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Original Research Article

Inhibitive Effect of Hexamine Aluminium in Ethyl Alcohol Solution

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ABSTRACT

Corrosion is an electrochemical process whereby most metals react with oxygen and moisture in the surrounding air to form oxides. As a result of such reactions, the metals gradually deteriorate Corrosion includes the dissolution of ceramic materials and can be refer to as discoloration of and weakening of polymers by the sun ultraviolet light. It is also observed that we have different or various forms of corrosion such as pitting corrosion cervice corrosion, galvanic corrosion, stress corrosion etc. The identification of these forms of corrosion is an important step towards resolving the problems associated with corrosions. There are various techniques used for monitoring corrosion but not single techniques can provide answers to all corrosion problems. But a good result could be gotten by combination of different techniques. Aims and objectives: (i) to investigate corrosion of aluminium in alcohol (ethyl alcohol or ethanol) medium (ii) to determine the inhibitive effect of hexamine compound containing nitrogen on alcohol corrosion of aluminium. Gravimetric studies of corrosion of aluminum in the presence of an organic inhibitor. An organic inhibitor is a chemical compound that reduces the corrosion rate of the metals and alloys when it is added in small amount or concentration into the corrosive media or environment of the metallic material. It reduces the rate of corrosion by being absorbed on the metal surfaces. The inhibitive effect of hexamine on corrosion rate of aluminum in 99%, 98%, 97%, 96%, 95% of ethyl alcohol solution was studied by gravimetric technique. It was found that this organic inhibitor behavior was more pronounced at the highest concentration of the medium and inhibits better at a lower concentration. The inhibitive efficiency ranges from 50.00%-71.43%.

Keywords: Corrosion, Inhibitor, metals.

INTRODUCTION

Corrosion is an electrochemical process whereby most metals react with oxygen and moisture in the surrounding air to form oxides. As a result of such reactions, the metals gradually deteriorate. [1] Corrosion includes the dissolution of ceramic materials and can be refer to as discoloration of and weakening of polymers by the sun ultraviolet light. [2] It is also observed that we have different or various forms of corrosion such as pitting corrosion cervice corrosion, galvanic corrosion, stress corrosion etc. The identification of these forms of corrosion is an important step towards resolving the problems associated with corrosions. There are various techniques used for monitoring corrosion but not single techniques can provide answers to all corrosion problems. But a good result could be gotten by combination of different techniques. The main importance of corrosion-monitoring techniques is that is used to measure

uniform corrosion rates. The techniques are divided into two:

(i) Chemical techniques which involves the weight loss in coupons and
(ii) Electrochemical techniques (Galvanostatic polarization method)

This method is based on the determination of corrosion current density, which is measure of corrosion rate. The methods involved are stern-Geary [3] method and intercept [4] method and they are based on anodic and /or cathodictafel curve.

Chemical techniques involve the loss of weight in coupons. It is still the most reliable method to evaluate the corrosion because corrosions forms can be determined precisely. Disadvantaged of this method is that it provides only average data over a long period of time, it consumes time and requires intensive labor. A lot of applications require the use of more advanced technology experimental measurement; the temperature sensitivity is a strong limiting factor of electrical resistance (E/R) techniques. The principle of the measurement of the resistance of corroding metal and it varies with temperature. Electrochemical Techniques is conducted in galvanic, open circuit and potentiostaic modes and is based on potential and current relationship.

Reaction mechanisms of corrosion are: Oxidation-reduction reactions metallic atoms lose electrons during oxidation reaction

$Fe\text{-}fe^{2}+2e^{-}$

$Al\text{-}Al^{3+}+3e^{-}$

Oxidation takes place at the anode and is called anodic reaction

The electrons generated from each atom that is oxidized must be transferred to and become a part of another chemical specie known as reduction reaction.

For metals undergoing corrosion in acids, the H^{+} ions are reduced as follows:

$$2H^{+}+2e\text{-}H_2$$

For neutral or basis aqueous solution with we have;

$O_2+2H_2O+4e^{-}4(OH^{-})$

Reaction occurs at the cathode, rusting of steel in the most common corrosion reaction.

$$4Fe+6H_2O+3O_2\text{-}4Fe\ (OH^{-})_3$$

The overall electrochemical reaction consists of at least one oxidation and one reduction reaction and is the total sum of them.

Aluminium has the atomic number of 12, atomic weight of 26.98-153g, boiling point of 259^{0}c, specify gravity 2.6989 (20^{0}c) and the valence of 3.

It is the most abundant metal in the earth's crust (8.1), it is not found in nature. Electronic configuration is $1s^{2}2s^{2}2p^{6}3s^{2}3p^{1}$

The most important source is bauxite $Al2O_3.2H_2O$

Physical properties of aluminium includes lightness, softness snd pleasant silvery-white appearance.

Chemical properties includes;

1. Formation of oxide film which prevents corrosion of mental in moists
2. Reacts with concentrated hydrochloric acid to give chloride and hydrogen
3. It reacts directly under high temperature with oxygen, halogens, Nitrogen and sulphur

Uses of Aluminium includes; Electrical transmission, coating in telescopic mirrors, finely divided aluminium powder called bronze [5] for preparing aluminium paints, cooking utensils, for making duralumin and magnalium and used for packaging

Aluminium and its alloys have a remarkable economic and attractive material for engineering application owning to its low cost, light weight, high thermal and electrical conductivity [6]

Corrosion of metals and its alloys have been subjected to a lot of studies due to the importance of these materials in contemporary civilization and its great industrial application. [7]

Factors influencing corrosion of aluminium includes; ph values, fluid velocity, temperature. Forms of corrosions includes;

[8] uniforms, Galvanic, pitting, cervice, concentration cell corrosion, Graphic, stress, selective, erosion corrosion. Aims and objectives (i) to investigate corrosion of aluminium in alcohol (ethyl alcohol or ethanol) medium (ii) to determine the inhibitive effect of hexamine compound containing nitrogen on alcohol corrosion of aluminium

MATERIALS AND METHODS

Aluminium sheets were produced from Aluminium Rolling Mills, OtaOgun state. The piece where used as test coupons for weight loss studies in ethyl alcohol.

Metal	Mg	Si	Mn	Cu	Zn
% Composition	0.01	0.098	0.032	0.030	0.032
Metals	Ti	Fe	Pb	Sn	Al
% Composition	0.013	0.475	0.009	0.001	

The aluminum sheet was cut into rectangular shapes of short pieces known as coupons and the piece was used for the study of corrosion.

Distilled water- used for cleaning or washing coupons and used for both stock and inhibitive solutions, Acetone- is a laboratory reagent used for washing of coupons to remove grease, Inhibitor-Hexamine laboratory reagent grade gotten from glaxo chemical England, Alcohol-ethyl alcohol

Apparatus used include; Desiccators, filter paper, boiling tube, test tube rack, measuring cylinder, emery paper, wash bottle, analytical weighing balance, brush, volumetric flask and beakers.

Coupon preparation-Each aluminium coupon was polish with different grades of emery papers ranging from 220, 400, 800, 1000 respectively to a mirror-like surface, after which they are washed with distill water and degreased by rinsing with acetone after which they are desiccated overnight before weighing. Preparation of Ethyl alcohol solutions- To prepare 99%, 98%, 97%, 96%, and 95% of ethyl alcohol, we measure 1ml, 2ml, 3ml, 4ml and 5ml respectively to give 100ml of solution. Preparation of Hexamine solution- A constant concentrate of 10^{-}M hexamine was prepared by getting the molar mass of the hexamine which is 140.19g/mol. Then to get 0.1M concentration of hexamine we have

1M-140g/It

0.1M-14.0g/It

Experimental Procedure for gravimetric studies- Gravimetric procedure involves the polishing of coupons with the various grades of emery paper (220, 400, 800, 1000, 1200) to mirror-like surface, washing the polished coupons with distill water and degreasing with acetone followed by drying within folds of filter paper in a desiccators overnight. The coupon were weighed and recorded before exposing them to the corrosion media which include; 99%, 98%, 97%, 96% and 95% of ethyl alcohol solution and the organic inhibitor which is hexamine which was studied at a concentration of 10^{-1}M in each ethyl alcohol solution respectively. The coupons are immersed in the above specified corrosion media by suspension from the corrosion testing racks at time intervals of 5, 10, 15, 20, 25hrs respectively. The coupons were taken out of the corrosion media at end of the specific time intervals, washed to remove with distill water and brush and with oxide layer from the surface degreased with acetone, tried within folds of filter paper and desiccated overnight, after which the new weight is taken and weight loss is obtained. All this procedures were carried out at room temperature and result/data was recorded from.

To calculate the inhibition efficiency [9] from the weight loss data we have the expression.

$\% I.E = [w_0 - w_{inh}/w_0]x100\%$.....(1)

Where

W_0-Weight Loss on the absence of inhibitor

14_{inh}-Weight Loss in the presence of inhibitor

All the above procedures and experiments where carried out of the chemistry laboratories of Olabisi Onabanjo University, Ago-Iwoye, Ogun state

RESULT

Gravimetric studies of corrosion of aluminium in solution of ethyl alcohol also known as ethanol is particularly useful in the industrial application of its high affinity for both water and compound, [10] because of its affinity for water (that is it absorb water a lot) it causes corrosion by reacting with metal by diffusing through the pores of the protective oxide film and it lead to metal dissolution and metal surface exposure. [11]

The corrosion rate is calculated by CR=KW/DAT…….(ii)

Where

C_R-The rate of corrosion

K-The corrosion constant characteristics of the metal which is $7{,}25x10^4$

W-weight loss in gram

D-density of aluminum $2700kg/m^3$

A-area of coupons in Cm^2 (2.82cm)

T-Time of immersion in hours

Ethyl alcohol and its solution do not attack aluminum up to the boiling point. Tables below show the corrosion rate and weight loss of aluminum in 99%, 98%, 97%, 96% and 95% of ethyl alcohol respectively at the specific time intervals.

Conc. Of $c_2$hsoh (%)	Time (hrs)	Weight loss	Corrosion rate $x10^{-4}$ (mm)
99%	5	0.0007	13.33
	10	0.0009	8.57
	15	0.0011	6.98
	20	0.0013	6.19
	25	0.0015	5.71

Conc. Of $c_2$hsoh (%)	Time (hrs)	Weight loss (g)	Corrosion rate $x10^{-1}$ (mmpy)
98%	5	0.0009	17.14
	10	0.0011	10.47
	15	0.0013	8.25
	20	0.0015	7.14
	25	0.0017	6.47

Conc. Of $c_2$hsoh (%)	Time (hrs)	Weight loss (g)	Corrosion rate $x10^{-1}$ (mmpy)
97%	5	0.0011	20.95
	10	0.0013	12.38
	15	0.0015	9.52
	20	0.0017	8.09
	25	0.0019	7.24

Conc. Of $c_2$hsoh (%)	Time (hrs)	Weight loss (g)	Corrosion rate $x10^{-1}$ (mmpy)
96%	5	0.0015	20.57
	10	0.0017	16.19
	15	0.0019	12.06
	20	0.0020	9.52
	25	0/0023	8.76

Conc. Of $c_2$hsoh (%)	Time (hrs)	Weight loss (g)	Corrosion rate $x10^{-1}$ (mmpy)
95	5	0.0017	32.37
	10	0.0019	18.09
	15	0.0020	12.70
	20	0.0023	10.95
	25	0.0028	10.66

Gravimetric studies of corrosion of aluminum in the presence of an organic inhibitor. An organic inhibitor is a chemical compound that reduces the corrosion rate of the metals and alloys when it is added in small amount or concentration into the corrosive media or environment of the metallic material. It reduces the rate of corrosion by being absorbed on the metal surfaces. Tables below show the corrosion parameters.

Conc. Of $c_2$hsoh in 1.0^{-1} of hexamine	Time (hrs)	Weight loss (g)	Inhibitive efficiency (%)	Corrosion rate $x10^{-4}$ (mmpy)
99%	5	0.0002	17.43	3.81
	10	0.0003	66.46	2.86
	15	0.0004	63.64	2.90
	20	0.0005	61.64	2.38
	25	0.0006	60.00	2.23

Conc. Of $c_2$hsoh in 1.0^{-1} of hexamine	Time (hrs)	Weight loss (g)	Inhibitive efficiency (%)	Corrosion rate $x10^{-4}$ (mmpy)
98%	5	0.0003	66.66	5.71
	10	0.0004	63.64	3.81
	15	0.0005	61.54	3.17
	20	0.0006	60.00	2.86
	25	0.0007	58.00	2.67

Conc. Of $c_2$hsoh in 1.0^{-1} of hexamine	Time (hrs)	Weight loss (g)	Inhibitive efficiency (%)	Corrosion rate $x10^{-4}$ (mmpy)
97%	5	0.0004	60.00	7.62
	10	0.0005	58.82	4.76
	15	0.0006	57.89	3.81
	20	0.0027	55.00	3.33
	25	0.0019	52.17	3.05

Conc. Of $c_2$hsoh in 1.0^{-1} of hexamine	Time (hrs)	Weight loss (g)	Inhibitive efficiency (%)	Corrosion rate $x10^{-4}$ (mmpy)
96%	5	0.0006	60.00	11.43
	10	0.0007	58.82	6.67
	15	0.0008	57.89	5.08
	20	0.0009	55.00	4.28
	25	0/0011	52.17	4.19

Conc. Of $c_2$hsoh in 1.0^{-1} of hexamine	Time (hrs)	Weight loss (g)	Inhibitive efficiency (%)	Corrosion rate $x10^{-4}$ (mmpy)
95%	5	0.0007	58.82	13.33
	10	0.0008	57.89	7.62
	15	0.0009	55.00	5.71
	20	0.0011	52.17	5.24
	25	0.0014	50.00	5.33

From the data obtained in the above table we can see that weight loss is depending on two variants: the hexamine concentration and the immersion time, while there is the corrosion rate as ethyl alcohol concentration increases. The inhibition increases also as the concentration decreases with the immersion time. The range is from 50.00% to 71.43% for 25-5 hours respectively. I t show that hexamine is an effective inhibitor of corrosion of aluminum ethyl alcohol.

DISCUSSION

It is however very essential to recommend that further research should be carried out in order to investigate how the inhibitive performance of hexamine can be improved to become a good corrosive inhibitor.

CONCLUSION

The inhibitive effect of hexamine on corrosion rate of aluminum in 99%, 98%, 97%, 96%, 95% of ethyl alcohol solution was studied by gravimetric technique. It was found that this organic inhibitor behavior was more pronounced at the highest concentration of the medium and inhibits better at a lower concentration. The inhibitive efficiency ranges from 50.00%-71.43%.

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