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Study of *Adathoda vasica* as corrosion inhibitor on mild steel

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ABSTRACT

The present study is attempted to investigate the inhibition of corrosion in mild steel in acid medium by using Adathodavasica plant extract. The weight of the mild steel specimen at different time intervals was measured at different concentration levels of the adathodavasica in 1N HCl. A quadratic equation was fitted to the corrosion phenomena by least squares method using SPSS statistical package. It is found that adathodavasica at 100 ppm was an efficient inhibitor to an extent of 96.3%. It was also found that corrosion was slowed down to the extent of 78.2%.

Keywords: Adathodavasica plant extract; Corrosion; Inhibitor; Quadratic equation

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INTRODUCTION

Most of the engineering materials are made up of iron, copper and aluminium base alloys. These are mainly used in condensers, heat exchangers, boilers, fabrications and refineries. The use of sea water or back water for cooling is economical in industries like fertilizers, petrochemicals, chemical processing plants etc situated around Surathkal. The corrosion of these materials by chemical and electrochemical reaction leads to material damage, accidents, material loss etc.

The metallic corrosion being an electrochemical process with anode or cathode reactions. It is possible to reduce corrosion by reducing the rate of either or both of these reactions. The literature survey reveals that organic inhibitors in lower concentration (ppm level) decreases corrosion rate [1,2]. Many of these possesses nitrogen, sulphur, oxygen containing aliphatic or aromatic molecules that forms a protective screen and prevent evolution of hydrogen in cathode region[3] or anodic reactions. The corrosion rate depends on the nature, shape and irregularity of the metal surface, properties of inhibitor, medium, temperature etc.

A good number of inhibitors[4,9] are implemented to retard corrosion, but many of these although successfully retard corrosion are not economically favorable, require tedious preparation technique and are toxic and hence a choice of inhibitor which are ecofriendly, non toxic, degradable and economically profitable are widely studied, such as plant extracts in aqueous and organic phase[10-16].

MATERIALS AND METHODS

2.1. Weight Loss Method:

The commercially available alloys having dimensions 5x2x0.1cm are polished and these specimens are immersed in known amount of medium with various diverse ions. The weight loss is measured in the absence and presence of inhibitors for any specific period of time. The specimen were taken out and washed with distilled water rinsed with trichloroethylene dried and reweighed. The percentage inhibition efficiency can be calculated

$$I.E = \frac{w_o - w_i}{w_o} \times 100$$

Where w_o and w_i are the weight losses in uninhibited and inhibited corroding solutions respectively.

2.2. Preparation of plant extract:

a)Adathodavasica (Adusoge) :The leaves of adathodavasica were collected and dried under sun light for three days and finely powdered and used as inhibitor.

Phytochemical Sreening:

Plant extract used	Alkaloids		Carbohydrates	Saponins	Phenols	Flavonoids	Proteins
	Wagner's test	Hager's test	Molisch's test	Foam test	$FeCl_3$ Test	Lead acetate test	Xanthoproteic test
Adathoda vasica	Present	Present	Present	Present	Present	Present	Present

Preparation of specimen: The commercially available mild steel was used for experiment. The elemental composition is as follows, carbon 1-2 %; Mn 0.1-0.2 %; P 0.4-0.5 %; S 0.02 – 0.03 % and remaining Fe. The mild steel bar having dimensions 4 cmx3 cm x 0.5 cm was polished using different grade emery papers(100,180,320,400,600,720,800and 1/0, 2/0,3/0, 4/0).The finished specimen are used for weight loss experiment.

Preparation of test media:

Hydrochloric acid 1N: About 110 ml concentrated (11 N) hydrochloric acid is diluted using distilled water to 1000 ml. This approximate 1 N HCl was standardized by 1N sodium carbonate solution using methyl orange indicator. The known concentrated acid is then made to 1 N HCl by proper addition of distilled water.

100 ml of 1N HCl was taken in three 150 ml beakers. The known weight of solid plant extract was carefully added. The above mixture stirred well. The mild steel specimen was suspended and covered with watch glass.

Weight loss method:

Mild steel specimen were mechanically polished and polished by emery of different grade. The polished specimens were decreased using acetone or trichloroethylene. The weighed specimen was carefully immersed in each beaker containing 100ml of 1N HCl with and without plant extract. Weight loss measurements were made for five days in every 24 hours .At an interval of 24 hours test specimens were taken out and washed with distilled water and rinsed with trichloroethylene or acetone, dried and reweighed.

2.2. *Tabulation and Calculation*:

The weight loss without inhibitor for mild steel in 100 ml of 1 N HCl , sea water (5%salinity), 10% NaCl at 24hours, 48hours ,72 hours ,96 hours ,120 hours were recorded in Table 1.

Table 1:Weight loss of mild steel without inhibitor for in 1N HCl, 10% NaCl and sea water

Medium	Weight loss in gram					
	24 Hrs	48Hrs	72 Hrs	96 Hrs	120 Hrs	144 Hrs
100 ml of 1N HCl	0.7427	1.7562	3.0171	4.5058	6.1993	8.0746
100ml of 10% NaCl	0.0047	0.0081	0.0126	0.0159	0.0203	0.0231
100 ml of sea water	0.0032	0.0062	0.0104	0.0141	0.0175	0.0215

The weight loss for every 24 hours in 100 ml of 1 N HCl medium is tabulated in Table 2.

Table 2: Weight loss of mild steel without inhibitor in 1N HCl

Time in Hrs	Weight in g	Weight loss for every 24 Hrs (g)	Difference of weight loss for every 24 Hrs (g)	Difference of weight loss as increase of 24 Hrs (g)
0	57.5263			
24	56.7836	0.7427		
48	55.7701	1.0135	0.2708	
72	54.5092	1.2609	0.2474	0.0234
96	53.0205	1.4887	0.2278	0.0196
120	51.3270	1.6935	0.2048	0.0230
144	49.4517	1.8753	0.1818	0.0230
168	47.4173	2.0344	0.1591	0.0227
192	45.2467	2.1706	0.1362	0.0229

The details of weight loss for every 24 hours in 100 ml of 1 N HCl with inhibitor adathodavacica at different concentration is tabulated in Table 3.

Table 3: Mild steel in 1N HCl at room temperature (30±1^0 C) with Adathodavasica extract

Inhibitor concentration in (ppm)	Weight loss in g					% inhibitor efficiency				
	24	48	72	96	120	24	48	72	96	120
0	0.7427	1.7562	3.0171	4.5058	6.1993					
10	0.1343	0.2928	0.6302	1.1083	2.2172	81.92	16.61	20.89	24.60	35.76
20	0.2948	0.5079	0.8033	1.2163	1.6864	60.31	28.92	26.62	26.99	27.20
50	0.1527	0.4005	0.6255	0.8626	1.3520	79.40	77.10	79.26	80.85	78.19
80	0.1247	0.2720	0.3930	0.5120	0.6530	83.20	84.50	86.97	88.63	89.46
100	0.0381	0.1276	0.2816	0.5301	0.7290	87.00	90.00	89.00	87.00	88..82
200	0.1219	0.2570	0.4696	0.7248	1.0398	83.97	85.53	84.33	88.30	85.13

RESULTS AND DISCUSSION

The results of weight loss with exposure time for mild steel specimen immersed in 100 ml of 1 N HCl with varied concentration of plant extract shows the inhibition to corrosion. The plot of graph weight loss against time (Figure 1), percentage efficiency against time and inhibitor concentration (Figure 2) indicates that as concentration of inhibitor increased the percentage efficiency increases in most cases. In case of adathodavasica extract lower concentration also found to be quite protective against corrosion. The plant extract normally composed of N or O atom containing compounds and results of inhibition found to be chemisorptions.

The plot of graph % Efficiency against Concentration (Figure 3) supports the chemisorptions. The plot of graph % Efficiency against time higher concentration above 100 ppm inhibits corrosion of mild steel effectively.

Thus the above plant extract expected to contribute significantly in promoting suitable efficient and economical corrosion inhibitor in commercial scale.

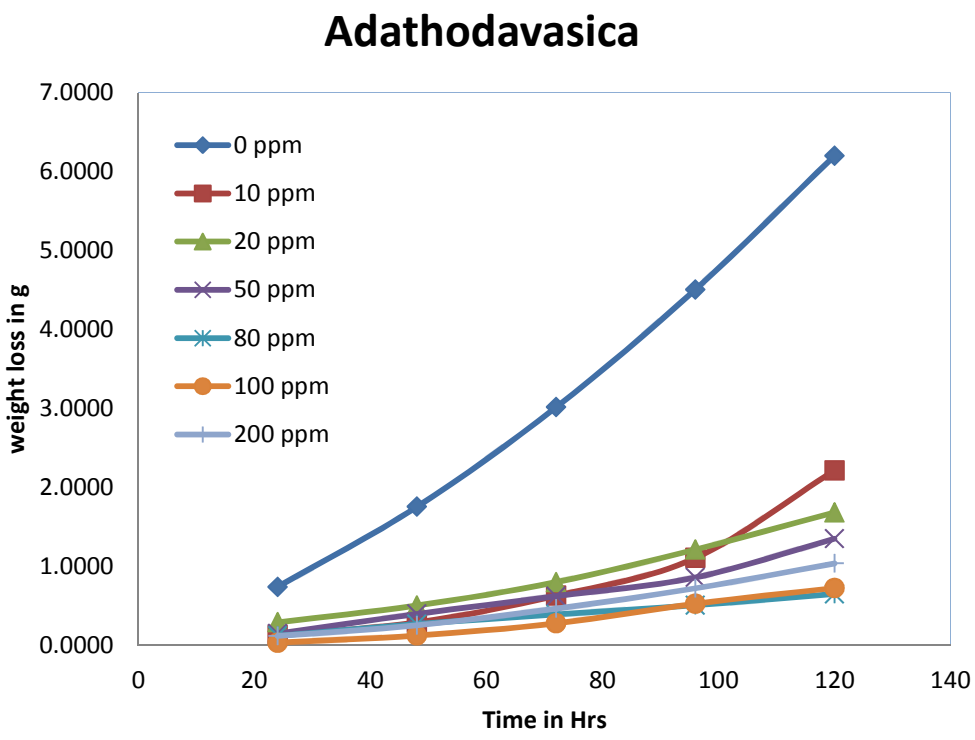


Figure 1. The plot of graph weight loss against time

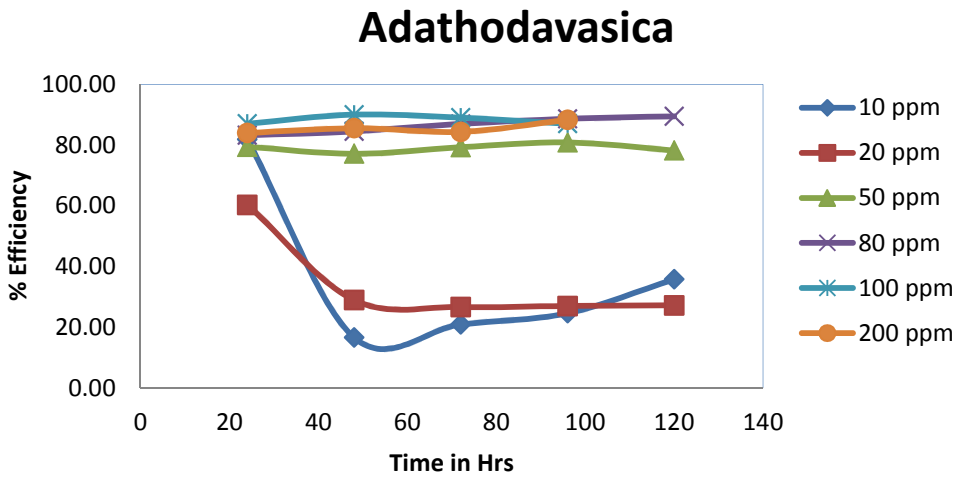


Figure 2. The plot of % Efficiency vs time in hrs

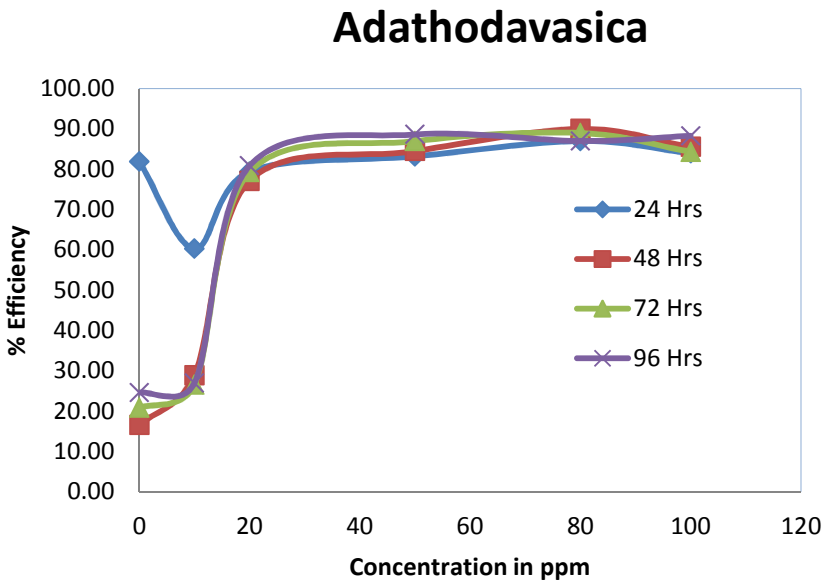


Figure 3. The plot of % Efficiency vs concentration in ppm

Table 4: Mild steel in 1N HCl at room temperature (30±1^0 C) with Adathodavasica extract

Concentration (ppm)							
hours	0	10	20	50	80	100	200
0	57.5263	57.5263	57.5263	57.5263	57.5263	57.5263	57.5263
24	56.7836	57.392	57.2315	57.3736	57.4016	57.4882	57.4044
48	55.7701	57.2335	57.0184	57.1258	57.2543	57.3987	57.2693
72	54.5092	56.8961	56.723	56.9008	57.1333	57.2447	57.0567
96	53.0205	56.418	56.31	56.6637	57.0143	56.9962	56.8015
120	51.327	55.3091	55.8399	56.1743	56.8733	56.7973	56.4865

Linear

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.990	.981	.976	.363
The independent variable is Weight Measured at(hours).			

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	27.090	1	27.090	205.206	.000
Residual	.528	4	.132		
Total	27.618	5			
The independent variable is Weight Measured at(hours).					

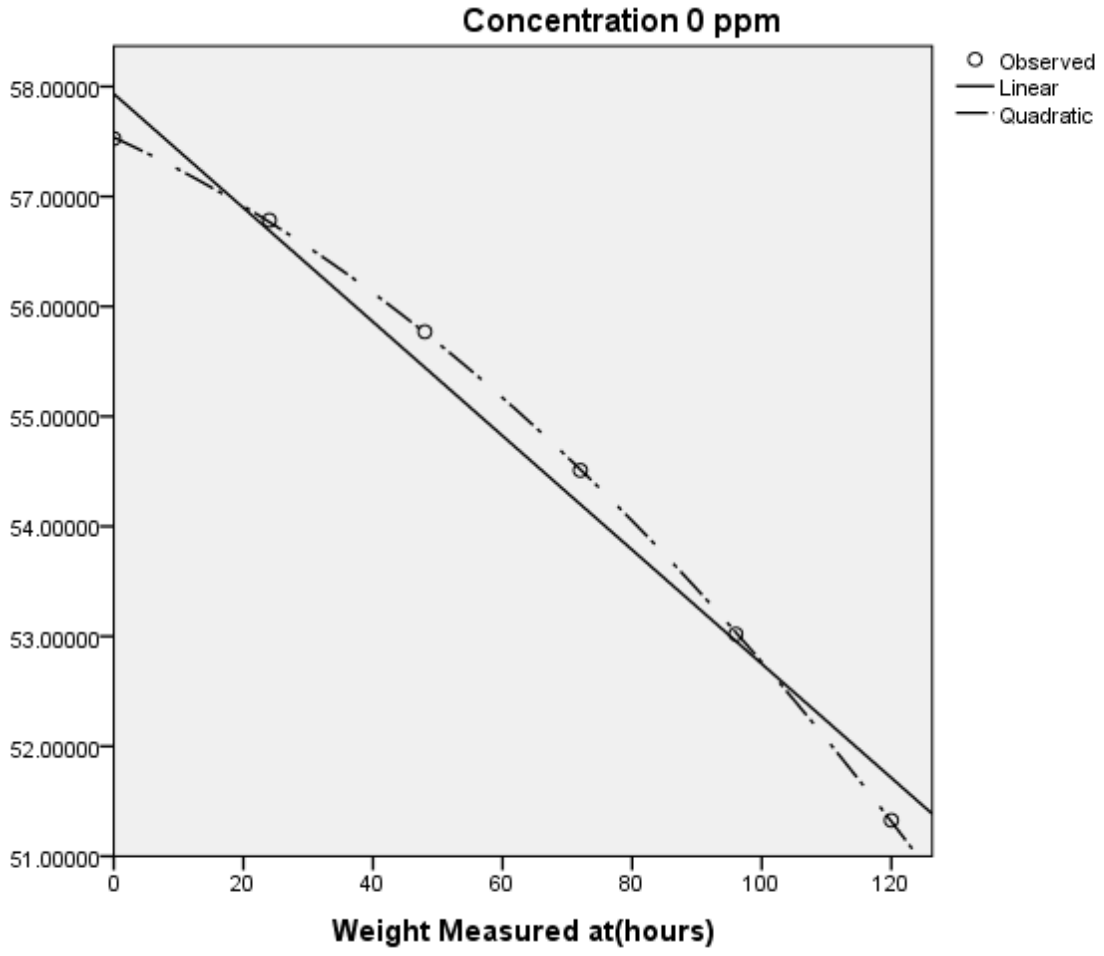
Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Weight Measured at(hours)	-.052	.004	-.990	-14.325	.000
(Constant)	57.933	.263		220.308	.000

Quadratic

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
1.000	1.000	1.000	.017
The independent variable is Weight Measured at(hours).			

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	27.617	2	13.809	49315.706	.000
Residual	.001	3	.000		
Total	27.618	5			
The independent variable is Weight Measured at(hours).					

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Weight Measured at(hours)	-.027	.001	-.517	-45.565	.000
Weight Measured at(hours) ** 2	.000	.000	-.493	-43.392	.000
(Constant)	57.537	.015		3793.843	.000

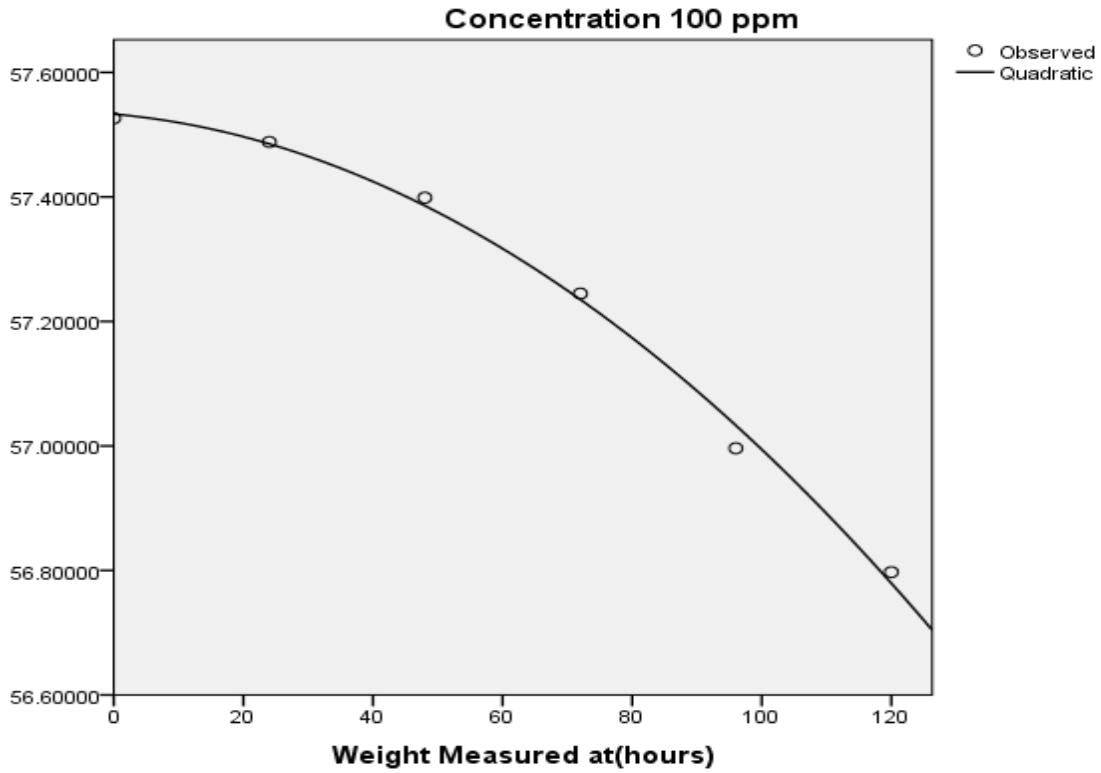


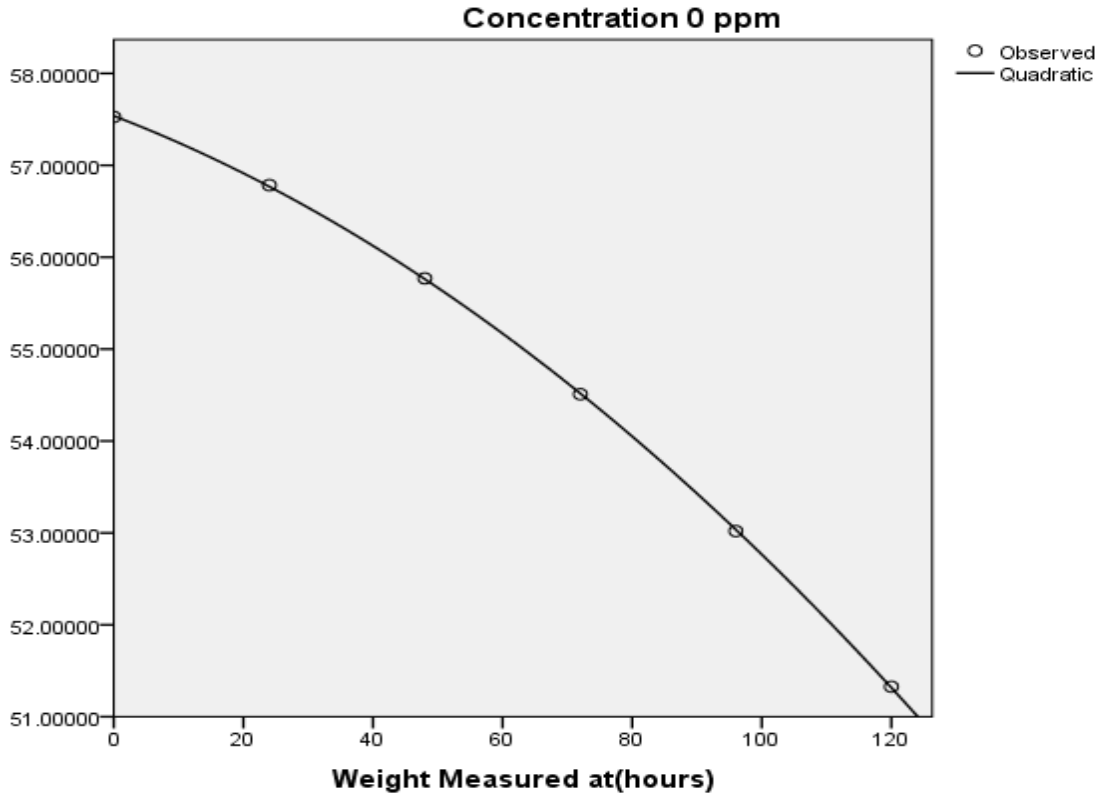
Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.968	.937	.921	.082
The independent variable is Weight Measured at(hours).			

From the above tables and the graph it is clear that Quadratic relation better explains the phenomena of decrease in weight of the metal due to rusting. The quadratic equation is given by

$Y = 57.537143 - 0.027084X – 0.00021X^2$

Y = weight of the metal at time X.,
-0.027084 is the rate of decrease in the weight for one unit of change in the time x.
-0.00021 is the amount of decrease in the rate of change. It is clear that weight decreases at a faster rate as the time passes.





From the very first graph it is clear that inhibitor concentration 100 ppm is more successful in reducing the weight decrease than any other concentration level. For further analysis we take this concentration level 100. Proceeding similarly as above this time we get the quadratic equation as follows.

$Y = 57.533 - 0.000923X - 0.000045X^2$

-0.000923 is less than -0.027084. Therefore rate of decrease in the weight has come down. This is because of inhibitor. Also, amount of decrease in the rate of change has also come down. This is because -0.000045 is less than -0.00021. This shows that inhibitor really works.

CONCLUSION

Adathodavasica extract is found to be the efficient inhibitor for mild steel at 100 ppm level in 1 N HCl medium. This study is statistically evaluated and the corrosion inhibition is in accordance with quadratic equation. *Adathodavasica* extract is non toxic and economical.

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REFERENCES

[1]. Subramanian N.C, Sherhadri B.S and Mayanna S.M; *Br. Corros.J* 19 (**1984**) 177.
[2]. Herbert H Uhling, Winston Revil R, *An Introduction to Corrosion Scienceand Engineering, Corrosion and Corrosion control*, Third edition(**1984**).
[3]. Thornhill R.S, Prevention of Corrosion by means of inhibitors 5 (**1952**)35.
[4]. Rajagopalan K and Venkatacharya G ; *Corrosion* 36(**1980**).
[5]. Gadiyar H.R.A. Gadag R.V, Gajendragad M.R, Sudhakar Nayak H.V and Ramachandran T, *Transaction of the SAEST* 18 (**1983**) 101.
[6]. Gadiyar H.R.A. Gadag R.V, Gajendragad M.R, Sudhakar Nayak H.V and Ramachandran T, Proceedings of the Annual Technical Meeting and symposium on electroplating in electronics, The Electrochemical Society of India, September 12-13,(**1983**).

[7]. Girish T. Kuchinad, *M.Phil Thesis* Mangalore University (**1990**)29
[8]. Isobe Yasuaki, Tanaka Shinichi, Hini Funio; *Boshoku gijutsu* 39(4) (**1994**) 185 Japan.
[9]. Valenev I.A, Kuznetsov Ya. I, Tyr E.V *Zashch.Met* 26(4)**1990** 564(Russ).
[10]. Farooqui I.H, Aqbal Hussain, Quraishi M.A. & Saini P.A; *Anti-Corros methods mater* 6(5)(**1999**)328.
[11]. Ananda Louise Bathiyanathan R , Maruthamuthu S, Selvanayogam M, Mohanan S & Palaniswamy. *Indian J. of Chem. Tech.*12(**2005**)356.
[12]. Mohanan S, Manimegalai m, Rajeshwari P, Maruthamuthu. S & Palaniswamy N , *Bull Electrochem*, 18 (8) (**2001**) 332.
[13]. Zakvi S.J. & Mehta G.N, *J Electrochem Soc*, 37(**1998**)237.
[14]. Smitha A, Verma& Mehta G.N, *Bull Electrochem*, 15(2)(**1999**)67.
[15]. Muhanath Basha, Mubarak Ali, Kulanthai Kannan; *J Applied Sciences and environment management* 13(11)(**2009**).
[16]. Anand B and Balasubramanian V, *E.J. Chem* 7(3)(**2010**)942.