CORROSION INHIBITION CHARACTERISTICS OF LEAF EXTRACTS OF SWEET CASSAVA ON MILD STEEL USING WEIGHT LOSS METHOD

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ABSTRACT

The cassava leaves were successfully collected and 60g of different extracts of Manihot esculenta was obtained using standard laboratory procedures. Volumetric concentrations of the leaves extracts expressed in cubic centimeter (cm^3) were determined and the concentrations of the acid, alkali and salt for different moles were also determined. The weight loss of each of the sample coupons of mild steel were determined and recorded. The composition of the mild steel rods was analyzed using Optical Emission Spectrometer. From the result obtained it can be suggested that the Manihot Esculenta leaf extracts act as good green corrosion inhibitor and can be used to retards the corrosion rate on mild steel.

Key words: cassava leaf, mild steel, corrosion

1. INTRODUCTION

The applications of new green inhibitors have continued to gain interest in the technological world. In the field of material science and corrosion control, scientists are persistent in seeking better and more efficient ways of combating the corrosion of metals (Idenyi, Nwofe, and Idu, 2015).

The Corrosive effects are of remarkable consequence in food processing industry as leaves contain corrosion aggressive substances, such as tannins, saponins and flavonoids etc (Jamiu and Olorunfemi, 2013), thereby causing significant impact on the degradation of constructional materials and the maintenance or replacement of products lost or contaminated as a result of corrosion reactions. Corrosion has posed to be more of a nuisance than good (JL Shadma, Shanthi and Rajiv, 2015).

Acid solutions are used in the most important industrial applications in etching and acidic cleaning. Hydrogen tetraoxosulphate (vi) acid is widely used for the removal of rust and industrial acid cleaning, acid descaling and oil well acidizing, because of the general aggressiveness of acid solutions. The practice of inhibition is commonly used to reduce the corrosive attack on metallic materials. Inhibitors are generally used for this purpose to control the metal dissolution. A number of studies have recently appeared in the literature on the corrosion of mild steel in acidic solutions. The important materials used in the manufacturing sector are mild steel. Mild Steel is widely used in the construction of machine parts that are employed in manufacturing, processing and production industries. The best approach to militate corrosion of these structures is to study the corrosive behaviour of this metallic material in an environment concerned in order to proffer appropriate method of protection (Helen, Rahim, Ibrahim and Brosse, 2016; Mourya, Banerjee and Singh, 2014). Mild steel corrodes when exposed to air and the oxide formed on it is readily broken down, in the presence of moisture, especially if it is not repaired (Mohsin, Husam and Rasha, 2014).

Cassava is a versatile crop and can be processed into a wide range of products such as starch, flour, tapioca, beverages and cassava chips for animal feed. Cassava is also gaining prominence as an important crop for the emerging bio-fuel industry and, as corroborated by Ziska et al. (2009), is a potential carbohydrate source for ethanol production. A well planned strategy for the development and utilization of cassava and cassava products can provide incentives for farmers, crop vendors and food processors to increase their incomes. It can also provide food security for households producing and consuming cassava and cassava products (Plucknett et al, 1998).

Traditionally, cassava has been grown by farmers throughout the Bahama Islands and has been of particular importance to small farmers of the central and southeastern islands, where it is still cultivated. It is a crop that is generally grown on marginal lands with a minimum of agricultural inputs (Hillocks et al., 2002). Cassava varieties are generally distinguished from each other by their morphological characteristics which include leaf, stem and tuber color, leaf shape and number of storage roots per plant.

Leaf Products are organic in nature, and contain certain photochemical substances such as: tannins, flavonoids, saponins, organic and amino acids; alkaloids, and pigments which could be extracted by simple less expensive procedures. Extracts from different parts of leaves have been widely reported as effective and good metal corrosion inhibitors in various corrosive media (Nnanna, Nnakaife, Ekekwe and Eti, 2016).

II. MATERIALS AND METHOD

Prior to measurement, each coupon were washed in absolute ethanol, rinsed in distilled water, dried in acetone and then weighed (Nnanna, Nnakaife, Ekekwe, and Eti, 2016). The same experiment was repeated in the absence and presence of inhibitor. The sample coupons of mild steel were first weighed using a digital weighing balance, METTLER TOLEDO model ME204E with a least count of O.OOOlg, labeled and immersed in the test solutions of acid, alkali and salt with inhibitor. The weight loss of each of the sample coupons were determined and recorded. The determination of weight loss and recording was repeated consistently every 68 hours (7 days) for a period of 672 hours (28 days). The composition of the mild steel rods was analyzed using Optical Emission Spectrometer, and the mild steel rods were sourced from metal stockiest. The chemicals and reagents that were used in this paper were of analytical grade.

Cylindrical mild steel-samples of diameter 8mm and height of 16mm was machined using lathe machine and hacksaw. Each coupon was degreased by washing in ethanol, dried in acetone and kept in a desiccator and then weight of each coupon was weighed before insert into beaker to obtain the weight difference. The coupons were immersed in the different media by means of a nylon thread that were hang on a retort stand and tied to the coupons. Samples of the mild steel were inserted into the beakers and allowed to stand for 28 days (672 hours) with a set withdrawn after every 7 days (168 hours).

The cassava leaves were successfully collected and 60g of different extracts of Manihot esculenta was obtained using standard laboratory procedures. Volumetric concentrations of the leaves extracts were expressed in cubic centimeter (cm^3). Concentrations of Manihot esculenta leaf extracts that were used for this paper were 5 cm^3 , 10 cm^3 and 15 cm^3 while the concentrations of the acid, alkali and salt were 0.5 M and 1.0 M respectively. A total of sixty (60) beakers were rinsed with distilled water and dried in air before the experimental were set up, so as to avoid additional water.

III. RESULTS AND DISCUSSION

The results of corrosion rate of mild steel against exposure time at various concentration of vegetable leaf extracts in NaOH, NaCl and H_2SO_4 are as presented in table 1 to 6 below.

Table 1: Cassava Leaves Extract in 0.5 M NaOH.

Media/ Exposure time (Hrs)	Initial weight (g)	Final weight (g)	Weight difference (g)	CR(mm/yr)
Control				
168	9.52	8.70	0.82	0.0010
336	9.50	8.86	0,64	0.0004
504	9.48	8.84	0.64	0.0003
672	9.42	8.90	0.52	0.0002
5cm^3				
168	9.56	9.11	0.45	0.0005
336	9.52	9.12	0.40	0,0002
504	9.36	9.00	0.36	0.0001
672	9.41	9.13	0.28	0.0001
10cm^3				
168	9.32	8.90	0.42	0.0005
336	9.43	9.15	0.30	0.0002
504	9.51	9.21	0.30	0.0001
672	9.12	8.92	0.20	0.0001
15cm^3				
168	9.66	9.35	0.31	0.0004
336	9.63	9.38	0.25	0.0001
504	9.14	8.92	0.22	0.0001
672	9.52	9.42	0.10	0.00003

Table 2: Cassava Leaves Extract in 1.0 M NaOH.

Media/ Exposure time (Hrs)	Initial weight (g)	Final weight (g)	Weight difference (g)	CR(mm/yr)
Control				
168	9.13	8.19	0.94	0.00111
336	9.71	8.91	0.80	0.00041
504	9.66	8.96	0.70	0.00028
672	9.78	9.08	0.70	0.00021
5cm^3				
168	9.47	8.69	0.78	0.0009
336	9.50	8.78	0.72	0.0004
504	9.23	8.59	0.64	0.0003
672	9.25	8.75	0.50	0.0001
10cm^3				
168	9.52	8.99	0.53	0.0006
336	9.45	9.05	0.40	0.0002
504	9.44	9.04	0.40	0.0002
672	9.26	8.90	0.36	0.0001
15cm^3				
168	9.51	9.11	0.40	0.0005
336	9.13	8.81	0.32	0.0002
504	9.22	8.94	0.28	0.0001
672	9.22	8.98	0.24	0.0001

Table 3: Cassava Leaves Extract in 0.5 M NaCl.

Media/ Exposure time (Hrs)	Initial weight (g)	Final weight (g)	Weight difference (g)	CR(mm/yr)
Control				
168	9.52	9.46	0.06	0.00007
336	9.39	9.34	0.05	0.00003
504	9.43	9.39	0.04	0.00002
672	9.65	9.61	0.04	0.00001
5cm^3				
168	9.70	9.62	0.08	0.00009
336	9.40	9.33	0.07	0.00004
504	9.75	9.68	0.07	0.00003
672	9.28	9.22	0.06	0.00002
10cm^3				
168	9.71	9.64	0.07	0.00008
336	9.51	9.45	0.06	0.00004
504	9.47	9.40	0.07	0.00003
672	9.48	9.43	0.05	0.00001
15cm^3				
168	9.45	9.39	0.06	0.00007
336	9.83	9.78	0.05	0.00003
504	9.85	9.81	0.04	0.00002
672	9.58	9.55	0.03	0.00001

Table 4: Cassava Leaves Extract in1.0M NaCl.

Media/ Exposure time (Hrs)	Initial weight (g)	Final weight (g)	Weight difference (g)	CR(mm/yr)
Control				
168	9.26	9.17	0.09	0.00011
336	9.31	9.23	0.08	0.00005
504	9.43	9.35	0.08	0.00003
672	9.45	9.38	0.07	0.00002
5 cm^3				
168	9.79	9.74	0.05	0.00010
336	9.13	9.09	0.04	0.00002
504	9.66	9.62	0.04	0.00002
672	9.87	9.84	0.03	0.00001
10cm^3				
168	9.24	9.20	0.04	0.00005
336	9.97	9.94	0.03	0.00002
504	9.03	9.94	0.02	0.00001
672	9.89	9.87	0.02	0.00001
15cm^3				
168	9.57	9.54	0.03	0.00004
336	9.76	9.73	0.03	0.00002
504	9.91	9.89	0.02	0.00001
672	9.42	9.39	0.03	0.00001

Table 5: Cassava Leaves Extract in 0.5M H_2S0_4.

Media/ Exposure time (Hrs)	Initial weight (g)	Final weight (g)	Weight difference (g)	CR(mm/yr)
Control				
168	9.55	6.74	2.81	0.00333
336	9.49	7.76	1.73	0.00102
"504	9.38	8.42	0.96	0.00038
672	9.42	8.53	0.89	0.00026
5cm^3				
168	9.32	8.72	0.60	0.00071
336	9.45	8.87	0.58	0.00034
504	9.40	8.90	0.50	0.00020
672	9.38	8.93	0.45	0.00013
10cm^3				
168	9.35	8.83	0.52	0.00062
336	9.41	8.98	0.43	0.00025
504	9.42	9.03	0.39	0.00015
672	9,40	9.05	0.35	0.00010
15cm^3				
168	9.55	9.15	0.40	0.00047
336	9.14	8.78	0.36	0.00021
504	9.68	9.40	0.28	0.00011
672	9.32	9.06	0.26	0.00008

Table 6: Cassava Leaves Extract in 1.0M H_2SO_4.

Media/ Exposure time (Hrs)	Initial weight (g)	Final weight (g)	Weight difference (g)	CR(mm/yr)
Control				
168	9.42	5.99	3.43	0.00406
336	9.85	6.90	2.95	0.00175
504	9.63	8.06	1.57	0.00062
672	9.88	8.40	1.40	0.00041
5cm^3				
168	9.51	8.65	0.86	0.00102
336	9.66	8.82	0.84	0.00050
504	9.54	8.72	0.82	0.00032
672	9.64	8.84	0.80	0.00024
10cm^3				
168	9.60	8.90	0.70	0.00083
336	9.61	8.93	0.68	0.00040
504	9.49	8.89	0.60	0.00024
672	9.50	8.90	0.60	0.00018
15cm^3				
168	9.55	8.95	0.60	0.00071
336	9.54	9.04	0.50	0.00030
504	9.49	9.09	0.40	0.00016
	9.34	9.03	0.31	0.00009

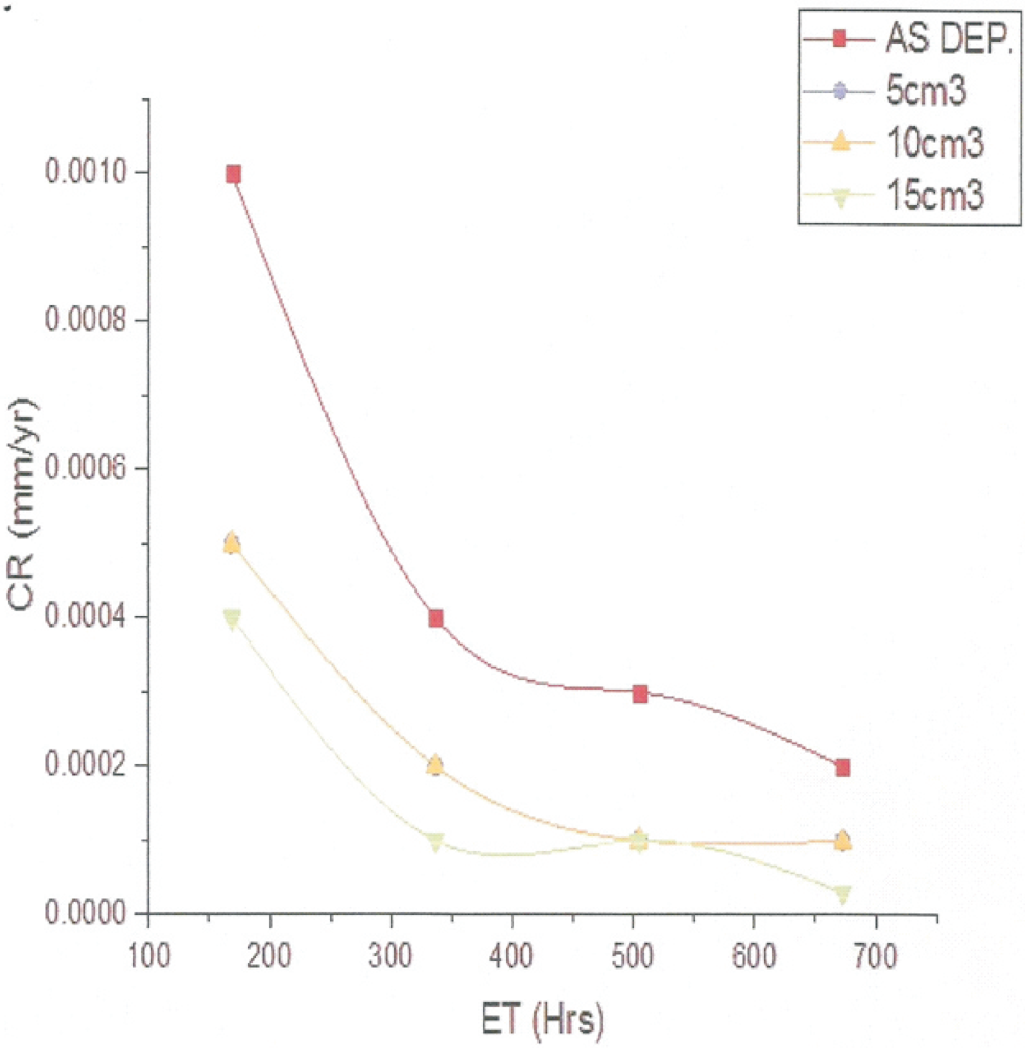

Figure 13: The graph of corrosion rate (mm/yr) against exposure time for cassava leaves extract in 0.5 M NaOH concentration.

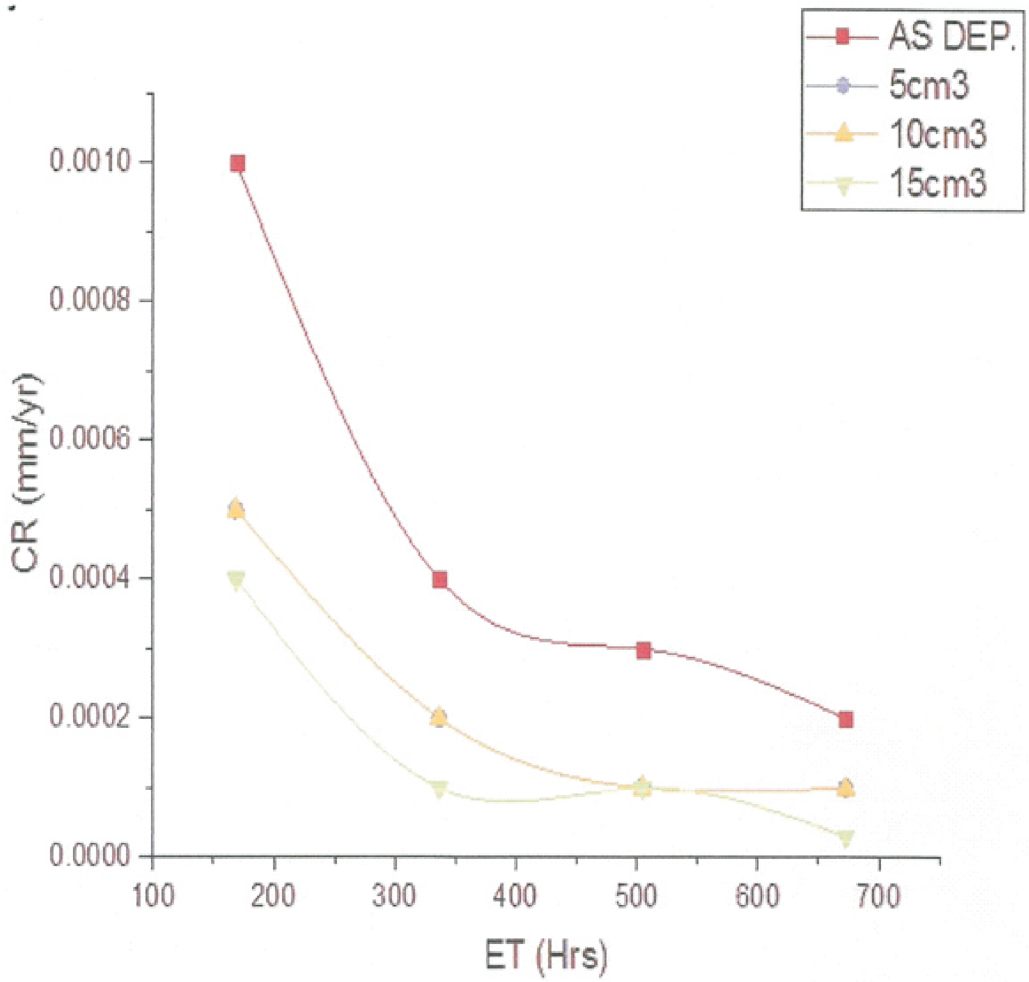

Figure 13: The graph of corrosion rate (mm/yr) against exposure time for cassava leaves extract in 0.5 M NaOH concentration.

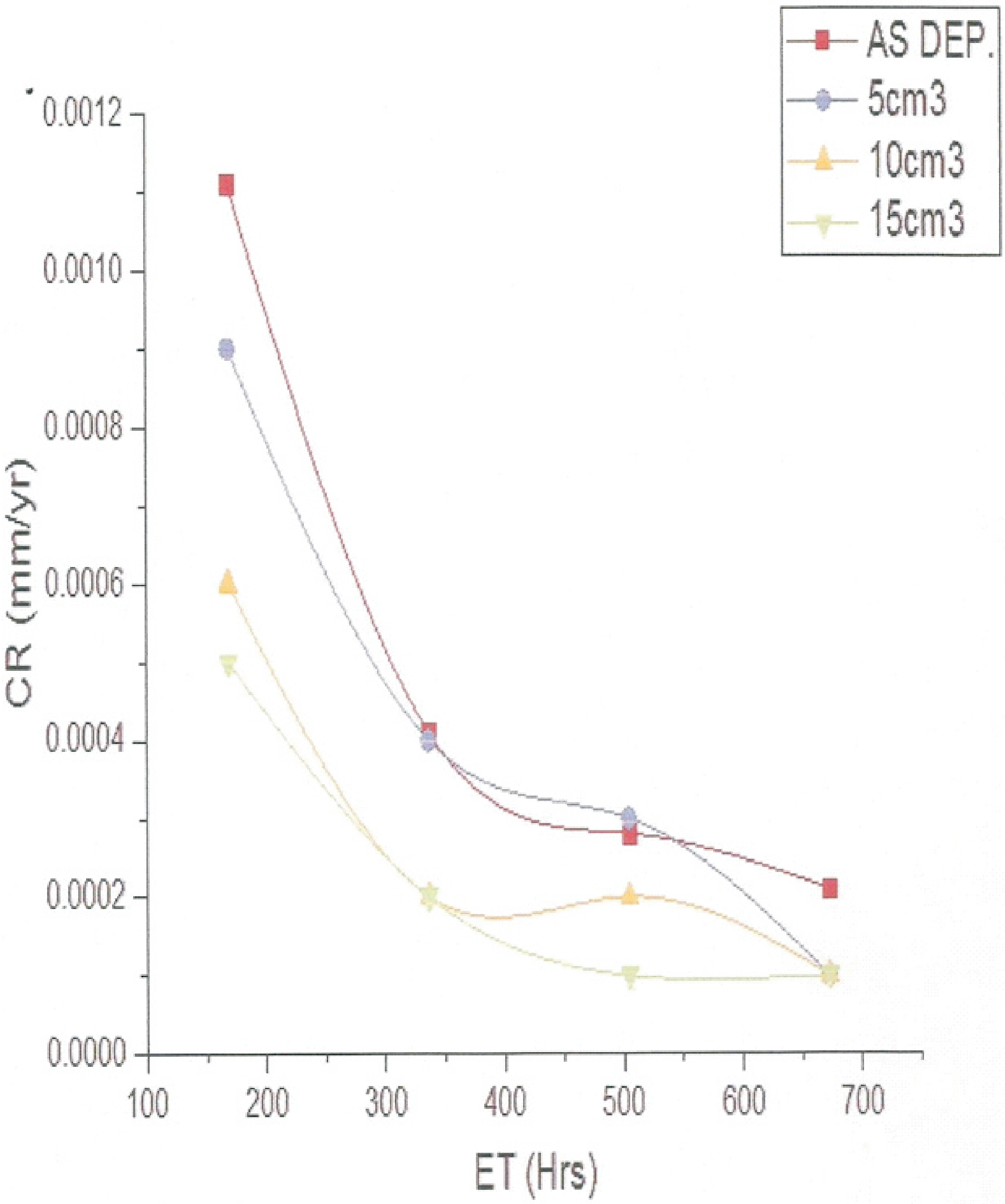

Figure 14: The graph of corrosion rate (mm/yr) against exposure time for cassava leaves extract in 1.0 M NaOH concentration.

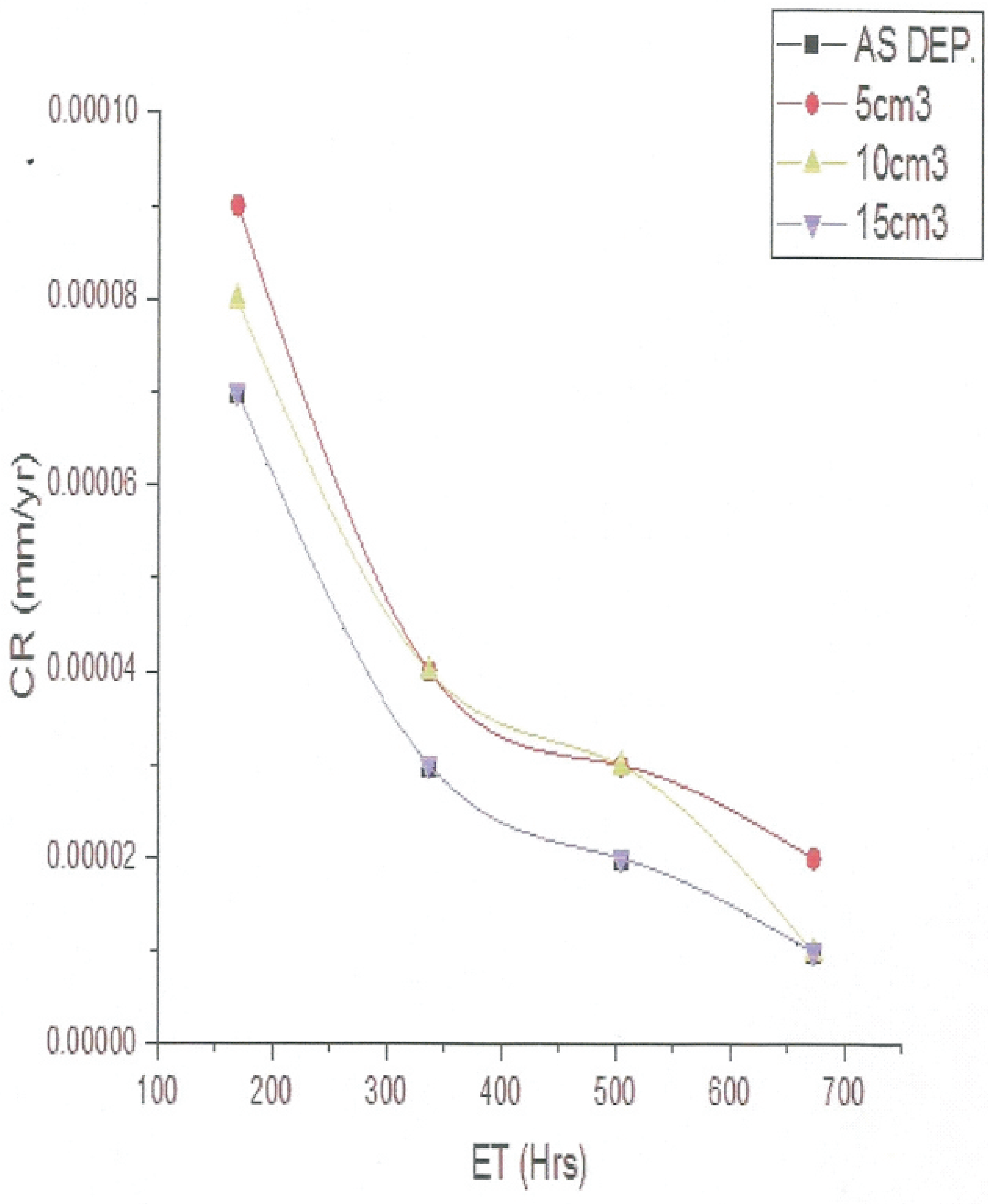

Figure 15: The graph of corrosion rate (mm/yr) against exposure time for cassava leaves extract in 0.5 M NaCl concentration.

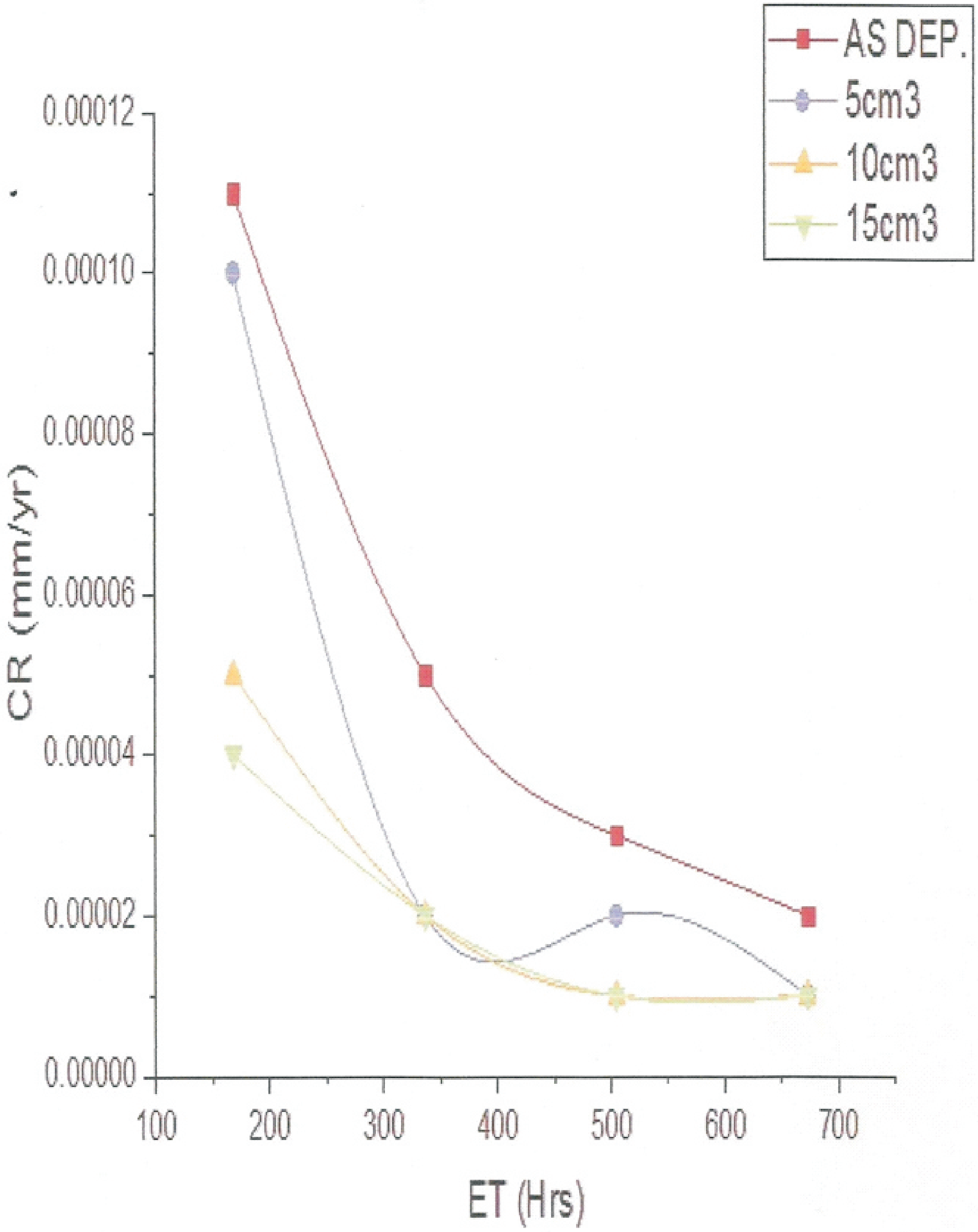

Figure 16: The graph of corrosion rate (mm/yr) against exposure time for cassava leaves extract in 1.0 M NaCl concentration.

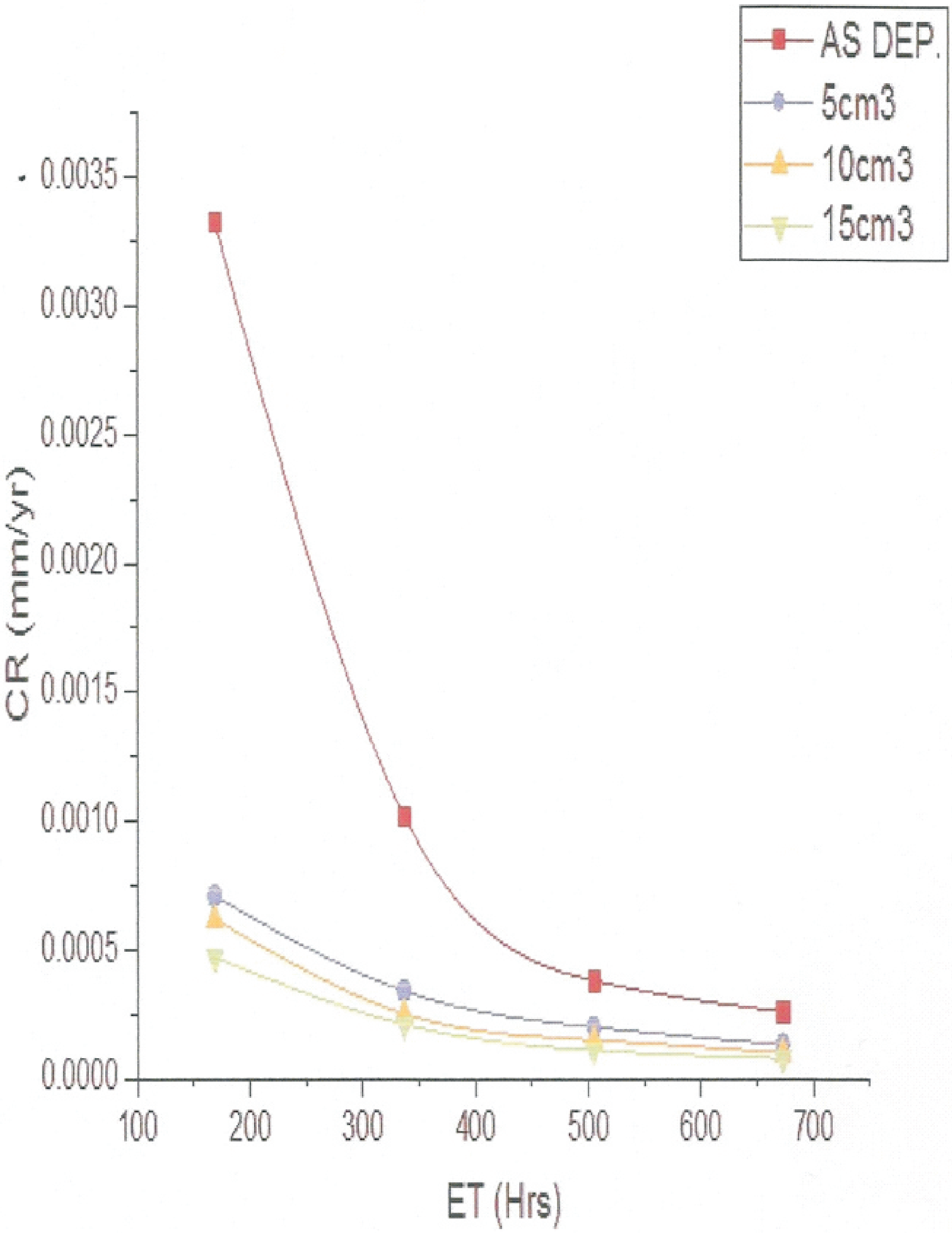

Figure 17: The graph of corrosion rate (mm/yr) against exposure time for cassava leaves extract in 0.5 H_2SO_4 concentration.

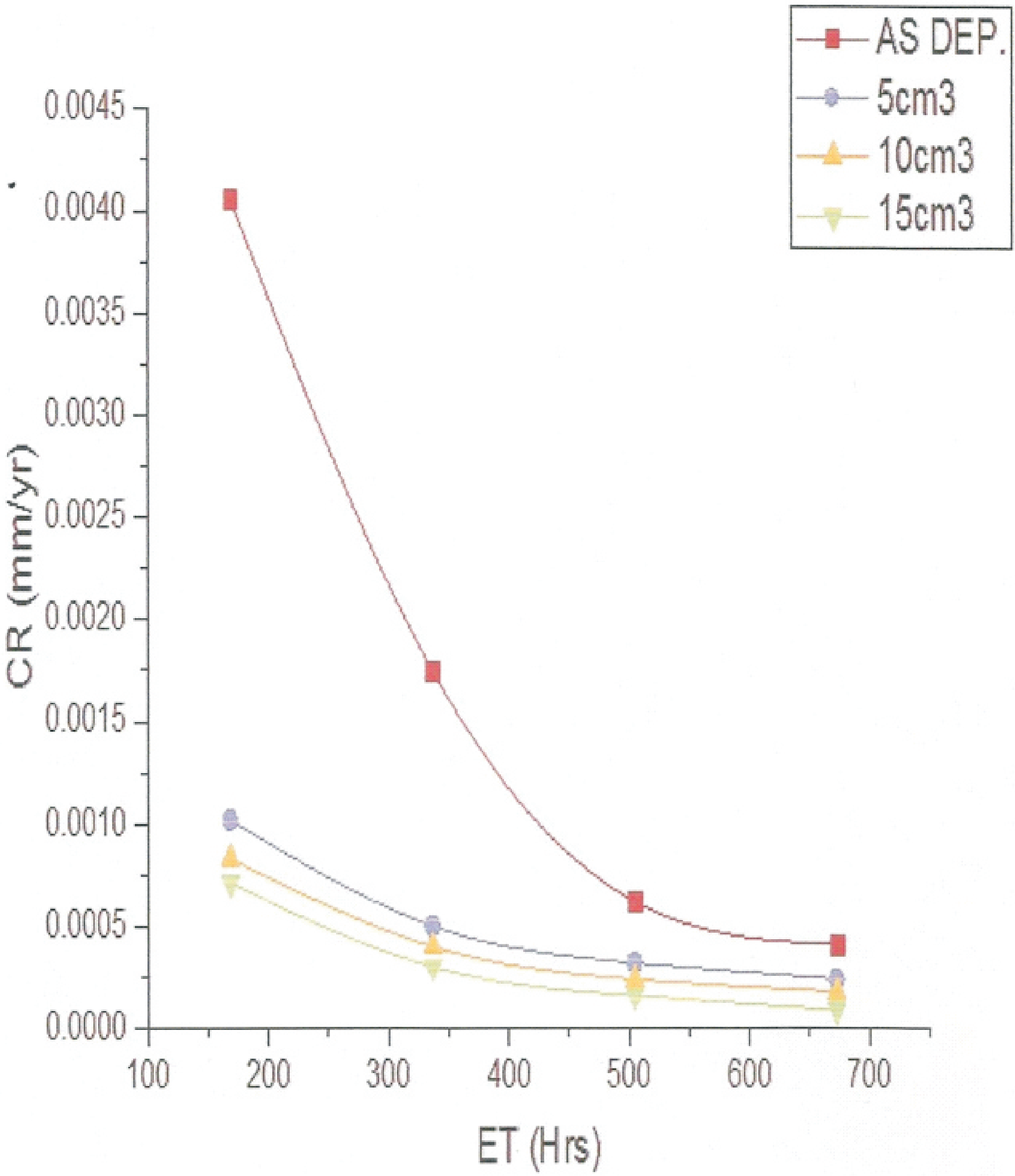

Figure 18: **T**the graph of corrosion rate (mm/yr) against exposure time for cassava leaves extract in 1.0 M H_2SO_4 concentration.

Figures 1and 2 show the corrosion rates against exposure time at various concentrations of leaf extracts in 0.5 M NaOH and 1.0 M NaOH media respectively. The plot also shows that in each medium, the corrosion rate increased, reached the maximum value and started to fall exponentially. The continued decrease in corrosion rate could be attributed to the formation of oxide layer/film which shields the specimen from having direct contact with the environment hence this fall in corrosion rate with days which is the inverse of the expected results is due to passivation. That is, as exposure hours increases, the material become less affected by environmental factors due to the formation of non-reactive and low solubility films on the material surfaces (Idu et al, 2016). The control experiment without any extract addition gave higher corrosion rate values throughout the experimental period. These results confirm that the Manihot esculenta possesses corrosion-inhibiting property. It is not certain, however, whether the optimum concentration needed for more effective corrosion inhibition have been reached with any of the three concentrations used.

The results obtained for the variation of corrosion rate with exposure time for the mild steel specimens immersed in 0.5 M NaCl with varied concentrations of Manihot esculenta added extract is presented in Fig. 3. From Fig. 3, the graph of the control experiment without Manihot esculenta clearly shows low corrosion rate throughout the experimental period as compared to 15 cm^3 concentration of Manihot esculenta leaf extract. The media with Manihot esculenta had a high corrosion rate from the 168 hours to the 672 hours. This shows that the Manihot esculenta leaf extract are more reactive in 0.5 M NaCl media that makes the coupon to be more corrosive. From Fig. 4, the graph of variation of corrosion rate shows control experiment without any Manihot esculenta extract addition having the highest corrosion rate values, achieving 0.00011, 0.00005, 0.00003 and 0.00002 mm/year for 168 hours to the 672 hours respectively. The addition of the various concentrations of the Manihot esculenta leaf extract shows significant reduction in the recorded corrosion rate values, which indicate the magnitude of corrosion rate reduction. In this case, it can be said that a reasonable degree of corrosion inhibition of the test specimen in the salt
medium was provided. Two different concentrations (10 and 15 cm respectively) of the Manihot esculenta leaf extract gave very close values of corrosion rate, however, the 5 cm^3 Manihot esculenta leaf extract addition had a higher corrosion rate 0.00010 mm/year for 168 hours. Manihot esculenta corrosion inhibition in 0.5M $H_2SO_4$for mild steel: The results obtained for the variation of corrosion rate with exposure time for the mild steel specimens immersed in 0.5M H_2SO_4 with varied concentrations of Manihot esculenta added extract is presented in Fig. 5. The acid test medium with 15 cm concentration of Manihot esculenta extracts addition showed the best corrosion rate inhibition effect of the immersed specimens as shown in Fig. 5. Figure 6 shows the decreasing trend of the corrosion rate with the exposure time, an indication of the weakening of the test environment by the corrosion deposit, which stifled the corrosion reactions. The presence of phytochemical constituents to a reasonable concentration in the plant extract would have been largely responsible for the exhibited corrosion inhibition property of this extract. The test without plant extract addition has a high corrosion rate.

IV. CONCLUSION

Based on the experimental results obtained, it can be concluded that the Manihot Esculenta leaf extracts act as good green corrosion inhibitor and can be used to retards the corrosion rate of mild steel if the appropriate concentration is used. Among the two plant extract used, it was observed that Manihot Esculenta has the best inhibition efficiency in mild steel in both acidic, alkaline and salty. Corrosion rate increased with time of exposure to the corrosive medium.

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