of mixture of Rubber leaf corn cob extract.

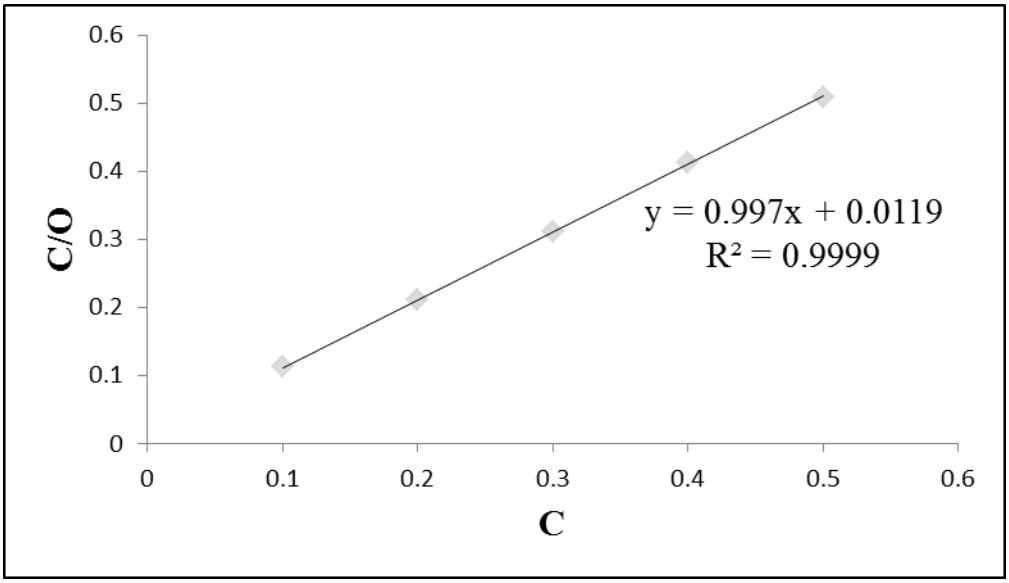

Fig. 4: Langmuir adsorption isotherm [c/ɵ] plot versus concentration [c] for the inhibition of mild steel in 1M H_2SO_4 solution

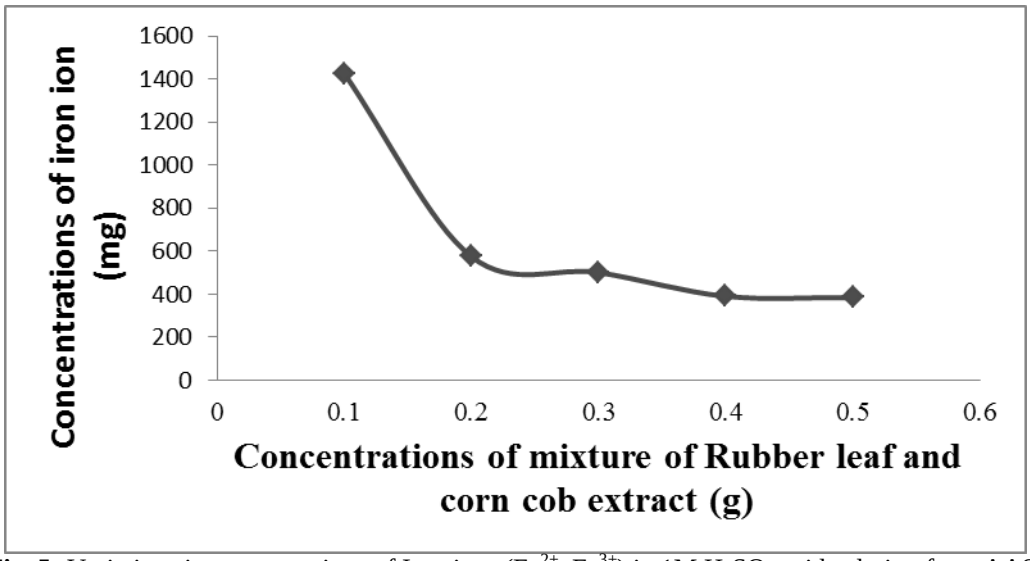

Fig. 5: Variations in concentrations of Iron ions (Fe^{2+}, Fe^{3+}) in 1M H_2SO_4 acid solution from AAS.

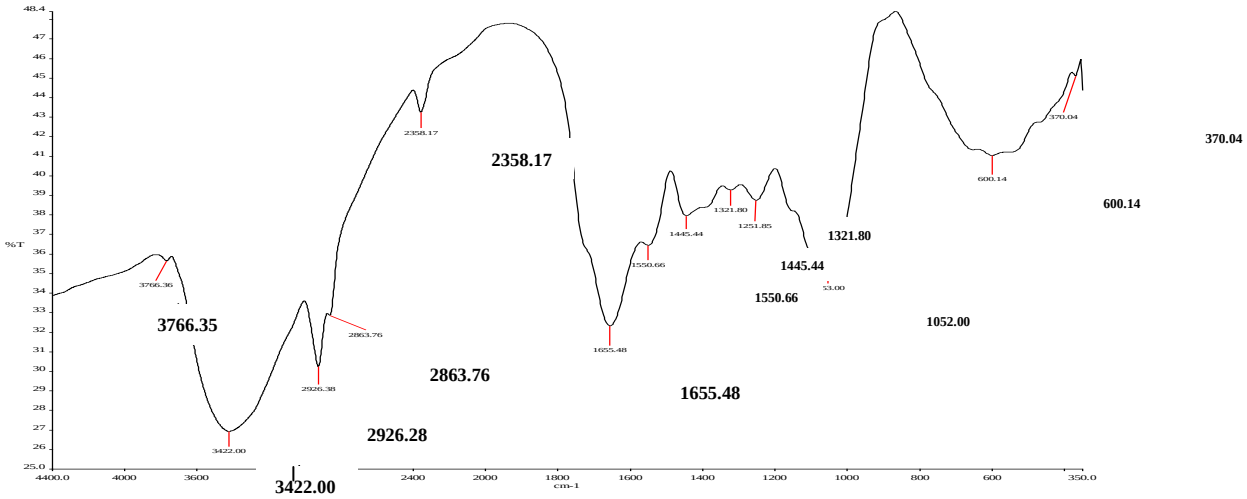

Fig. 6: FTIR Spectrum of Rubber Leaf Extract

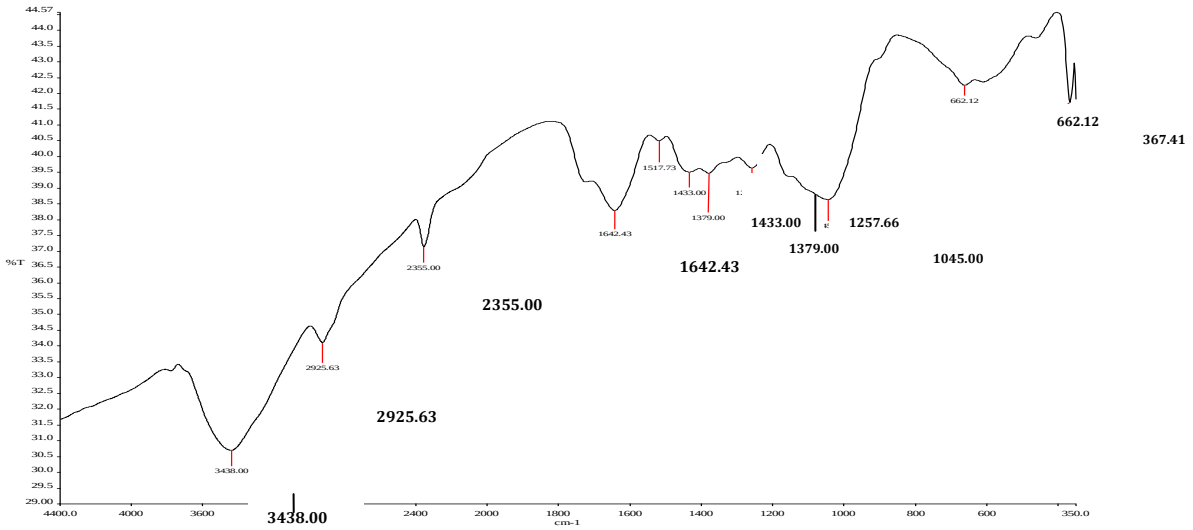

Fig. 7: FTIR Spectrum of Corn Cob

Discussion

Tables 2- 6 show the result from preliminary study. The tables show that at the acid concentration of 2 M H_2SO_4, 3 M H_2SO_4, and 4 M H_2SO_4 the dissolution (weight loss) of the mild steel increased as: 2.17g, 2.31g and 2.65g respectively. In the case of water (Table 2) and ethanol (Table 6), water shows a higher weight loss (0.42g) than ethanol (0.11g). The lesser weight loss obtained from water and ethanol as compared to the weight loss in 2 M-4 M H_2SO_4, shows that they have inhibitory properties which may be due to the presence of the O-H functional group in their molecule.

Weight Loss Studies: Fig.1 present the variation in weight loss in g/ml with time of the mild steel in 1 M H_2SO_4 varying concentrations of the mixture of rubber leaf (*Hevea brasiliensis*) and corn cob(*Zea mays*) extracts. It was observed from the plot in Fig.1 that weight loss decreases with increases in the concentration of the mixture of rubber leaf (*Hevea brasiliensis*) and corn cob (Zea mays) extracts. This infers that more of the metal surface were covered and protected from attack by the acidic medium as the concentration of the extract increased. Specifically, the addition of the extract decreased the dissolution of the metal from 1.94 g in the blank solution to 0.04 g in the presence of higher extract concentration of 0.5 g. This implies that the presence of the mixture of rubber leaves (*Hevea Brasiliensis*) and corn cob (*Zea Mays*) extract showed significant impact on the weight loss of mild steel in 1M H_2SO4 solution. This observation agrees with the report of Alamene, *et; al.* (2016).

Effect of time on weight loss: Table 7 shows the variation of weight loss with time for mild steel in 1 M H_2SO_4 at different concentrations of rubber leaf and corn cob extract. **T**he Table showed that at 24, 48, 72, 96, 120, 144 and 168 hours, weight loss increases as 0.59 g, 1.11 g, 1.58 g, 2.09 g, 2.49 g, 2.86 g, and 2.86 g respectively for the blank. This trend was also seen in the weight loss of the mild steels immersed in the various plant extract concentrations (test solution). This observation agrees with the report of Alamene, *et; al.* (2016).

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Effect of inhibitor concentration on weight loss: It was observed found in Table 12 that weight loss decreased significantly in the presence of the extracts compared to the blank acid solution and this decrease was found to be dependent on the concentration of the rubber leaf and corn cob extract. In particular the addition of 0.5 g of the rubber leaf and corn cob extract decreased the weight loss of the mild steel from 1.94 g in the blank solution to 0.04 g. This is in agreement with the work of Okeawale and Olaitan (2017).

The inhibition efficiency of mixture of rubber leaf and corn cob extracts on mild steel was calculated. Fig.3 shows the inhibition efficiency at different concentrations of the rubber leaf and corn cob extracts and it was also seen that the inhibition efficiency increases with increasing concentration of the plants extract. It was observed that the inhibition efficiency increased and the weight loss decreased as the extracts concentrations were increased. The highest value of the inhibition efficiency was 98.2%. It could be considered that the mixture of rubber leaf (*Hevea Brasiliensis*) and corn cob (*Zea Mays*) extract as inhibitor of mild steel in 1 M H_2SO_4 solution gave a high level of inhibition efficiency. (Umoren *et al.*, 2016, Alamene, *et; al*, 2016, Okeawale and Olaitan, 2017)

Adsorption Isotherm: Fig.4 is the Langmuir isotherm plot showing a straight line graph. It was found to be best suited for the experimental data generated. This is very clear from the correlation co-efficient (R^2) value of 0.999 which suggests that the mixture of rubber leaf and corn cob extract molecules form a monolayer on the surface of the mild steel.

Atomic Absorption Spectroscopy (AAS) Analysis: AAS analysis was carried out to determine the amount of the Iron ion dissolved from the mild steel into the electrolyte solution at different concentrations of the rubber leaf and corn cob extract after 168 hours of immersion period. The results obtained as shown in Fig.5 showed a decrease in the amount of dissolved Iron ion in the presence of the extracts compared to the blank. It was observed that the concentration of the Iron ion dissolved in the electrolyte was found to be 1427.04 mg for the blank in 1 M H_2SO_4 solution which decreased to 384.5 6 mg on addition of 0.5 g of the plant extracts. This may be attributed to the absorption of the components of the extracts on the surface of the mild steel, producing a barrier which isolates the surface from the corrosion environment. This observation is in line with the study of Alamene, *et. al.* (2016) on corrosion inhibition by rubber leaf extract on mild steel in acidic solution.

IV. Conclusion

The results of this study showed that weight loss decrease with increase in extract concentration. The mixture of rubber leaf and corn cob extract inhibited the corrosion of mild steel in 1M H_2SO_4 solution and the inhibition efficiency was found to increase with increasing concentration of the extract. The FTIR results showed that the inhibition was essentially by adsorption through the functional groups present in the extract.

From the results obtained from the study it showed that the mixture of rubber leaf and corn cob extract gave an inhibition efficiency of 98.2% which is close to 100% and that is to say that the mixture of the extract has a very good inhibitory action on mild steel in acid solution.

Recommendation

The mixture of Rubber leaf (*Hevea Brasiliensis*) and corn cob (*Zea Mays*) extract should be used as corrosion inhibitor on mild steel in acid environment since it has good inhibition efficiency. The mixture of Rubber leaf (*Hevea Brasiliensis*) and corn cob (*Zea mays*) extract should be used in further studies to test the inhibitory effect on different metals and higher concentrations of H_2SO_4.

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