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Leaves Extract of Carica Papaya Used As Corrosion Inhibitor for Aluminium in Acidic Media

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Abstract

The inhibitive action of leaves of carica papaya on aluminium corrosion in 0.5N sulfuric acid and 1N sulfuric acid solution at 303 K was studied using mass loss method.The results shows that inhibition efficiency increased with increasing concentration of plant extract and decreased with increasing of acid concentration.The leaf extract of carica papaya demonstrated better inhibition efficiency in acid medium.Corrosion inhibition is occured due to the adsorption of extract of leaves on the surface on aluminium.

Keywords: Carica Papaya, Aluminium,Corrosion ,Adsorption , Sulfuric Acid, Inhibition Efficiency,Mass Loss Method .

Introduction

Aluminium is non-magnetic and non-combustible, easily available and cheap due to the aluminium being widely used in chemical and electronics industries like in the formation of aircrafts tanks pipeline etc.

Aluminium and most of its alloy are rust resistant meaning it doesn't degrade due to oxide caused by iron and oxygen.Rust only occur in the iron and other metal that contain iron. Aluminium doesn't contain iron however, so it's naturally protected from rust even though it doesn't rust aluminium can still suffer from corrosion.

Corrosion refers to the degeneration of the metals by environment factors or elements.

Aluminium and most of its alloy are resistant to the major from the corrosion.The metal's natural coating of aluminium oxide provides a protective covering from air, temp , moisture and chemicals.

This protective film is generally stable in solution of pH 4.5-8.5[1] but due the solubility of the film in strong acid and alkaline media, metal shows a high rate of corrosion.

Aluminum suffers from severe corrosion in aggressive environment and it has to be protected. The corrosion of metal in aqueous solution occurs in two steps : oxidation and Reduction.

Oxidation reaction takes place at anode, whereas reduction takes place at cathode.

Cathodic reaction takes place by evolution of H or absorption of $O_2$to prevent corrosion, it is essential to add some corrosion inhibitors. A large number of organic compounds [2-7] are found to be used as corrosion inhibitors for aluminium.

Such compounds typically contain N, O and S in a conjugated system and function by absorption of molecules on the metal surface resulting in a barrier to corrosion. The adsorption is dependent on inhibitor structure as well as temperature and also on the composition of the metal and corpulent. These corrosion inhibitors because of containing hetero atoms in their aromatic or long carbon chain resulting in toxicity. The toxicity affects not only living organism but also the environment

Due to such toxicity there exists the need to develop a new claim of corrosion with the low toxicity and good efficiency.

The exploration of the natural product of plant origin containing different organic compound eg. alkaloids , toxins, pigments ,and amino acids exhibit inhibitor properties[8,9].

These green inhibitors are Eco friendly, cheap,easily available and products of plant[10]. Leaves, barks, seeds and root are mixtures of

organic compounds containing N , O , S and found to be effective as inhibitors of metal and alloy corrosion in different aggressive environments.

Datura stramonium[11], Tamarind, Saponin[12],Embellica officinalis,Prosopis juliflora[13],Vinca rosea,Heena[14],Ficus religiosa[15] have been reported as effective corrosion inhibitor

Aim of the Study

In this paper author worked with carica papaya on a medicinal plant alone or with other medicine to treat common diseases such as warts, corns, sinuses, eczema, cutaneous tubercles, glandular tumors, blood pressure andconstipation etc.The plant belongs to the family Caricaceae and has the scientific name carica papaya. Weight loss method and thermodynamic process are used in this present work to find the inhibition efficiency of carica papaya.

Extraction of Plant Parts

Leaves of carica papaya were collected from my village Chaksu and botanical garden university of rajasthan jaipur. Plant parts were shade dried at room temperature for 15 days and grind into fine powder in a mixer grinder , then soaked in ethanol solution for 48 hours and filtered using whatman filter paper(pore size 11µm) The solvent was removed completely using a rotary evaporator. The solution so obtained was used as a stock solution for preparing 0.1N and 1N H_2SO acid solution for mass loss method and thermometric method.

Material and Method

Aluminium sheet having weight % composition(wt%) of : si-0.49% , Fe-0.68%, Cu-0.082%, Mn-0.16%, Mg-0.37% and Al-98.02% was used for study. The test coupons were prepared rectangular size having dimension 2.60cmX1.44cm with 0.02cm thickness. Each coupon was degreased by washing with ethanol. The washed coupon was immersed in acetone and removed and dried.Then weighed the coupon and stored in a moisture free desiccator. All the reagents were analytical grade and deionized water was used for preparation of solution. Emery paper was used for cleaning the coupon sample. Shimadzu balance was used for determining the weight of specimens before and after immersion into the solution.

The degree of surface coverage(θ) is given by the following formula[16].

$\theta = (\Delta M_u - \Delta M_i)/\Delta M_u$

Where θ=degree of surface coverage.

ΔM_u = mass loss of metal in uninhibitedSolution (in mg)

ΔM_i =mass loss of metal in inhibited solution.(in mg)

Corrosion rate is calculated by following equation[17]

CR(mmpy)=Mass loss X 87.6 / DAT

Where D=Density(gm/cm^3,for aluminium 2.7gm/cm^3)

A=Area(cm^2) exposed area of metal surface.

T=Time in hours and 87.6 is the conversion factor

Thermometric method was also used for determining the inhibition efficiency. In the thermometric method each aluminium coupon having size 2.60cmX1.44cm and thickness is 0.02cm was immersed in a beaker having 50ml solution by glasshook and exposed to air for 24hours. Deionised water was used for evaporation. In each case, duplicate experiments were done and the mean value of mass losses were calculated.

0.5N, 1N,2N,3N,4N and 5N solution of sulfuric acid were prepared by deionised water. For each solution temperature changes were recorded at intervals of one minute using a thermometer. In the beginning temperature increased slowly, max temperature achieved was written down and inhibition efficiency percentages were calculated by the following formula.

$\eta = (RN_f - RN_i / RN_f) X100$

Where, RN_i is reaction no. in presence of plant extract and RN_f is reaction no. in the absence of inhibitors. RN is given as

$RN = (T_m - T_0) / t$

T_m is maximum temperature , T_0 is the initial temperature and t is time required to reach maximum temperature.

Result and discussion

In research study, extract of leaves carica papaya was used. Table 1 indicates that inhibition efficiency increased with increasing the concentration of leaves extract of carica papaya and decreased with increasing the concentration of sulfuric acid. Maximum inhibition efficiency was 87.36 observed for carica papaya in 0.5N sulfuric acid and in 1N sulfuric acid minimum inhibition efficiency was 49.95 observed for carica papaya.

In the thermometric method , the table indicates that temperature changes for aluminium in 2N , 3N ,4N and 5N was recorded and inhibition efficiency was calculated for different acid concentration. Calculation shows the minimum inhibition efficiency was 35.20 , 34.73 , 37.24 and 25.24 observed for 2N, 3N ,4N and 5N respectively. Maximum inhibition efficiency was 72.80,67.89,66.80 and 54.04 observed for 2N ,3N ,4N and 5N respectively.

Decreasing of corrosion rate and increasing inhibition efficiency was occurred due to adsorption of plant extract on the metal surface. The chemical composition of plant extract are molecules having heteroatoms (N,O,S). In the plant extract heteroatoms containing molecules are present.These heteroatoms containing molecules block the site of metal surface and produce a protection layer and reduce the exposed area of metal. Thus reducing the corrosion possibility. Plant extracts may function as follows.

1. Adsorption of molecule on metal surface.
2. To form a complex with metal ions.
3. To neutralise the corrosion causing agent.
4. Adsorbing the corrosion causing agent.

Observation Table

Table 1 Mass loss analysis for aluminium in 0.5N sulfuric acid with ethanolic extract of leaves of carica papaya

Concentration of leaves extract	Mass loss(mg)	Corrosion rate(mmpy)	Percentage inhibition efficiency	Surface coverage(θ)
Uninhibited (blank)	182.0	32.85		
0.15	94.0	16.97	48.35	0.4835
0.30	79.1	14.28	56.53	0.5653
0.45	56.5	10.20	68.95	0.6895
0.60	31.6	5.70	82.63	0.8263
0.75	23.0	4.15	87.36	0.8736

Table 2 Mass loss analysis for aluminium in 1.0N sulfuric acid with ethanolic extract of leaves of carica papaya

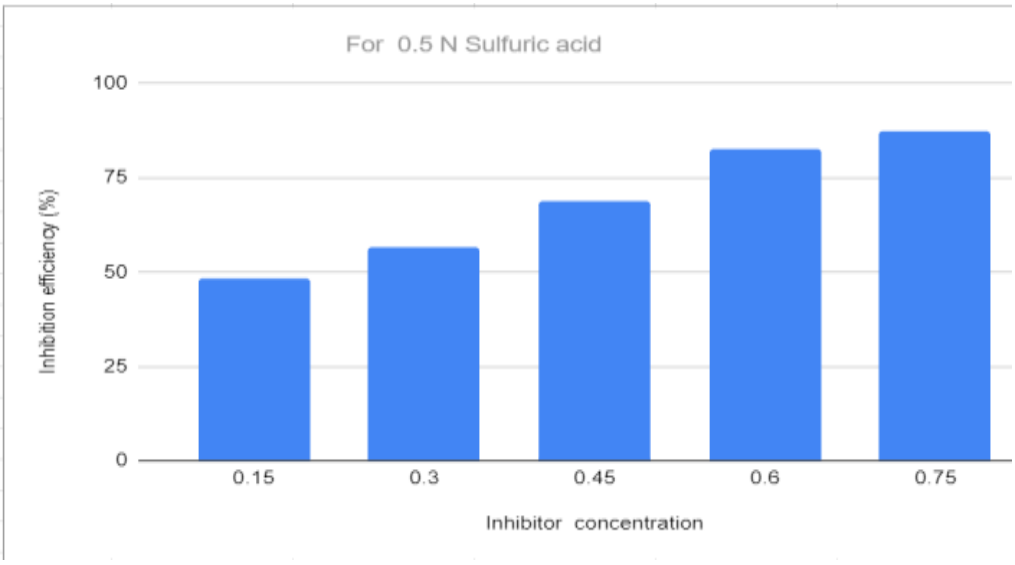
Concentration of leaves extract	Mass loss(mg)	Corrosion rate(mmpy	Percentage inhibition efficiency	surface coverage(θ)
Uninhibited (blank)	242.0	43.68		
0.15	121.1	21.86	49.95	0.4995
0.30	90.1	16.26	62.76	0.6276
0.45	72.2	13.03	70.16	0.7016
0.60	52.2	9.40	78.47	0.7847
0.75	48.1	8.68	80.12	0.8012

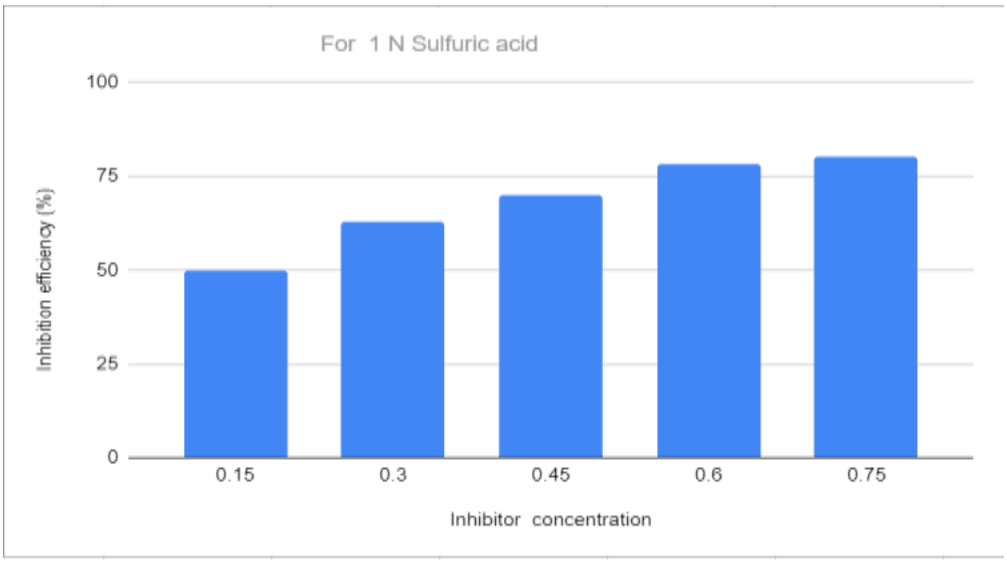
Table 3.Thermometric analysis for aluminium in 2N and 3N sulphuric acid with ethanolic leaves extract of carica papaya

Concentration of plant extract	Reaction number for 2N acid	Percentage Inhibition efficiency	Reaction number for 3N acid	Percentage Inhibition efficiency
Blank	1.25		1.90	
leaves				
0.15	.81	35.20	1.24	34.73
0.30	.75	40.00	1.14	40.00
0.45	.67	46.40	1.07	43.68
0.60	.40	68.00	0.72	62.10
0.75	.34	72.80	0.61	67.89

Table 4.Thermometric analysis for aluminium in 4N and 5N sulphuric acid with ethanolic leaves extract of carica papaya

Concentration of plant extract	Reaction number for 4N acid	Percentage Inhibition efficiency	Reaction number for 5N acid	Percentage Inhibition efficiency
Blank	2.47		3.09	
leaves				
0.15	1.55	37.24	2.31	25.24
0.30	1.50	39.27	2.18	29.44
0.45	1.41	42.91	2.06	33.33
0.60	0.95	61.53	1.58	48.86
0.75	0.82	66.80	1.42	54.04





Conclusion

From this research study it is concluded that leaves extract of carica papaya shows favorable corrosion inhibitor properties against aluminium in 0.5N and 1N sulfuric acid.

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