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Aloe-Vera: A Green Corrosion Inhibitor

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Abstract: Corrosion is a major problem in industries so corrosion control is technically, economically and aesthetically important. Corrosion inhibitors provide protection to metals and alloy against corrosion, but organic inhibitors are toxic in nature whereas green inhibitors are biodegradable and no toxic compound are promoted, they are inexpensive, readily available and are renewable. The paper discusses the effect of aloe-vera as green inhibitor on Galvanised iron in HCl and H₂SO₄ solution. The paper also compares the result in two solutions.

Keywords: Corrosion inhibitors, HCl, H₂SO₄, Aloe-Vera, Biodegradable, Galvanised Iron.

I. INTRODUCTION

Corrosion is the deterioration of materials by chemical interaction with their environment. The term corrosion is sometimes also applied to the degradation of plastics, concrete and wood, but generally refers

to metals. The most widely used metal is iron (usually as steel) [1]. Corrosion can cause disastrous damage to metal and alloy structures causing economic consequences in terms of repair, replacement, product losses, safety and environmental pollution. Due to these harmful effects, corrosion is an undesirable phenomenon that ought to be prevented [1], [2]. There are several ways of preventing corrosion and the rates at which it can propagate with a view of improving the lifetime of metallic and alloy materials. The use of inhibitors for the control of corrosion of metals and alloys which are in contact with aggressive environment is one among the acceptable practices used to reduce and/or prevent corrosion. A corrosion inhibitor is a substance which when added in small concentration to an environment, effectively reduces the corrosion rate of a metal exposed to that environment.

Corrosion inhibitors can be divided into two broad categories namely those that enhance the formation of a protective oxide film through an oxidizing effect and those that inhibit corrosion by selectively adsorbing on the metal surface and creating a barrier that prevents access of corrosive agents to the metal surface [1], [2]. Almost all organic molecules containing heteroatoms such as nitrogen, sulphur, phosphorous and oxygen show significant inhibition efficiency. Despite of these promising findings about possible corrosion inhibitors, most of these substances are not only expensive but also toxic non-biodegradable thus causing pollution problems. Hence, these deficiencies have prompted the search for their replacement.

Plants are sources of naturally occurring compounds, some with complex molecular structures and having different chemical, biological and physical properties. The naturally occurring compounds are mostly used because they are environmentally acceptable, cost effective and have abundant availability. These advantages are the reason for use of extracts of plants and their products as corrosion inhibitors for metals and alloys under different environment.

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Different plant extracts can be used as corrosion inhibitors commonly known as green corrosion inhibitors. Some of them are:

Tannins and their derivatives can be used to protect steel, iron and other tools from corrosion. To protect mild steel in 2 M HCl solutions from corrosion, extracts from leaves can be used. Extracts of tobacco from twigs, stems and leaves can protect steel and aluminium in saline solutions and strong pickling acids [1]-[3].

Tannins, organic amino acids, alkaloids, and organic dyes of plant origin have good corrosion-inhibiting abilities. Plant extracts contain many organic compounds, having polar atoms such as O, P, S, and N. These are adsorbed on the metal surface by these polar atoms, and protective films are formed and various adsorption isotherms are obeyed.

It was found that inhibition efficiency increases with increase in concentration of extract and decreases with increase in temperature.

The degree of inhibition depends on nature of metal and type of medium. For steel and nickel, the inhibition efficiency increased in the order: alkaline < neutral < acidic, while in case of zinc, it increased in the order: acid < alkaline < neutral, thereby reconciling with the observed concept of the *Lawsonia* extract being a mixed inhibitor [1], [2], [4].

The present work investigated the inhibition efficiency of an aqueous extract of plant material, *Aloe vera* extract, in controlling corrosion of galvanised iron (GI) immersed in HCl and H₂SO₄ solution in the absence and presence of inhibitor, using mass loss method.

II. EXPERIMENTATION

Preparation of plant extract

An aqueous extract was prepared by grinding fresh extract of aloe vera gel, filtering and making solution using distilled water.

Preparation of specimens

Galvanised iron specimens (iron + carbon alloy + zinc) of dimensions 5 * 5 cm were prepared.

Weight loss method

Three GI specimens were immersed in 150 ml of HCl and H₂SO₄ solutions containing various concentrations of the inhibitor for one day. The weight of the specimens before and after immersion were determined. In the end effect of aloe-vera as inhibitor is compared in HCl and H₂SO₄ solution by testing the presence of zinc in solution with the help of K₄Fe(CN)₆ solution.

After one day add K₄Fe(CN)₆ solution to test the presence of zinc. Filter the solution using Whatman filter paper and measure final volume of solution collected and weight of the filtrate.

The results are tabulated as below:

Galvanised iron (5*5cm) – initial weight = 8.55g

HCl solution :

TABLE 1:

READING FOR HCL SOLUTION

Aloe-vera coating	Initial volume		Final volume of solution collected (ml)	Weight (g)
	Volume of solution (ml)	Volume of aloe-vera (ml)		
Without coating (1)	150	-	132	3

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Coating with aloe-vera (2)	140	10	138	2.85
Coating with concentrated aloe-vera (3)	120	30	142	2.36

H₂SO₄ solution :

TABLE 2 :

READING FOR H₂SO₄ SOLUTION

Aloe-vera coating	Initial volume		Final volume of solution collected (ml)	Weight (g)
	Volume of solution (ml)	Volume of aloe-vera (ml)		
Without coating (1)	150	-	130	6.24
Coating with aloe-vera (2)	140	10	136	0.71
Coating with concentrated aloe-vera (3)	120	30	140	0.5

Following readings clearly depict the inhibition effects of aloe-vera, still for a much clear picture some comparative charts are drawn below:

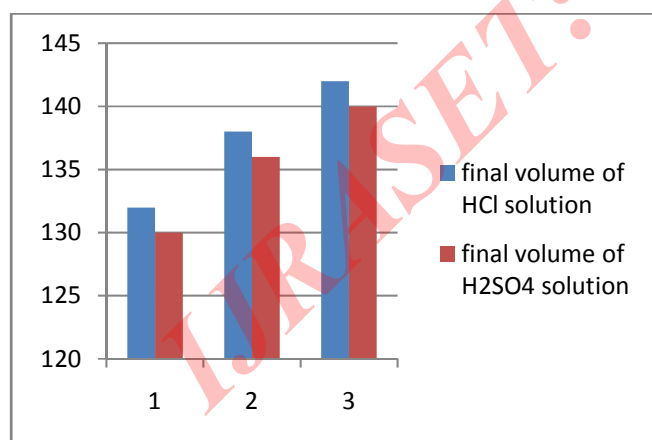


Figure 1: Final volume of HCl / H₂SO₄ solution obtained in the three different trails .

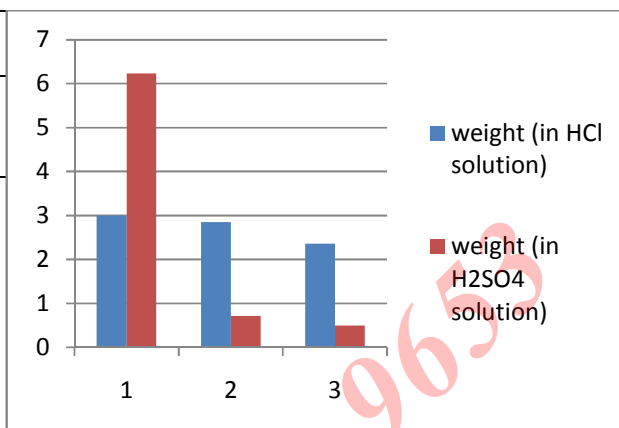


Figure 2: Weight of the filtrate obtained from HCl / H₂SO₄ solution in three different trails

III.RESULTS AND DISCUSSION

The graph shows that without inhibitor H₂SO₄ solution is more corrosive than HCl solution, but effect of aloe vera as inhibitor is also more in H₂SO₄ solution.

Thus, aloe-vera has high inhibition efficiency in H₂SO₄ solution.

IV.CONCLUSION

Corrosion inhibition is environmentally and economically important as it is a major problem in all industries. Green inhibitors are found to be effective due to environmental and ecological reasons as organic corrosion inhibitors are toxic in nature while green inhibitors are biodegradable, without any heavy metals and other toxic compounds and are inexpensive, renewable and readily available. The above work shows that aloe vera is potential corrosion inhibitor. Mannose-6-phosphate is the main constituent of the aqueous extract of aloe vera. It has excellent inhibition efficiency in controlling corrosion of galvanised iron in H₂SO₄ and HCl solution. Fe²⁺ aloe vera complex is found in protective film. It is UV

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fluorescent. Anodic reaction is predominantly controlled by formulation. Aloe vera is more effective in H₂SO₄ solution.

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