

Inhibition of corrosion action of aluminum in acid media by naturally occurring ethanolic extract of different plant parts of *Artocarpus heterophyllus* and *Acacia Senegal* plant

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Abstract

The inhibitive action of the ethanolic extract of different plant parts of the *Artocarpus heterophyllus* and *Acacia Senegal* plant towards hydrochloric acid and sulfuric acid corrosion of aluminum is tested using mass loss and thermometric techniques. It was found that the values of inhibition efficiency obtained by the two methods are in good agreement and are dependent upon the concentration of acid and inhibitor. The adsorption of these natural products on the metal surface from the acid has been found to obey Langmuir adsorption isotherm.

Keywords: Mass loss, Mylius thermometric method, *Artocarpus heterophyllus*, *Acacia Senegal*, Aluminum

Introduction

Inhibition of corrosion is the destructive attack on a metal or metal alloy by chemical or electrochemical reaction with its environment [1]. Aluminum and its alloys lend themselves too many engineering applications because of their combinations of lightness with strength, their thermal and electrical conductivities, heat and light reflectivity and their hygienic and non-toxic qualities. Although aluminum is a reactive metal according to electrochemical series ($E=1.66$). It is rendered unreactive in moisture due to the formation of a stable oxide film on its surface. Generally the organic compounds having heteroatoms O, N, S has higher basicity and thus assists corrosion inhibitor [2]. To reduce the corrosion problem in these environments Inhibitive effects of various naturally occurring substances like *Henna* [3], *Datura-stromonium* [4], *Capparis decidua* [5] *Ginge* [6] *Peepal (Ficus Religeosa)* [7], *Garlic* [8], *Prosopis Juliflora* [9], *Terminalia Bellerica* [10] which have been evaluated as effective corrosion inhibitor.

The present communication describes the application of extract of antioxidant [11] and antimicrobial [12] plants materials from acacia and antibacterial activity [13] and antioxidant property [14] from artocarpus as corrosion inhibitor. The alkaloids found in *Acacia Senegal* include less than 0.1% dimethyltryptamine (DMT) in leaf and N-Methyltrylamine (NMT) in plants part and Latex of *Artocarpus heterophyllus* contains 82.6-86.4% resin and proteins and bark contains 3.3% tannin. The seed powder was subjected to standard chemical tests as described by Farnsworth to determine the presence of alkaloids, flavanoids, phenols, steroids, oils, saponins, carbohydrates, starch, glucose, amino acids, and peptides [15]

Materials and Methods

Aluminum species containing 95% pure Aluminum of the dimension 1.5x2.5x0.025cm was used for the determination of corrosion rates. The specimens were cleaned by buffing to produce a mirror finish with the help of emery paper and were that degreased with acetone and distilled water each specimen was suspended by a glass hook and immersed in a beaker containing 50ml. of test solution at room temperature and left exposed to air.

The test solution of 0.1N, 0.2N, 0.5N, 1N HCl and H₂SO₄ were prepared by using double distilled water. The Senegal extract was obtained by drying the parts of the plant and then finely powdered and extracted with boiling ethanol. The solvent was vacuum distilled off and the residue treated with inorganic acid while the bases were extracted as their soluble salts. The free bases were liberated by various solvent eg. Ether, chloroform etc. The mixture of bases thus obtained was separated by various methods into the individual compound to clean the stuff obtained. It was boiled with activated charcoal (2gms) to remove gang and pure plant extract is obtained.

The corrosion inhibition efficiency of the compound is calculated by mass loss method using following equation [16].

$$(\eta\% = 100(\Delta M_u - \Delta M_i / \Delta M_u))$$

Where, M_u is the mass loss of metal in uninhibited acid and M_i the mass loss of metal in inhibited solution,

The degree of surface coverage (θ) can be calculated as

$$\theta = \Delta M_i / \Delta M_u$$

Where θ is surface coverage and ΔM_u and ΔM_i are the mass loss of the metal in uninhibited and inhibited acid.

The corrosion rate in miles per year can be obtained by the following equation [17].

$$\text{Corrosion Rate} = \frac{\text{mass loss} \times 87600}{\text{Area} \times \text{time} \times \text{density}}$$

Where mass loss in gram, Area is in of metal surface exposed time is expressed in hours of exposure and metal density is expressed in gram/cm³.

The corrosion current (i) can be calculated as [18].

$$\text{Corrosion Current (i)} = \frac{\text{Corrosion} \times F}{n}$$

Where F is faraday (96500) and n is number of electron. The inhibitive action and the compound will also be investigated by using mylius thermometric method. This involved the immersion of single specimens (2.5x1.5x0.025cm) in a reaction chamber containing 50 ml. of solution at initial temperature 298 ±0.1K. Temperature changes were measured at intervals of 5 minutes using thermometer with a precision of 0.01K. The temperature increased slowly at first then rapidly and attained a maximum value before falling. The minimum temperature was recorded the percentage inhibition efficiencies in this case were calculated ^[19].

$$(\eta\%)=100 (RN_{free} - RN_i) / RN_{free}$$

Where RN i and RN free are the reaction number in the presence and absence of inhibitor respectively and RN (K Min) is defined as

$$RN = (T_m - T_o) / t$$

T_m and t_o is the maximum and initial temperature respectively and t is the time required to reach the maximum temperature in mints.

Results and Discussion

The value of mass loss and percentage inhibitive. Efficiency (η) at different concentration of hydrochloric acid and sulphuric acid indicate that the inhibitive efficiency decreases with increasing acid concentration and. inhibitive efficiency increases with increase in inhibitor concentration. It was observed that all the inhibitors have reduced the corrosion rate to a significant extent but the maximum efficiency was obtained in lowest acid concentration (i.e. 0.1N) in hydrochloric acid. The inhibitors have shown efficiencies in the range from 65.77% to a maximum of 97.30% for Artocarpus latex and 59.91% to a 79.92% for Acacia leaves. It is observed that the value of corrosion current increases with increasing acid and inhibitor concentration. Inhibition efficiencies were also determined by thermometric method. The variation of inhibitor efficiency with inhibitor concentration. For latex in 0.1N, 0.2N, 0.5N and 1N solution of hydrochloric acid, and with sulphuric acid, shows that the maximum efficiency was obtained in lowest acid concentration. Inhibitor efficiency values were also determined by the thermometric method for aluminum in 2N hydrochloric and sulphuric acid they were recorded with various inhibitor concentration.

Adsorption plays an important role in the inhibition of metallic corrosion by inhibitors. Many investigators have used the Langmuir adsorption isotherm to study inhibitors characteristics ^[20]. The gradients are not equal to unity as would be expected for the Langmuir adsorption isotherm equation. The efficiencies of inhibitors expressed as the relative reduction in corrosion rate can be qualitative related to the amount of adsorbed inhibitors on the metal surface. It is assumed that the corrosion reaction are prevented from occurring over the active sites of the metal surface covered by adsorbed inhibitors species, where as the corrosion reaction occurs normally on the inhibitors free area. The inhibitors efficiency is then directly proportional to the fraction of the surface covered with adsorbed inhibitors.

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