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Gravimetric Studies of Pyridine as a Possible Inhibitor on the Corrosion of Mild Steel in Hydrochloric Acid Solutions

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Abstract: *The effect of pyridine on the acid corrosion of mild steel was studied by gravimetric technique at 8, 12 and 24 hours respectively. The corrosion parameters, corrosion rate, inhibition efficiency (I %) and weight loss were calculated. Inhibition efficiency ranges from 36% to 97%. Pyridine is present as a free base and the lone pair of electrons on the Nitrogen atom, is more readily available for coordination with ion. Thus the primary adsorption phenomenon between the metal surface and pyridine is a weak ion-pair formation. There is d π –p π interaction between the delocalized π -electron of pyridine and vacant d-orbital's of the metal atoms.*

I. Introduction

Corrosion of metals is a spontaneous destruction of metals in the course of their chemical, electrochemical or Biochemical interaction with the environment (1).

Corrosion, the most general problem of material science and its study has undergone a substantial expansion in the past decade in response to demand for new material to understand Hostile environment (2). The study of Corrosion has made ways for the development of new materials such as high temperature turbines, air-frame structures, electronic application of thin films and energy development programme of coal gasification, which makes the protection of metals against corrosion a very important and urgent one (3).

The phenomena, corrosion is one of the major problems encountered in production industries which use material that can be easily corroded, it includes all forms of metals and its alloys, plastics etc (4). Metals and its alloy are exposed to the action of acid in industrial process which cause several problems such as increase in mass and corrosion in surface resulting in economic losses(5). Metals, which occurs in natural state, for example gold, platinum etc usually do not corrode under conduction, which do not differ materially from those existing in nature(6). Corrosion effects are of particular consequences in the food processing industry as food substances like other organic and inorganic substances becoming corrosive, thereby causing significant impact on the degradation of constructional materials and the maintenance or replacement of product lost or contaminated as a result of corrosion reaction(7).

Mild steel corrode easily because all common structural metals form surface Oxide films when exposed to pure air, the oxide formed on mild steel is readily broken down and in the presence of moisture, it cannot be repaired. Therefore, reactions between steel (Fe), moisture (H_2O) and (O_2) takes place to form rust. This reaction is complex but it can be represented by a chemical equation on the following type; $4Fe+2H_20+ 30_2$ $2Fe_2O_3$. H_2O……… (1). Fe_2O_3. H_2O is the rust, and it is not usually protective, therefore, the processing is not impeded (8).

Conclusively, corrosion is a very undesirable thing that one should not encourage it and if encountered should be immediately controlled (9).

1.2 Aim And Objective

The aim of this work is to collect data on various aspects of adsorption behavior of pyridine in the light of known theories and also to determine corrosion resistance of mild steel produced in Nigeria.

II. Material And Method

2.1 Mild Steel Specimen

Hot rolled mild steel specimen was procured from Oshogbo steel rolling company, Oshogbo. The composition of steel as analyses is shown in table 2.1

Table 2.1: Percentage Composition of the Tested Material

Material	Elements												
% values in sample	Fe	C	Si	Mn	P	Cr	Mo	Ni	B	Co	Cu	Pb	Sn
	97.7	0.282	0.128	0.66	0.03	0.023	1.152	0.313	0.0009	0.012	0.574	0.08	0.02

2.2 Preparation Of Coupons

The Coupons were polished with various emery papers up to 1000. The polished coupons were weighed and recorded before exposure to corrosion medium i.e. immersion of Coupons by suspension in corrosion in corrosion testing racks designed in house.

The experiments were performed under stagnant conditions at intervals of 8, 12 and 24 hours respectively in the presence and absence of organic additive. The Coupons were immersed in various acid concentrations of 10^{-5}, 10^{-3} and 10^{-1} M with or without pyridine. Each specimen was taken out of the test medium at the end of 8, 12, and 24 hours immersion periods scrubbed with rubber stopper washed thoroughly and dried within folds of filter paper, kept in a desiccators overnight and when weigh for weight loss.

All reagents used are of analytical reagent grade procured from Glaxo Chemical England and were used directly without further purification or analysis for the preparation of solution.

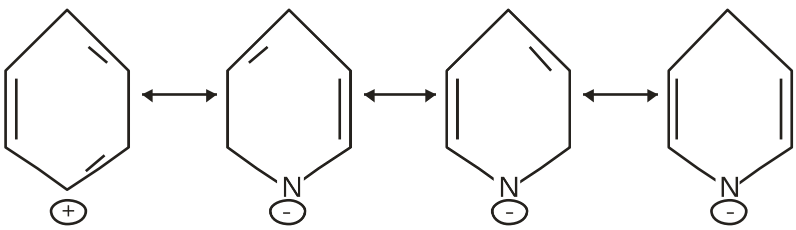
III. Results And Discussion

The table 3.1 below shows the results of corrosion parameter of mild steel in the presence and absence of pyridine at 0.5 and 0.3M acid concentrations.

Hours	Inhibitor Concentration (M)	Weight loss in the absence of pyridine (x10-2)	Weight loss in presence of pyridine (x10-3)	Inhibition Efficiency (1%)	Corrosion rate (mmg-1)
8hrs	10^{-5}	1.86	6.30	48	133
	10^{-3}	1.50	3.37	68	45
	10^{-1}	1.20	1.57	81	38
12hrs	10^{-5}	1.30	7.20	49	131
	10^{-3}	1.25	5.10	61	35
	10^{-1}	1.17	2.19	84	40
24hrs	10^{-5}	1.24	6.10	58	130
	10^{-3}	1.10	4.76	69	32
	10^{-1}	1.00	3.30	87	30
8hrs	10^{-5}	6.90	6.60	49	81
	10^{-3}	1.35	6.40	87	27
	10^{-1}	1.28	1.13	97	22
24hrs	10^{-5}	6.80	3.60	57	78
	10^{-3}	2.61	1.35	89	25
	10^{-1}	1.30	1.30	98	78
24hrs	10^{-5}	1.48	7.50	58	75

From the Corrosion parameters table, it was found out that additives behave differently in manners at different concentration, at lower concentration of pyridine turns out to be the inhibitor. The efficiency of pyridine increases with inhibitor concentration but decreases as the time increases. So weight loss is dependent of concentration and also dependent of the immersion time, visual inspection of coupons immersed in acid solution without inhibitor show the presence of pits which leads to much weight loss, but presence of pyridine at different concentration and time, there is no mush weight loss. The chloride ion which is a strong deactivating agent might probably be responsible for the pitting. As inhibitor concentration increases, corrosion rate decreases which show near constancy throughout the immersion period. As inhibitor concentration increases, corrosion rate decreases.

The high inhibition efficiency is as a result of pyridine being a strong base, gets adsorbed through weak-ion-pair formation and through its extensively delocalized π electrons system which is very strong because of incomplete d-orbital's of Fe.



Thus, the primary adsorption phenomenon between the metal surface and pyridine is a weak-ion-pair formation.The figure I below shows graph of percentage inhibitor against concentration in both 0.5 and 0.3 M acid.

Figure 1: The graph of 1% Vs Concentration of both 0.5 and 0.3 M

While figure 2 shows the graph of percentage inhibitor against time in both 0.5 and 0.3M acid.

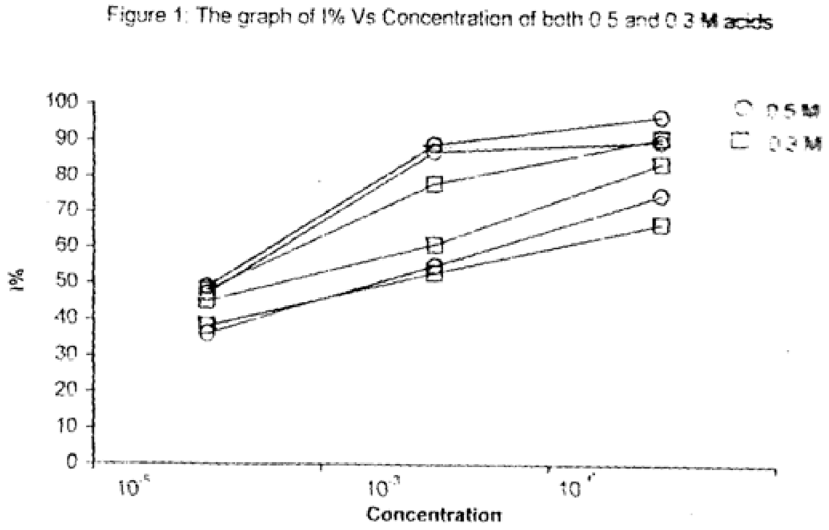
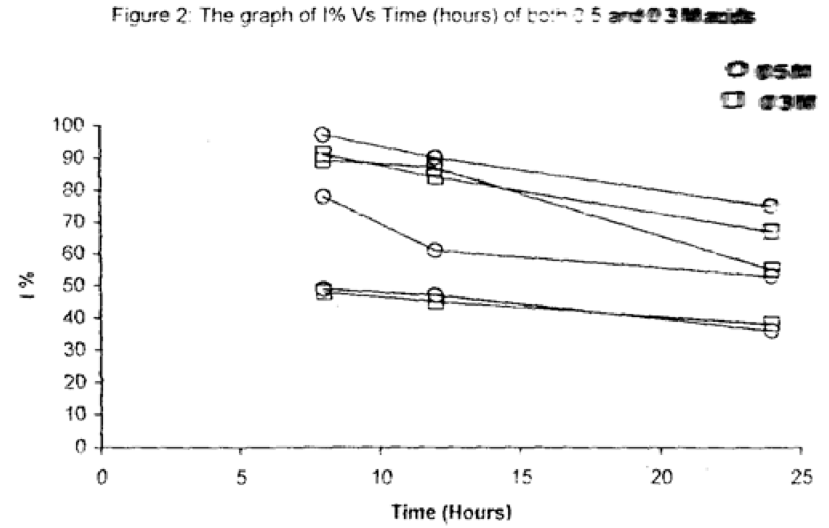


Figure 2: The graph of 1% Vs Time (hours) of both 0.5 and 0.3 M acids



The interpretation of two graphs is that as the inhibitor concentration increases, corrosion rate decreases.

Conclusively, pyridine turns out to be the best inhibitor on the corrosion of mild steel in Hydrochloric acid solutions.

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