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Research Article

Mild Steel Corrosion Inhibition by Plant Extract in 0.1 M Hydrochloric Acid Solution

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Abstract: Extract of Clerodendrumphlomidis plants leaves was investigated as corrosion inhibitor of mild steel in 0.5M HCl using conventional weight loss method and scanning electron microscopic studies. The weight loss results showed that all the plant extracts are excellent corrosion inhibitors, Scanning electron microscopic studies provided the confirmatory evidence of improved surface condition, due to the adsorption, for the corrosion protection.
Keywords: HCl Solution,Mild Steel, corrosion inhibitor, scanning electron microscopy

INTRODUCTION

Though many synthetic compounds have shown good anticorrosive activity, most of them are highly toxic to both human beings and environment. The safety and environmental issues of corrosion inhibitors arisen in industries has always been a global concern [1]. Such inhibitors may cause reversible (temporary) or irreversible (permanent) damage to organ system viz., kidneys or liver, or to disturb a biochemical process or to disturb an enzyme system at some site in the body. The toxicity may manifest either during the synthesis of the compound or during its applications. Although the most effective and efficient organic inhibitors are compounds that have π bonds, the biological toxicity of these products, especially organic phosphate, is documented specifically about their environmental harmful characteristics. From the standpoint of safety, the development of non-toxic and effective inhibitors is considered more important and desirable, nowadays, which are also called eco-friendly or green corrosion inhibitors. These toxic effects have led to the use of natural products as anticorrosion agents which are eco-friendly and harmless.

In recent days many alternative eco-friendly corrosion inhibitors have been studied and developed, they range from rare earth elements to organic compounds [2-6]. In the present work the extracts of the leaves of Clerodendrum phlomidis evaluated and studied in details. *Clerodendrum phlomidis*, a Verbenaceae family plant is found on low hills. The height of the tree is 6-9m, tolerably smooth and ash coloured. Leaves are heart-shaped, fine-tipped, entire or 3-lobed, mostly 2-5 cm long (but up to 12 cm), longer than wide [7].

EXPERIMENTAL

Weight Loss Method

The polished and pre-weighed MS specimens were suspended in 100 ml test solutions, with and without the inhibitor of different concentrations, for 2h of immersion at temperatures of 303K, 313K and 323K.The temperature was controlled by an aqueous thermostat. After the immersion test, the specimens were carefully washed in double-distilled water, dried and then weighed. The rinse removed loose segments of the film of the corroded samples. Duplicate experiments were performed in each set of the test and the mean value of the WL is reported. The loss in weight was determined by analytic digital micro-balance.

Preparation of Solutions

Preparation of HCl Solution

The Analytical Reagent grade of HCl was used for preparing the acid electrolyte in the present study. This acid was exactly diluted with double distilled water to prepare 0.1M HCl solution. For each set of experiment freshly prepared 0.1 M HCl solutions were used to avoid effect of any contamination.

Preparation of Herbal Extracts Solutions

About 25 g of dried and powdered leaves of the plant was refluxed with 0.1 M HCl for about 5 h and was kept overnight to completely extract the basic components as these are soluble in the acid. The solution was filtered off and the filtrate was diluted to 500 ml with 0.1 M HCl prepared as above. To know the concentration of mass of plant compounds extracted, 100 ml of the extract was taken to neutralize with 1M NaOH up to pH 8 in order to liberate the solid base from the salt formed in the extract.The neutralized solution was then extracted with chloroform. The

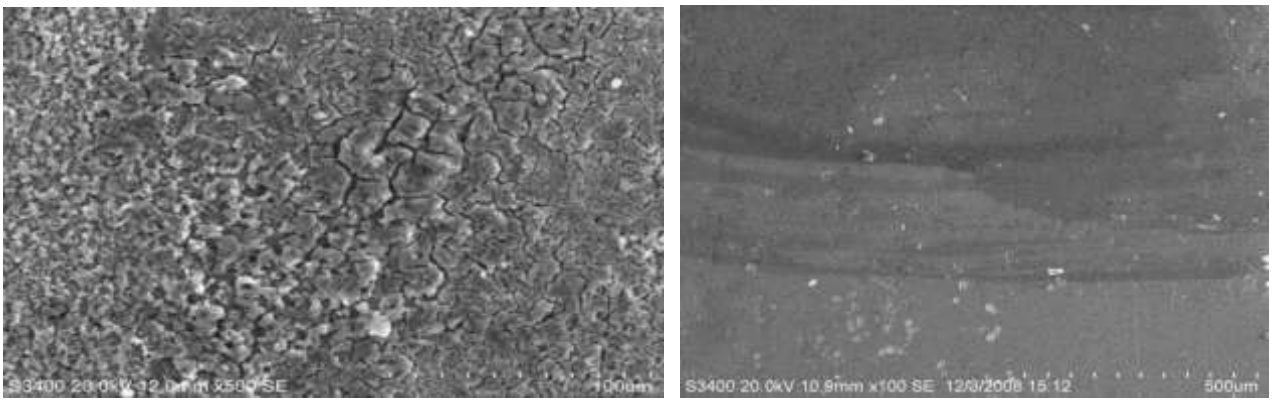
chloroform layer consisting of basic organic compounds was evaporated and the resultant gummy material obtained was dried and powdered and weighed accurately by digital micro-balance. From the weight of extracted mass as above, the concentration in mg of the plant compounds in each of the diluted 100 ml extract is calculated. The concentration range studied was varied from 10 to 50ppm in 100 ml of 0.1 M HCl.Theoriginal 100 ml acid extract was containing 50 ppm of the mass and was used to study its effect on corrosion of MS in blank 0.1 M HCl.The remaining original acid extract was then diluted by 0.1 M HCl, after calculating the volume of 0.1 M HCl to be added to into an aliquot of the original acid extract, to obtain 10,20,30,40 and 50ppm ppm of concentrations in each of the separate 100 ml diluted extract solutions, as in each set of experiment 100 ml the test solutions were used, except in WL method in which similarly prepared 500 ml of the test solutions were used.

Evaluation of Clerodendrum phlomidis Leaves as Corrosion Inhibitor of MS in 0.1M HCl Solutions

From the WL measurements, W_{corr} and the Ew% at various concentrations of Clerodendrumphlomidis leaves extract, after 2 h of immersion, at the temperatures of 303K, 313K and 323K are given in Table-1. Table 1. Inhibition Efficiency of MS in 0.1 M HCl solutions at various concentrations of Clerodendrum phlomidis leaves extract at various temperatures It could be clearly observed from the table that the values of Ew% were increased with increase in the concentration of Clerodendrum phlomidis leaves extract, reaching a maximum value of 96.30 % at the highest concentration of 50 ppm at temperature of 303 K. The results have shown that Clerodendrum phlomidis leaves extract could effectively protect the steel even at high temperature.

Table-1: Evaluation of Clerodendrum phlomidis Leaves as Corrosion Inhibitor of MS in 0.1M HCl Solution

Temperature (K)	Concentration of additive (ppm)	W (µg/cm2 h)	Inhibition Efficiency Ew%
303K	10	4.22	88.23
	20	3.32	89.22
	30	2.83	90.22
	40	2.33	93.11
	50	2.25	96.30
313K	10	4.97	84.23
	20	3.02	85.31
	30	3.50	87.01
	40	3.06	90.29
	50	3.68	92.27
323K	10	5.29	86.79
	20	4.59	87.25
	30	3.44	89.45
	40	3.51	90.58
	50	3.11	92.56



(a) (b)

Figure 1. SEM image of MS surface, a) in 0.1 M HCl solution, and that of b) with 50 ppm of Clerodendrum phlomidis leaves extract

The SEM photograph in Fig.a) shows that the surface of MS was tremendously damaged due to corrosion, in the absence of the extract while that in Fig.b) could clearly confirmed the formation of a light bluish film due to adsorption of the active Clerodendrum phlomidis leaves constituents on the MS surface and that the film was responsible for the corrosion inhibition.

RESULTS & DSSCUSIONS

A general trend of gradual increase in the weight loss with an increase in temperature is observed, and a gradual decrease in the degree of MS surface coverage and Ew% at highest concentrations of 50 ppm of each extract to establish that there was overall good stability and compactness of the barrier layers formed due adsorption of active molecules present in each extract and a gradual removal of some inhibitive molecules which were loosely adsorbed. From these data, it could be concluded that the order of Ew% at highest concentrations of 50 ppm of each extract at the highest temperature of 323 K.

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