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Effect of Watermelon Rind Inhibitor on the Corrosion Behaviour of Mild Steels in Alkaline and Acidic Environments

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***Abstract* - Agro-waste disposal has become a major source of environmental pollution. It is imperative to find an alternate use for agricultural waste. This research used water rind which is an agro-waste to develop an inhibitor. The inhibitors developed were used in different percentages to study the corrosion behaviour of mild steel in 1M HCl, 0.5M H_2SO_4 and 0.5 M NaOH using weight loss and potentiodynamic methods. The extract was synthesized from the watermelon rind (*Citrullus lanatus*) using the maceration method. Characterization of the extract was done by Atomic Absorption Spectroscopy, Fourier Transform Infrared Spectroscopy, Phytochemical Screening and Gas Chromatography (mass spectroscopy). The Atomic Absorption Spectroscopy results showed that the plant extract is ecofriendly as it does not contain heavy metals. The Fourier Transform Infrared Spectroscopy showed the different functional groups present in the extracts. Phytochemical screening result showed the presence of the chemical constituents. Gas Chromatography was used to determine the different compositions of the extracts. The weight loss and potentiodynamic polarization results showed that the addition of extracts inhibited the mild steels in all the media. The corrosion rate reduces as the inhibition efficiency increases and the concentration increases.**

Keywords: Watermelon, Rind Inhibitor, Corrosion Behaviour, Mild Steels, Alkaline, Acidic Environments.

I. INTRODUCTION

Almost 70% of metals used for engineering applications are made up of iron-carbon alloys named steels, and mild still contributes to the greater percentage of steels used for engineering applications because of cost-effectiveness, toughness, ductility and ease of manufacture [1]. Currently, the adverse effect of corrosion – a natural electrochemical (wet form) or chemical (dry form) process which transforms a refined metal into a more chemically stable form, has vastly contributed to various engineering failures around the world [2].It occurs either uniformly [3] or at preferential sites [4-7] – which is the most dangerous form of corrosion [8].

Corrosive environments are involved in many manufacturing processes such as Sulphuric acid in the production of fertilizers, dyes, drugs and organic salts, petroleum refining and metallurgical processes. Hydrochloric acid is used in production of batteries, photoflash bulbs, acid pickling and electroplating. Sodium Hydroxide is used as a cleaning agent and manufacturing of rayon, spandex, paints and washing soda. Additionally, industrial cleanup activities involve exposing the metals to different environments. The unending cycle of metal susceptibility to corrosion in acidic and alkaline environments has created a great challenge for corrosion scientists and engineers around the world [9-10].

Among the methods of corrosion control, the use of inhibitors is the most preferred because of its sustainability and cost-effectivenessThe laws on ecosystem sustainability make the use of inorganic corrosion inhibitors deleterious, thereby necessitating the need for more investigation of ecologically viable corrosion inhibitors [11].Organic inhibitors protect the metal surface by adsorption of ions onto the metal surface, increasing or decreasing the anodic and cathodic reaction, reduction in the diffusion rate for reactants to the surface of the metal, and decreasing the electrical resistance of the metal surface [12-13].

Organic inhibitors contain biomolecules such as tannins, alkaloids, saponins, amino acid pigment, catechins, proteins, etc. which makes them versatile in a different aggressive environment [14-15]. Some of the extracts that have been used for organic inhibitors include sweet potato, orange peels, moringa leaves, cashew nut, garlic, yeast, pepper, coffee seeds and watermelon rind [16].

Watermelon rind has several health benefits as well[17], but since most people would prefer not to consume it, it remains available in large quantities for usage. Therefore, if the inhibitive properties of the various organic compounds in watermelon rind could be proven, it would be a good source of agro-waste knowledge and wealth. The average moisture content of watermelon is about 92 percent with so many health benefits as it contains antioxidants emanating from L-citrulline [17]. The functional group contained in watermelon includes hydroxyl (cellulose) and carboxyl (pectin) and could easily bond with metal ions [18].

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II. EXPERIMENTAL PROCEDURE

API 5L steel samples were used. The chemical composition of the API 5L was determined using a spark spectrometric analyzer. The sample used for corrosion tests were cut into square sized coupons of 1cm by 1cm by 0.6cm dimension. Each coupon was grinded with silicon carbide abrasive papers of grades 60 to 1200 using a polishing machine and rinsed with distilled water. The residue of the polishing process was removed by degreasing with ethanol. The metal samples used for the polarization were prepared by mounting the steel with polyester resin at room temperature and the surfaces were polished.

Characterizations of the extracts were carried out using Atomic Adsorption Spectroscopy (AAS) Phytochemical analyzer, Chromatography-Mass Spectroscopy and Fourier Transform Infrared Spectroscopy (FTIR). The aim of characterization is to identify the elements, functional groups and structures in the extract.

III. RESULTS AND DISCUSSION

3.1 Chemical Composition of Metal Specimen

Table 1: Chemical Composition of the API 5L used

C	Si	Mn	P	S	Cr	Mo	Ni	Al	Co
0.157	0.279	1.280	0.0213	0.00053	0.0248	0.0031	0.0220	0.0381	0.001
Nb	Ti	V	N	Zn	Sn	As	Zr	Ca	Fe
0.0380	0.0023	0.0017	0.0073	0.0011	0.0002	0.0171	0.001	0.0022	Bal.

3.2 Elemental analysis

Table 2: The Elemental composition of water melon rind

Sample (ppm)	Ca	Fe	Cu	Mn	K	Na	Zn
Rind	1712.00	36.00	17.00	17.50	44732.00	4752.00	59.50

Table 2 shows the concentration of metals in water melon rind.

3.3 Phytochemical Analysis

The result of the phytochemical tests shows that watermelon rind contains several heteroatoms and covalent-bond organic compounds like Saponins, Alkaloids, Flavonoids, Terpenoids, Tannins and Phenols. These phytochemicals display anticorrosive properties through ionic interaction with the metal surface, this shows watermelon is a good inhibitor. The results agree with previous works [18-19].

Table 3: The phytochemical analysis results for water melon rind

Sample	Saponin (%)	Alkaloids (%)	Flavonoids (mg/100g)	Terpenoids (mg/100g)	Tanin (mg/100g)	Phenols (mg/100g)
	3.04	6.10	0.10	0.93	0.48	0.32

3.4 Fourier Transform Infrared (FTIR) Result

The wavelength and transmittance for each peak in the watermelon rind are shown in Table 4, The spectrum, Figure 1, of the watermelon rind shows a peak at a wavelength of 3317.3 a functional group of Acetylenic-Alkyne C-H stretch. The second peak is at 2094.8 which shows the Nitrogen multiple and cumulated double bond compound of Isothiocyanathe (-NCS). The third peak is at 1640.0 which is a simple hetero-oxy compound (nitrogen-oxy compounds) of organic nitrates. The fourth peak is at 1088.4 showing silicon-oxy compounds of organic siloxane or silicone (Si-O-Si). The fifth peak is at 607.6 which shows the thiols and the thio-substituted compounds of disulfides (S-S stretch). The last peak was obseerved at 432.4 showing aryl disulfides (S-S

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stretch) in the watermelon rind. All the peaks in the extract shows that water melon rind is a good inhibitor.The results of the FTIR experiment was interpreted according to Nandiyanto et al., [20].

Table 4: The wavelength and transmittance for each peak in the watermelon rind

Wavelength	3317.3	2094.8	1640.0	1088.4	607.6	432.4
Transmittance	48.657	96.591	68.067	48.557	41.983	57.337

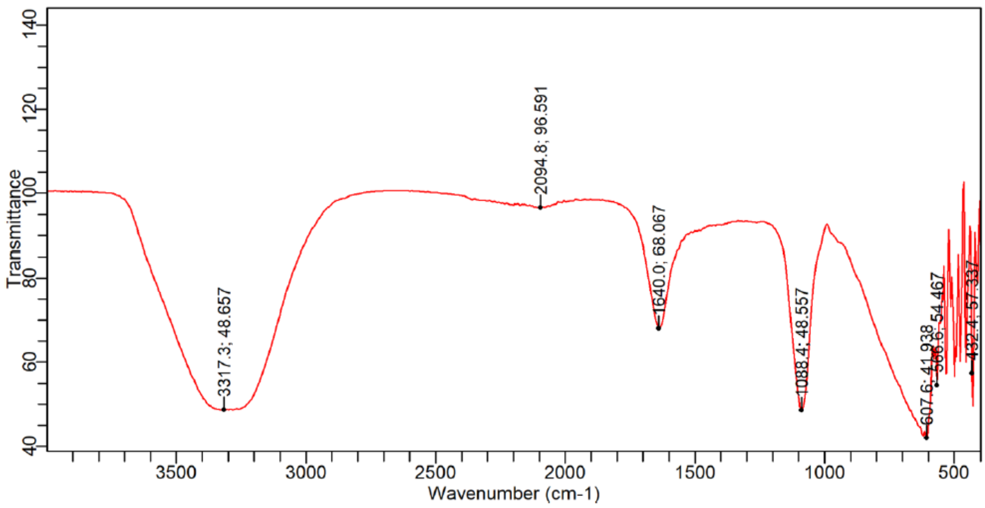
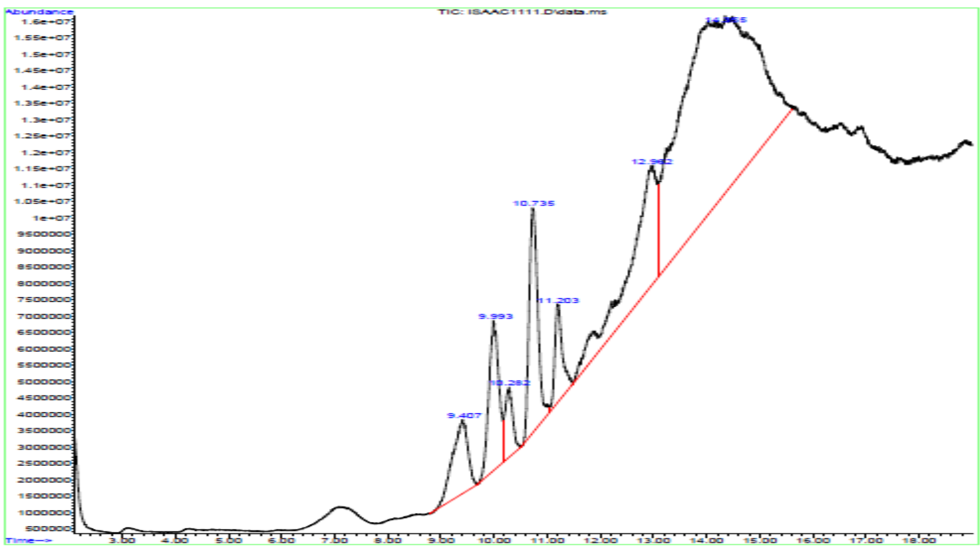


Figure 1: The FTIR Spectrum for the watermelon rind extract

3.5 Gas Chromatography/ Mass Spectroscopy (GC-MS)

The GC-MS instrument was used to characterize the chemical consistent and functional compounds present in the watermelon rind extract and the special functional compound present in the extract was shown in Figure 2, Table 5 and Table 6. The retention time (RT) is the measure of the time taken for the solute to pass through the chromatography column, as components of the mixture are separated, each component elutes at a different time based on its boiling point and polarity. GC-MS is used to identify different substances within a test specimen. It can also be used to identify trace levels of contamination and identify unknown peaks. Peak areas are proportional to the quantity of the corresponding compound. The results in Table 6 contain environmentally friendly compounds like alkyl-chain indazole derivatives and1-benzyl-4-phenyl-1H-1, 2, 3-triazole, this agrees with previous studies [21-22].



Figures 2: The GC/MS spectrum of the watermelon rind extract

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Table 5: The retention time, scans, peak height and correct areas of the watermelon in the gas chromatography column

Peak	R.T. min	1st Scan	Max. Scan	Last Scan	PK TY	Peak Height	Corr. Area	Corr. % Max	% of Total
1.	9.407	1073	1170	1214	BV 8	2257808	453723643	7.94%	4.859%
2.	9.993	1214	1264	1293	PV	4511034	593778857	10.39%	6.359%
3.	10.282	1293	1310	1346	VV 4	2132876	219392294	3.84%	2.350%
4.	10.735	1346	1383	1433	PV 4	6803784	774929103	13.56%	8.299%
5.	11.203	1433	1457	1502	VV 7	2987043	296662793	5.19%	3.177%
6.	12.962	1502	1739	1760	PV 7	3667327	1285625442	22.50%	13.768%
7.	14.355	1760	1961	2162	VB 7	5363395	5713600358	100.00%	61.188%
Sum of corrected areas: 9337712489									

Table 6: The organic compounds of water melon rind in the gas chromatography column

Peak	RT Qual	Compounds
1.	2.387	N'-Furfurylidene-4-nitrobenzohydrazide, Acetic acid, (1-methyl-2(1H)-pyridinylidene)-,ethyl ester, Perfluorooctanoic acid, 4-methylphenyl ester
2.	2.425	1-Leucyl-l-O-methylthreonine, Adipamide, (.beta.-Diethylaminopropionyl)-5,7-dimethyl, 1,2,3,4-tetrahydropyrimido (3,4-a)indole
3.	2.481	Ethanone, 1-[1-(4-amino-1,2,5-oxadiazol-3-yl)-5-methyl-1H-1,2,3-triazol-4-yl]-, 1,2,5-Triazole, 1-(3-propenyl)-3-nitro-4-formamido-, 2-oxide, Cyclohexanecarboxamide, N-furfuryl
4.	2.506	2,1,3-Benzoxadiazole-5,6-dicarbonitrile, 1-oxide, 3,4-Dinitrobenzonitrile, Benzofurazan-1-oxide, 6-cyano-
5.	2.550	2,2,4-Trichloro-1,3-cyclopentenedione, Thiophene-2-carboxylic acid, 4-bromo-3-methoxy-, Pyrazine, methyl-
6.	2.581	3,3'-Dipyrazole, 1,1'-dinitro-4,7-Methano-1H-indene, 4,5,6,7,8,8-hexachloro-3a,4,7,7a-tetrahydro-, 4,8-Methano-s-indacene, 1,2,3,3a,4, ,4a,5,7a,8,8a-decahydro-2-methylene-
7.	2.600	Benzaldehyde, 4-nitro-, O-(3-nitrobenzoyl) oxime, Ethyl 5-bromonicotinate, Benzaldehyde, 4-bromo-
8.	2.618	1-Pentene, 5-bromo-5,5-difluoro-, Quinazoline, 6-chloro-4-(4-morpholino)-2-phenyl-, 1,1,2,2-Cyclopropane-tetracarbonitrile
9.	2.725	Dimethyl bicyclo[2.2.1]-2,5-heptadiene-2,3-dicarboxylate 1,1-Dichloro-1-silacyclo-3-hexene, 4,7-Ethanoisobenzofuran-1,3,5,8(4H)-tetrone, tetrahydro-
10.	2.775	6-Methyl-4-propan-2-on-3-propyl-2, 6-dioxo-4,5,6,7-tetrahydro-1,2,3-triazolo[4,5-d]pyrimidine, 2,6,7-Trimethyl-(1,2,4)-triazolo(2,3-b)(1,2,4)-triazine, [1,2,4]Triazolo[3,4-b][1,3,4]thiadiazole, 3-(1-methylethyl)-6-(2-pyrazinyl)-

3.6 Weight Loss

The weight loss variation with exposure time for API 5L steel immersed in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with different concentrations of watermelon rind extract inhibitors are reported in Figures 3 to 12.

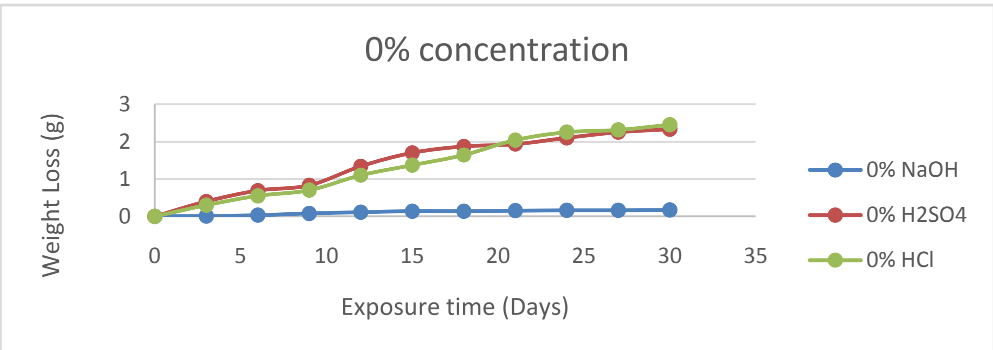

Figure 3: Weight loss variation with exposure time for API 5L steel immersed in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 0% concentrations of watermelon rind extract

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Table 7: Corrosion parameters from the weight loss measurements of API 5L steel in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 0% concentrations of watermelon rind extract

Concentration (%)	Immersion Time (hours)	Weight loss (g)	Inhibition Efficiency (%)	Corrosion Rate (mmpy)
0% HCl	720	2.458	-	8.658E-03
0% H_2SO_4	720	2.337	-	8.232E-03
0% NaOH	720	0.171	-	6.023E-04

Figure 3 and Table 7, show the corrosion rate of API 5L steel in 1M HCl, 0.5M H_2SO_4 and 0.5 M NaOH with 0% inhibitor concentration. The data shows that hydrochloric acid had higher corrosion rate than sulphuric acid, the weight loss of the hydrochloric acid over a period of 35 days was higher. The NaOH had the lowest weight loss and consequently the lowest corrosion rate. The weight loss increases with time for all the environments. The corrosion rates of the acidic environment increase over the period of 35days.

Figure 4 and Table 8showthe corrosion rate of API 5L steel in 1M HCl, 0.5M H_2SO_4 and 0.5 M NaOH with 1% inhibitor concentration. The data shows that hydrochloric and Sulphuricacid had the highest corrosion rate with an inhibition efficiency of 21.46% and 25.75% respectively while the NaOH was with the lowest corrosion rate with an inhibition efficiency of 32.74%.

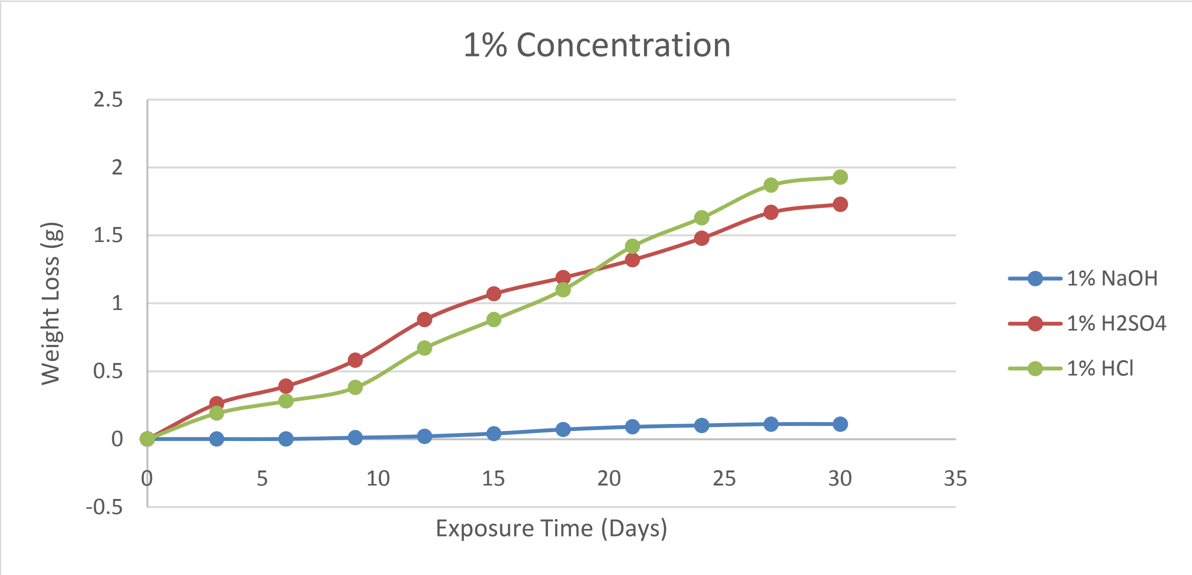

Figure 4: Weight loss variation with exposure time for API 5L steel immersed in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 1% concentrations of watermelon rind extract.

Table 8: Corrosion parameters from the weight loss measurements of API 5L steel in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 1% concentrations of watermelon rind extract

Concentration (%)	Immersion Time (hours)	Weight loss (g)	Inhibition Efficiency (%)	Corrosion Rate (mmpy)
1% HCl	720	1.931	21.46	6.800E-03
1% H_2SO_4	720	1.735	25.75	6.112E-03
1% NaOH	720	0.115	32.74	4.051E-04

Figure 5 and Table 9, show the corrosion rate of API 5L steel in 1M HCl, 0.5M H_2SO_4 and 0.5 M NaOH with 2% inhibitor concentration. The data shows that Hydrochloric and Sulphuricacid has the highest corrosion rate with an inhibition efficiency of 67.89 % and 54.81% respectively while the NaOH with the lowest corrosion rate and also the lowest inhibition efficiency of 38.59%.

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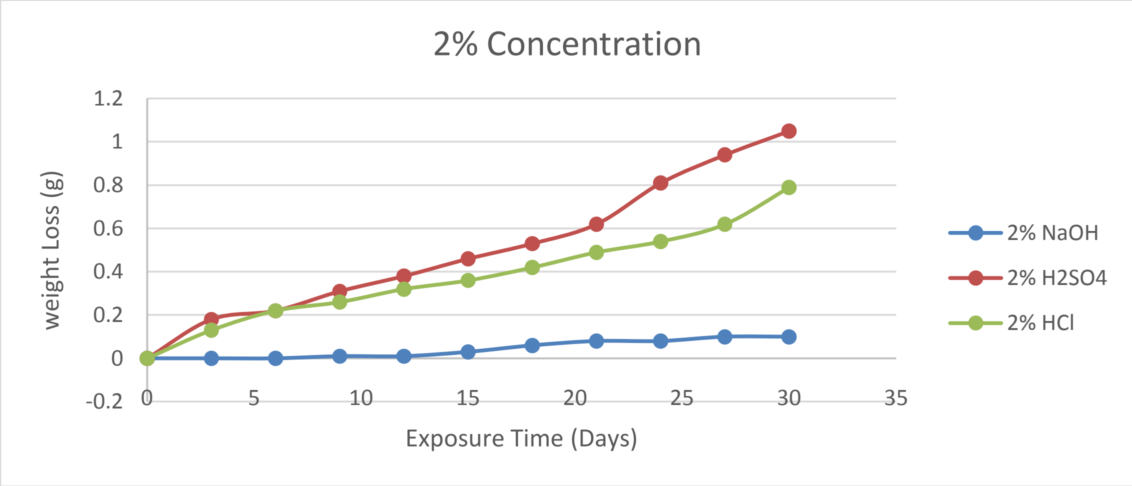

Figure 5: Weight loss variation with exposure time for API 5L steel immersed in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 2% concentrations of watermelon rind extract.

Table 9: Corrosion parameters from the weight loss measurements of API 5L steel in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 2% concentrations of watermelon rind extract

Concentration (%)	Immersion Time (hours)	Weight loss (g)	Inhibition Efficiency (%)	Corrosion Rate (mmpy)
2% HCl	720	0.790	67.89	2.780E-03
2% H_2SO_4	720	1.056	54.81	3.720E-03
2% NaOH	720	0.105	38.59	3.699E-04

Figure 6 and Table 10, show the corrosion rate of API 5L steel in 1M HCl, 0.5M H_2SO_4 and 0.5 M NaOH with 3% inhibitor concentration. The data shows similar corrosion rates for the hydrochloric, sulphuric acid and NaOH with inhibition efficiency of 90.81 %, 84.00% and 43.27% respectively.

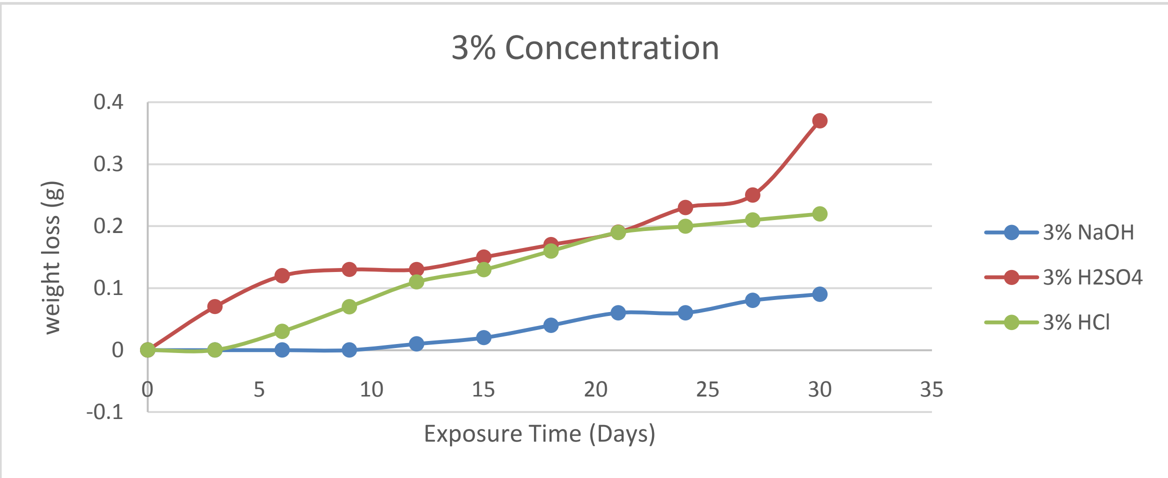

Figure 6: Weight loss variation with exposure time for API 5L steel immersed in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 3% concentrations of watermelon rind extract.

Table 10: Corrosion parameters from the weight loss measurements of API 5L steel in 1M HCl, 0.5 M H_2SO_4 and 0.5 M NaOH with 3% concentrations of watermelon rind extract

Concentration (%)	Immersion Time (hours)	Weight loss (g)	Inhibition Efficiency (%)	Corrosion Rate (mmpy)
3% HCl	720	0.226	90.81	7.960E-04
3% H_2SO_4	720	0.374	84.00	1.317E-03
3% NaOH	720	0.097	43.27	3.417E-04

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3.6 Polarization Measurement

From Figure 7 and Table 11, the data shows that the API 5L steel in NaOH has the highest polarization resistance and hence the lowest corrosion rate when compared to the HCl and H_2SO_4, the polarization resistance of the H2SO4 is higher than that of the HCl which is responsible for the lower corrosion rate.

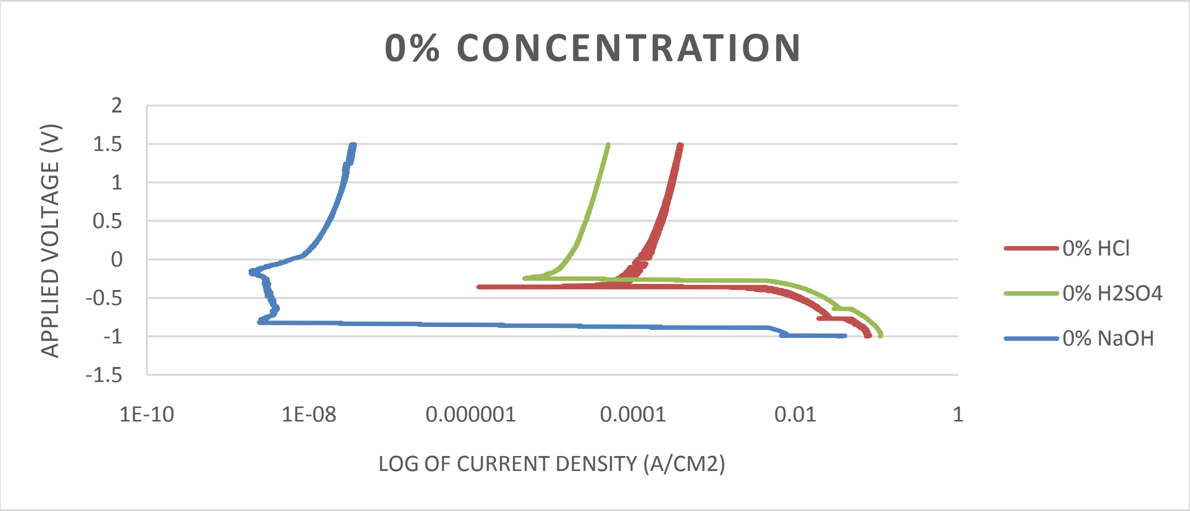

Figure 7: Polarization curves showing the corrosion behaviour of API Steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 0% watermelon rind extract

Table 11: Polarization values of API 5l steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 0% watermelon rind extract

	ba (V/dec)	bc (V/dec)	E_{corr}(V)	I_{corr}(A/cm^2)	Corrosion Rate (mm/yr)	Polarization Resistance(Ω)	E begin (V)	Inhibitor Efficiency (%)
0% HCl	0.017498	0.84622	-0.35553	5.8277E-05	6.7718E-01	127.76	-0.36041	-
0% H_2SO_4	1.09150	0.013904	-0.24363	9.2269E-06	1.0722E-01	646.19	-0.26764	-
0% NaOH	0.016617	1.15010	-0.80733	2.5895E-09	3.0090E-05	2.7471E+06	-0.84869	-

From Figure 8 and Table 12, the data shows that the API 5L steel in NaOH has the highest polarization resistance and hence the lowest corrosion rate when compared to the HCl and H_2SO_4, the polarization resistance of the H_2SO_4 is higher than that of the HCl which is responsible for the lower corrosion rate. The steel in the HCl environment has the highest inhibition efficiency of 90.2%, closely followed by the H_2SO_4 with 75.5% inhibition efficiency and the lowest inhibition efficiency of 18.5% is for the NaOH.

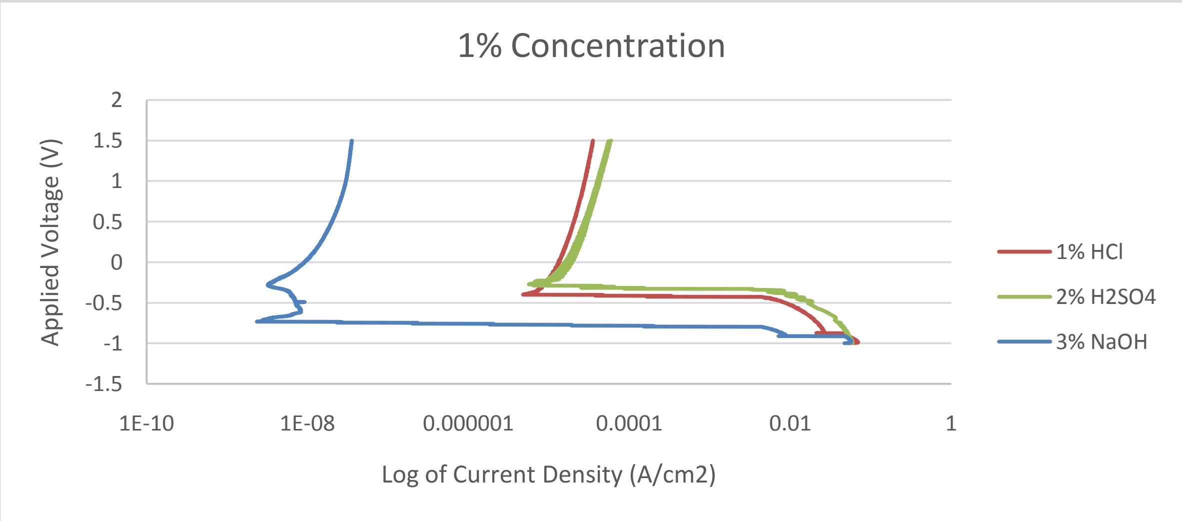

Figure 8: Polarization curves showing the corrosion behaviour of API Steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 1% watermelon rind extract

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Table 12: Polarization values of API 5l steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 1% watermelon rind extract

	ba (V/dec)	bc (V/dec)	E_{corr}(V)	I_{corr}(A/cm^2)	Corrosion Rate (mm/yr)	Polarization Resistance(Ω)	E begin (V)	Inhibitor Efficiency (%)
1% HCl	0.022318	0.32225	-0.38473	5.7112E-06	6.6364E-02	1587.2	-0.42389	90.2%
1% H_2SO_4	0.03899	0.210600	-0.36053	2.2563E-06	2.6218E-02	6333.1	-0.31403	75.5%
1% NaOH	0.008234	0.25352	-0.73494	2.1092E-09	2.4509E-05	1.6421E+06	-0.76080	18.5%

From Figure 9 and Table 13, the data shows that the API 5L steel in NaOH has the highest polarization resistance and hence the lowest corrosion rate when compared to the HCl and H_2SO_4, the polarization resistance of the H2SO4 and HCl is similar resulting in the little difference in the corrosion rate. The steel in the HCl environment has the highest inhibition efficiency of 99.1%, closely followed by the H_2SO_4 with 94.4% inhibition efficiency and the lowest inhibition efficiency of 24.1% is for the NaOH.

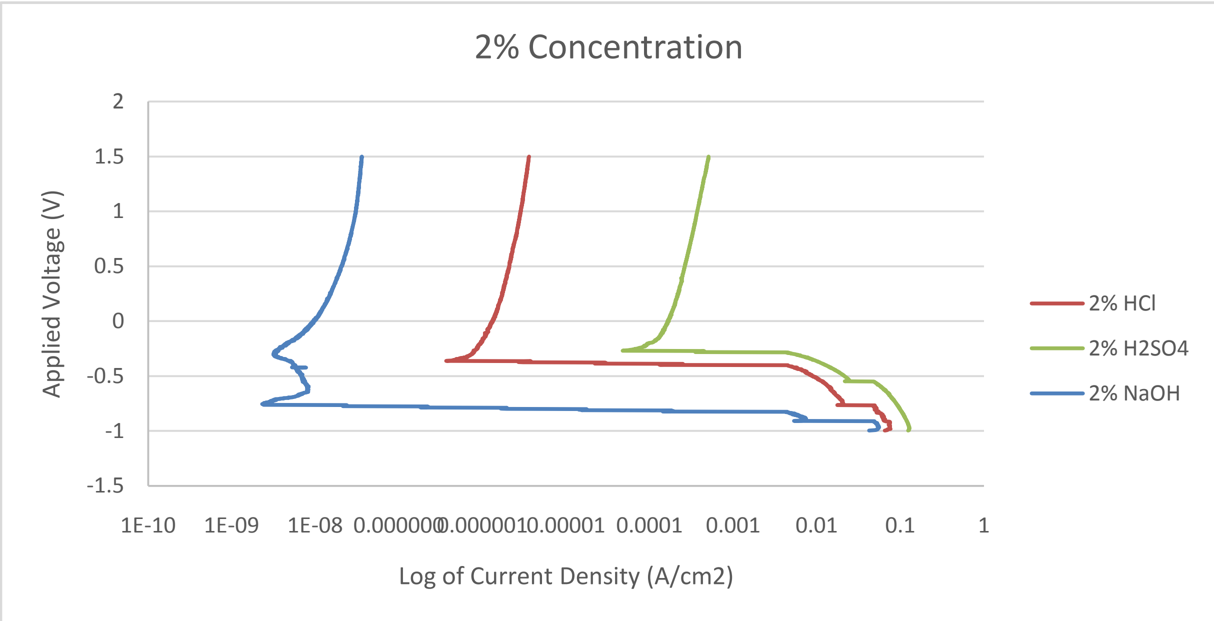

Figure 9: Polarization curves showing the corrosion behaviour of API Steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 2% watermelon rind extract

Table 13: Polarization values of API 5l steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 2% watermelon rind extract

	ba (V/dec)	bc (V/dec)	E_{corr}(V)	I_{corr}(A/cm^2)	Corrosion Rate (mm/yr)	Polarization Resistance(Ω)	E begin (V)	Inhibitor Efficiency (%)
2% HCl	0.008262	0.51021	-0.36575	5.4827E-07	6.3709E-03	6440.6	-0.37994	99.1%
2% H2SO4	0.11888	0.22959	-0.46553	5.2085E-07	6.0522E-03	65307	-0.24811	94.4%
2% NaOH	0.018276	0.13406	-0.77169	1.9642E-09	2.2824E-05	3.5563E+06	-0.79987	24.1%

From Figure 10 and Table 14, the data shows that the API 5L steel in NaOH has the highest polarization resistance and hence the lowest corrosion rate when compared to the HCl and H_2SO_4, the polarization resistance of the H2SO4 and HCl is similar resulting in the little difference in the corrosion rate. The steel in the HCl environment has the optimum inhibition efficiency of 99.9%, closely followed by the H_2SO_4 with 99.3% inhibition efficiency and the lowest inhibition efficiency of 27.2% is for the NaOH.

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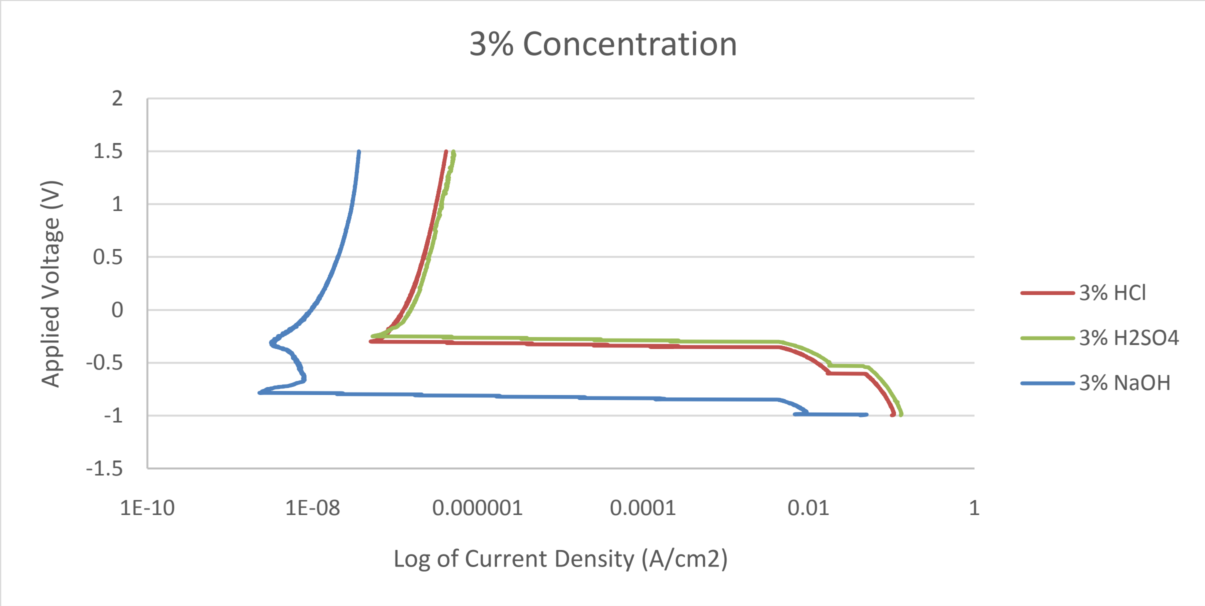

Figure 10: Polarization curves showing the corrosion behaviour of API Steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 3% watermelon rind extract

Table 14: Polarization values of API 5l steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 3% watermelon rind extract

	ba (V/dec)	bc (V/dec)	E_{corr}(V)	I_{corr}(A/cm^2)	Corrosion Rate (mm/yr)	Polarization Resistance(Ω)	E begin (V)	Inhibitor Efficiency (%)
3% HCl	0.018001	0.56247	-0.35071	5.9759E-08	6.9440E-04	1.2676E+05	-0.31647	99.9%
3% H2SO4	0.02019	0.39853	-0.23916	6.4402E-08	7.4835E-04	1.2963E+05	-0.26520	99.3%
3% NaOH	0.008235	0.16930	-0.76339	1.8859E-09	2.1914E-05	1.8086E+06	-0.78033	27.2%

From Figure 11 and Table 15, the result showed thatHCl had the highest corrosion rates. The 4% inhibitors are more effective in HCl and H_2SO_4environments showing that the optimum efficiency was observed inan acidic environment while it did not inhibit well in the alkali environment. The steels in the HCl and H_2SO_4 environment has the optimum inhibition efficiency of 99.9% and the lowest inhibition efficiency of 35.3% is for the NaOH.

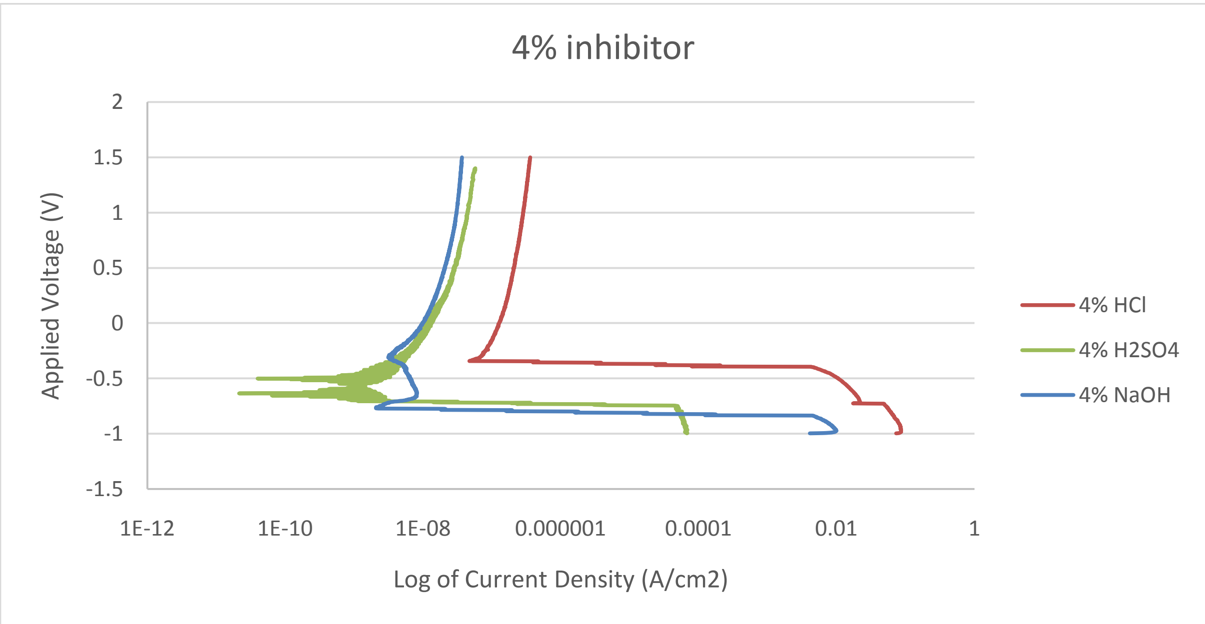

Figure 11: Polarization curves showing the corrosion behaviour of API Steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 4% watermelon rind extract

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Table 15: Polarization values of API 5l steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 4% watermelon rind extract

	ba (V/dec)	bc (V/dec)	E_{corr}(V)	I_{corr}(A/cm^2)	Corrosion Rate (mm/yr)	Polarization Resistance (Ω)	E begin (V)	Inhibitor Efficiency (%)
4% HCl	0.019590	0.45227	-0.33180	5.8135E-08	6.7553E-04	1.4027E+05	-0.35797	99.9%
4% H2SO4	0.45126	0.12719	-0.65728	7.8745E-10	9.1501E-06	5.4724E+07	-0.67280	99.9%
4% NaOH	0.008406	0.12476	-0.77486	1.6767E-09	1.9483E-05	2.0399E+06	-0.79254	35.3%

From Figure 12 and Table 16, the data shows thatfurther addition of inhibitors did not increase the inhibitor efficiency inan acidic environment. The API 5L steel in H_2SO_4 has the highest polarization resistance and hence the lowest corrosion rate. The polarization resistance of the NaOH is higher than HCl resulting in a difference in the corrosion rate. The steels in the HCl and H_2SO_4 environment have the optimum inhibition efficiency of 99.9% and the lowest inhibition efficiency of 47.8% is for the NaOH.

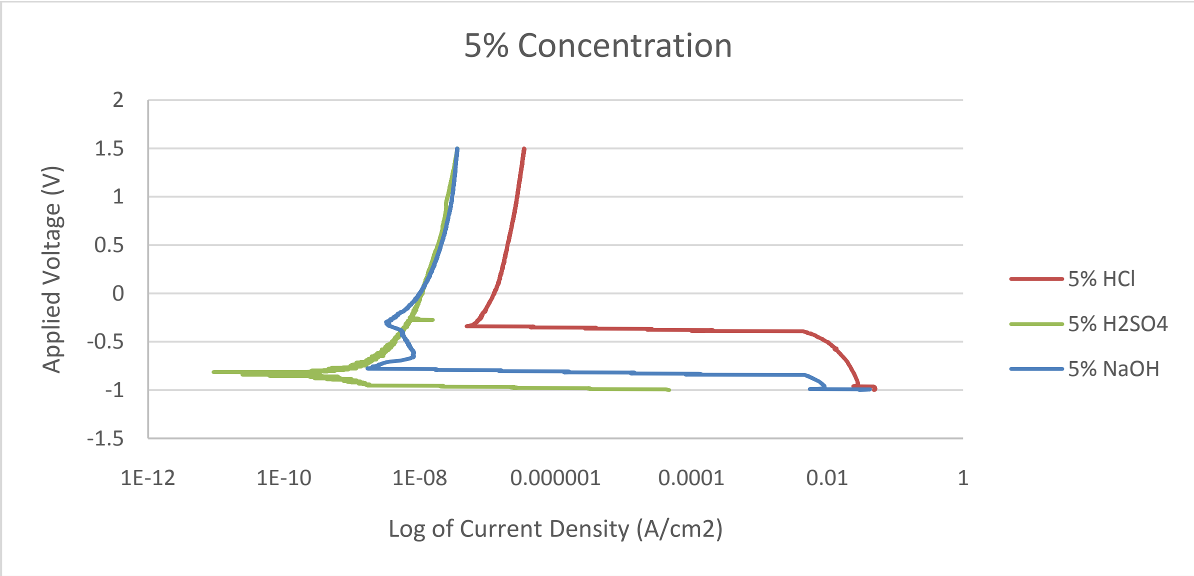

Figure 12: Polarization curves showing the corrosion behaviour of API Steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 5% watermelon rind extract

Table 16: Polarization values of API 5l steel in 1 M HCl, 0.5M H_2SO_4 and NaOH with 5% watermelon rind extract

	ba (V/dec)	bc (V/dec)	E_{corr}(V)	I_{corr}(A/cm^2)	Corrosion Rate (mm/yr)	Polarization Resistance(Ω)	E begin (V)	Inhibitor Efficiency (%)
5% HCl	0.008856	0.44122	-0.34420	5.3607E-08	6.2991E-04	70341	-0.36530	99.9%
5% H2SO4	0.04268	0.069563	-0.33987	1.7215E-10	2.0040E-06	6.6729E+07	-0.37018	99.9%
5% NaOH	0.008240	0.13060	-0.77242	1.3520E-09	1.5710E-05	2.4899E+06	-0.78766	47.8%

IV. CONCLUSION

From the results obtained, it can be concluded that:

1. The presence of various phytochemicals in the watermelon rind is responsible for the good inhibitive properties possessed by the watermelon rind.
2. The results from both the weight loss method and the polarization method showed the corrosion rate reduces with an increase in the inhibitor concentration. The weight loss result agreed with the polarization result.
3. The optimum inhibitor efficiency value of 99.9% was attained at 3%inhibitor concentration for HCl and 4% inhibitor concentration for H_2SO_4. The maximum inhibitor efficiency value of 47.8% was obtained at a 5% inhibitor concentration in a NaOH environment.
4. The inhibition efficiency value obtain for the acidic environments was higher than that of the alkaline environment.
5. The 4% inhibitors are more effective in HCl and H_2SO_4 environments showing that the optimum efficiency was

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observed for the acidic environment while it did not inhibit well in the alkali environment.

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