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Anti Corrosion Potential of Drug Intermediate for Zinc in Acid Media

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Abstract: **In the present study, the corrosion behavior of zinc in the presence of inhibitor and in the absence of inhibitor is studied in acid media (0.1M HCl). The investigators studied the corrosion potential of drug intermediate 4-chloro 8-trifluoro methyl quinoline using weight loss method and electrochemical methods (Tafel polarization method and AC impedance method) at 303 K. Different concentrations of drug intermediates are prepared and found out the corrosion potential.**

Index Terms: **Corrosion, Zinc, Acid, Weight loss method, Electrochemical method, Corrosion Prevention Method**

I.INTRODUCTION

Corrosion is a natural process that converts a refined metal to a more chemically stable form such as oxide, hydroxide or sulphide. It is the gradual destruction of materials by chemical or electrochemical reaction with their environment. Corrosion engineering is the field dedicated to controlling and preventing corrosion. Rusting, the formation of oxides is a well-known example for electrochemical corrosion[1].

ZINC

Zinc, a component found throughout your body, helps your immune system and metabolism function. It is also important to wound healing and your sense of taste of smell.

Zinc undergoes corrosion when it exposed to aggressive environment and which gives the white rust. To prevent this corrosion, many methods have put forward.

The corrosion can be prevented by many methods[2]:

- Cathodic protection

It is a chemical compound that when added to a liquid or gas, decreases the corrosion rate of the material.

- Coating

It is a covering that is applied to the surface of an object, usually referred to as substrate

- Environmental modifications:

Corrosion is caused by chemical interaction between metal and gases in the surrounding environment.

- Plating

It is a surface covering of which a metal deposited on a conductive surface and used to control the corrosion of a metal surface by making the cathode of an electrochemical cell.

- Corrosion inhibitors

The substances which inhibit the corrosion are called as corrosion inhibitor. This technique is simple and more cost effective. This technique is used in all around the world from past two decades[3,4].

Therefore the investigators have chosen above technique as the student research project in the undergraduate level. In the present study a drug intermediate 4-chloro 8-trifluoromethylquinoline is used for the investigation. This intermediate is procured from sequent scientific limited, Mangaluru, Karnataka.

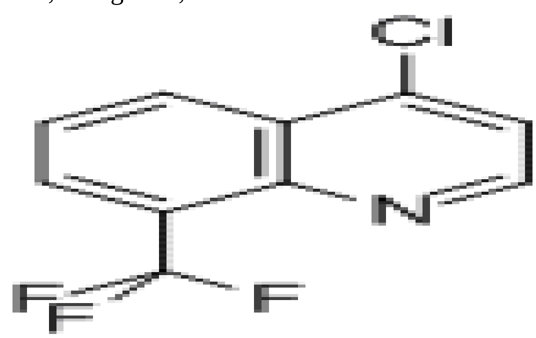

Fig.1: Structure of 4-chloro 8-trifluoromethylquinoline

II.MATERIALS AND METHODS

A) Materials used:

The following materials, chemicals and apparatus/equipment were used for the research,

- 500ml beakers
- Sand paper

- 0.1N HCl solutions
- Analytical weighing balance
- Inhibitor
- Zinc strips
- Electrochemical workstation (for electrochemical studies)

B) Method:

1. *Weight Loss Method:*

Weight loss corrosion measurements are simple, because they require no specialised equipment other than an accurate balance[5]. Experiments are normally performed according to a standard method. Weight loss methods are slower than other techniques but multiple samples can be run simultaneously. This method gives the average corrosion rate over an extended period of time, as per the following equation.

Corrosion rate = (weight loss × K)/(alloy density × exposed area × exposed time)

in which K is a constant that depends on the desired units. For a corrosion rate K = 8.76 × 104. The results from laboratory weight loss studies have been used to determine the relative corrosiveness of the different operating parameter.

C) Electrochemical method:

In the present study, the corrosion potential of zinc metal in the absence and in the presence of inhibitor is investigated by following electrochemical methods.

1. Tafel polarization method
2. AC impedance method

The investigators used Electrochemical workstation (CH instrument) to carry out above electrochemical methods and reported the values from the software of CHI 608D electrochemical work station (manufactured by CH Instruments, Austin, USA) at 303 K.

III.EXPERIMENTAL

A. Weight loss method:

The zinc specimens were pre-treated by polishing with sand paper and cleaned with the distill water and clean cloth. Different types of sand papers were used for fine polishing. The strips were then weighed on an analytical balance to four decimal places.

Table 1: The Weight Loss and Inhibition Efficiency of zinc strips with different concentrations :

Sl No	Con (ppm)	Initial Weight (g)	Final weight (g)	Weight Loss (g)	Inhibition Efficiency (IE) (%)
Time period =12 hrs					
1	0	3.0465	2.373	0.6732	-
2	5	3.0361	2.550	0.4861	27.7
3	10	2.8645	2.4077	0.4568	32.0
4	15	2.8254	2.4685	0.3569	46.9
5	20	2.4623	2.2298	0.2325	65.4

A solution of 0.1M HCl was prepared and kept distributed equally (100 ml each) in five different beakers. The zinc strips which were scribbled to take off the rust were weighed exactly and kept dipped in one beaker which contain 0.1M HCl. These zinc strips used are in the dimensions of 10cm × 4cm in length and breadth respectively. The inhibito 4-chloro 8-fluoromethyl quinoline was dissolved in four other beakers (Concentration: 5, 10, 15, 20 ppm) and the strips of zinc after pretrearment were kept immersed in these beakers which contain the inhibitors. It is then kept under the observation for specific period of time (12 hrs) and weighed in electronic balance after each period. Finally by comparing the weight loss of zinc strips which contain inhibitor and without inhibitor, it is observed that the above drug intermediate shows the inhibiting action.

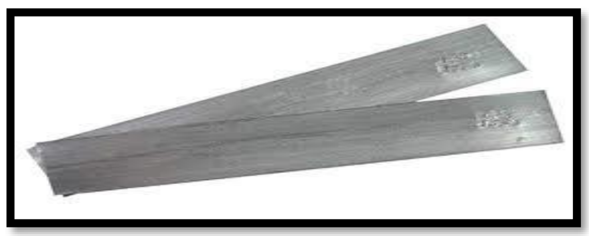

Fig. 2: Image of zinc strips.

Fig. 3: Image of zinc in HCl solution.

B. Electrochemical Method:

1.Tafel Polarization measurements:

The absolute corrosion rate can measure by The electrochemical technique of polarization resistance and it expressed in Milli-inches per year (mpy).Polarization resistance also called as "linear polarization"[6]. The obtained Tafel plots are as shown in Fig 4. The electrochemical corrosion kinetic parameters such as corrosion potential (E_{corr}), corrosion current density (i_{corr}) and inhibition efficiency (η_p) are reported in Table 2.

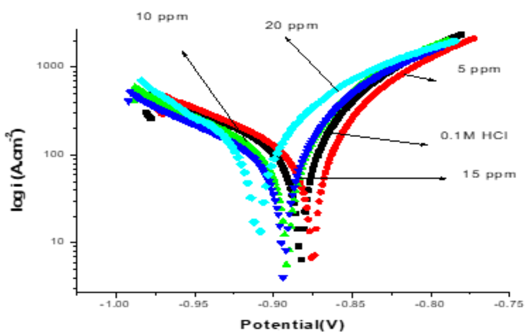

Fig.4: Tafel plot

Table 2: Tafel resilts:

Inhibitor conc. (ppm)	E_{corr} (V)	i_{corr} (mA cm^{-2})	Corrosion Rate (mpy)	IE (%)
0.1M HCl	-0.879	16.3	1.903	-
5	-0.874	12.3	1.715	24.6
10	-0.888	10.4	1.404	36.1
15	-0.890	9.5	1.325	41.7
20	-0.908	6.0	1.010	62.5

A potentiodynamic polarization plot, such can yield important information such as The Tafel extrapolation method is very accurate which is equal or greater than conventional weight loss methods.It is possible to measure extremely low corrosion rates by using potentiodynamic polarization plots.Tafel plots can provide a direct measure of the corrosion current. As expected, As the increase in the concentration of inhibitor, the rate of corrosion was inhibited. The addition of the inhibitor that reduces the anodic reaction and also retards the cathodic reaction [7].According to literature [8] the compound can be classified as an anodic or cathodic inhibitor when the potential displacement is at least 85 mV with respect to the blank solution.

2. AC impedance method:

AC impedance Nyquist plots for zinc in the presence and absence of inhibitor at a different temperature as shown in Fig..5. An equivalent circuit model (Fig 6) was used to fit the Nyquist plots. The parameters such as polarization resistance (R_p) and double capacitance values (c_{dl}) are measured using equivalent circuit are listed in Table 3.

Table 3: AC impedance results:

Inhibitor conc. (ppm)	R_p (Ωcm^2)	C_{dl} (µF cm^{-2})	IE
0.1M HCl	72.57	0.047	-
5	85.12	0.039	24.7
10	92.55	0.031	31.55
15	125.41	0.015	42.1
20	72.57	0.010	60.5

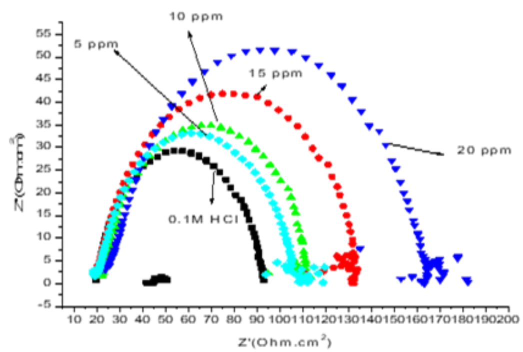

Fig. 5: AC impedance Plot

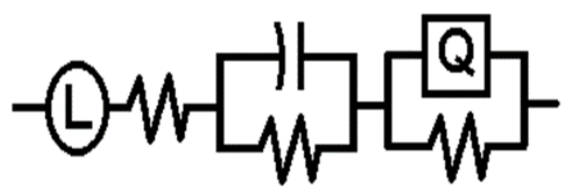

Fig 6: Electrical Equivalent circuit model used to fit impedance data

The depressed semicircle shows the characteristics of solid electrodes, and it referred to as frequency dispersion. This frequency dispersion attributed to roughness and inhomogeneities [9].

According to literature [10], two models have been adopted to describe the EIS spectra for the inhomogeneous films on the metal surface of rough and porous electrodes. One is the filmed equivalent circuit model, and the other is the finite transmission line model. In this work, the filmed equivalent circuit model is used to describe the inhibitor-covered metal/solution\interface [11].

IV. CONCLUSION

In the present study, the anticorrosion potential of drug intermediate, 4-chloro 8-trifluoromethylquinoline is investigated for zinc metal in 0.1 M HCl solution. The investigators have achieved around 60-65% of inhibition efficiency from weight loss method and electrochemical methods. The inhibition efficiency is maximum at 20 ppm and above the 20 ppm inhibition efficiency remains constant. Therefore it is concluded that small quantity of drug intermediate gives good inhibition efficiency.

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