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Podophyllum Hexandrum Fruit Extract as Corrosion Inhibitor of Mild Steel in 1N HCl

KEYWORDS: podophyllum hexandrum fruit extract , Adsorption, mild steel, Inhibition Efficiency

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ABSTRACT *The effect of podophyllum hexandrum fruit extract as an inhibitor for mild steel in 1N HCl using weight loss method has been investigated. The corrosion coupons were immersed in 1N HCl solution containing varying inhibitor concentrations (1%, 2%, 3%, 4% and 5% v/v) within a period of 1-4 hours. From the result, it was found that the adsorption of podophyllum hexandrum fruit extract reduced the corrosion rate in acid medium. The inhibitive action of this plant extract has been found to be significant. The most suitable inhibitor concentration was found to be 5% for an inhibition efficiency of 89%. The inhibition is attributed to physical adsorption. The adsorbed molecules of the inhibitor lie on the surface of the mild steel blocking the active corrosion sites on the alloy. This makes the alloy to have a higher corrosion resistance in the studied environment.*

INTRODUCTION

The use of inhibitors to secure metal against corrosion has come under severe criticism. Large amounts of sulphuric acid are being used in the chemical industry for the removal of undesired scales and rust (1). In chemical and allied industries mild steel has been extensively used. One of the ways of protecting mild steel from corrosion is the use of organic inhibitors (2). The use of natural products as corrosion inhibitor is becoming the subject of extensive investigation due to the low cost and eco-friendliness of these products and their biodegradability. This method is fast replacing the synthetic and expensive hazardous organic inhibitors (3). The yield of these compounds as well as their corrosion inhibition abilities varies widely depending on the part of the plant and its location (4). The extracts from the leaves, seeds, heart wood, bark, root and fruit of plant have been reported to inhibit metallic corrosion in acid media (5). The corrosion inhibitive action of flower extracts of Magnolia champaca flower on mild steel corrosion in 0.5 M H_2SO_4 solution was studied (6). The inhibition efficiency of sodium molybdate (SM) - Zn^{2+} system in controlling corrosion of carbon steel in seawater has been evaluated by weight-loss method(7). The inhibition behavior of Momordica charantia seeds extract (MCSE) as an environmentally benign corrosion inhibitor for J55 steel was investigated in 3.5 wt.% NaCl saturated with CO_2 solution(8). The corrosion and inhibition behaviors of mild steel in sulfuric acid + 5% EtOH in the presence of tannin extract of Chamaerops humilis plant (LF-Ch) and potassium iodide (KI) have been studied(9). The corrosion inhibition of mild steel in hydrochloric solution by Black pepper extract (Piper nigrum fem. Piperaceae) was studied(10). The inhibitive effect of the aqueous extract of Coffee senna (CS) on the corrosion of mild steel in 1M HCl and 0.5M H_2SO_4 solutions was investigated(11). An improved inhibition efficiency of 95.36% was observed with the mixture of Nypa fruticans' wurmb extract and KI at 30·C in 0.5M HCl(12). The inhibition of the corrosion of mild steel in aqueous solutions by ethyl acetate extract of Uncaria gambir containing catechin has been studied. Inhibition was found to be highest at a concentration of 150 ppm in solutions with a pH of 5(13). Acetone extract of red peanut skin gave an excellent protection on mild steel in 2M hydrochloric acid at 303K – 323K(14). The corrosion inhibitive action of flower extracts of Magnolia champaca flower on mild steel corrosion in 0.5 M H_2SO_4 solution was studied. The results obtained indicate that the extracts functioned as good inhibitors in 0.5 M H_2SO_4 solution(15). Silver nanoparticle using Cleistanthus Collinus Leaf Extract has been reported(16-17). The aim of the present work is to study the effect of the fruit extract of Podophyllum Hexandrum on the corrosion rate of mild steel in HCl acid using weight loss measurements and Electrochemical impedance studies.

EXPERIMENTAL

Materials

Methanol (Aldrich chemicals), Distilled water, Podophyllum hexandrum fruit extract and HCl (Qualigens chemicals).

Preparation of specimens

The Mild steel specimens with a dimension of 4×2×0.2 cm were taken. The specimens were mechanically polished by using different grades of SiC(grades 120-400-600) emery papers, degreased with acetone, dried and then stored in desiccator before use.

Preparation of extract

Fresh fruits of the podophyllum hexandrum were washed under running water. Exactly 300g of the fruit was taken. This was crushed and extracted using 600 ml methanol for a duration of 72 hrs at 60°C to obtain 50% of the solution. This methanolic extract was used for the corrosion studies.

Weight loss method

The Mild Steel was weighed and tied with threads and suspended in 100 ml HCl solution, with and without the extract of different concentrations at different intervals. Duplicate experiments were performed in each case and the mean value of the weight loss has been recorded. The weight loss has been calculated using the formula:

Corrosion rate = 87.6 x W/ Surface area of the specimens

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x T x D

Where, W = Weight loss in mg, A = Area of specimens in SqCm, D = Density of specimens in gm/Cm^3 and T = Time for which the specimens were exposed to the corroding medium (in hours)

Results and Discussion

The Corrosion behavior of MS substrate in 1N HCl in the absence and in the presence of extract was studied at different concentrations of extract and different time intervals. The variation of the corrosion rates with time of exposure for the reference and five different inhibitor concentrations in 1N HCl solution (Tables 1-4) has been studied. The inhibition efficiency varies with time of exposure for different inhibitor concentrations in 1N HCl solution.

The significant decrease in corrosion rate at 5% inhibitor concentration can be attributed to the adsorption of molecule of the inhibitor on the alloy surface, since this inhibitor contains tannin which acts as physical barrier to restrict the diffusion of ions to and from the alloy and then prevent the alloy atoms (ions) from participating in further anodic or cathodic reactions, thus resulting in decrease in the corrosion rate [18]. The plant extract can adsorb on the alloy surface and block the active sites on the surface, thereby reducing the corrosion rate in the medium.

Table 1 Corrosion behavior of mild steel in 1N HCl in the absence and presence of different concentrations of podopyllum hexandrum fruit extract. Immersion time 1 hr.

S.No	Concentration Of inhibitor(ml)	Initial weight of the substrate (g)	Final weight of thesubstrate (g)	Difference in weight (g)	Rate of Corrosion (mpy)	I.E(%)
1	Blank	5.717	5.713	0.004	10.3070	-
2	1%	5.623	5.620	0.003	7.7302	25.0%
3	2%	5.788	5.784	0.003	7.6085	25.0%
4	3%	4.846	4.844	0.002	5.1535	50%
5	4%	5.283	5.281	0.002	5.15	50%
6	5%	4.905	4.904	0.001	2.5767	75%

Table 2 Corrosion behavior of mild steel in 1N HCl in the absence and presence of different concentrations of Podopyllum Hexandrum fruit extract. Immersion time 2 hrs.

S.No	Concentration Of inhibitor (ml)	Initial weight of the substrate(g)	Final weight of the substrate (g)	Difference in weight(g)	Rate of corrosion (mpy)	I.E(%)
1	Blank	5.893	5.888	0.005	6.443	-
2	1%	5.309	5.305	0.004	5.153	20.0%
3	2%	4.916	4.913	0.003	3.865	40.0%
4	3%	5.295	5.292	0.003	3.865	40.0%
5	4%	5.106	5.086	0.002	2.576	60%
6	5%	5.562	5.561	0.001	1.288	80%

Table 3 Corrosion behavior of mild steel in 1N HCl in the absence and presence of different concentrations of podopyllum hexandrum fruit extract. Immersion time 3 hrs.

S.No	Concentration Of inhibitor(ml)	Initial weight of thesubstrate (g)	Final weight of thesubstrate (g)	Difference in weight(g)	Rate of corrosion (mpy)	I.E(%)
1	Blank	4.807	4.800	0.007	6.012	-
2	1%	4.93	4.925	0.005	8.865	28%
3	2%	5.558	5.554	0.004	3.220	42.8%
4	3%	4.950	4.947	0.003	2.576	57.1%
5	4%	4.902	4.9	0.002	1.932	71.4%
6	5%	4.838	4.837	0.001	0.644	85.7%

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Table 4 Corrosion behavior of mild steel in 1N HCl in the absence and presence of different concentrations of podopyllum hexandrum fruit extract. Immersion time 4 hrs.

S.No	Concentration Of inhibitor(ml)	Initial weight of the substrate (g)	Final weight of thesub-strate (g)	Difference in weight(g)	Rate of corrosion (mpy)	I.E(%)
1	Blank	4.807	4.800	0.007	6.012	-
2	1%	5.531	5.525	0.006	3.865	35.7%
3	2%	5.868	5.863	0.005	3.220	46.4%
4	3%	4.432	4.428	0.004	2.576	57.1%
5	4%	4.203	5.200	0.003	1.932	67.8%
6	5%	4.623	4.622	0.001	0.644	89.2%

Conclusions

The plant extract (podopyllum hexandrum fruit extract) decreases the corrosion of mild steel in 1N HCl solution to an extent of 89% at the level of 5% inhibitor concentration upto four hours. The interaction between the inhibitor and the alloy results in physical adsorption. The adsorbed inhibitor molecules are attached at the alloy surface thereby blocking active corrosion sites hence lowering corrosion rate.

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