



## CORROSIVE BEHAVIOUR OF IRON ALLOY WITH VARIABLE OXYGEN CONCENTRATION IN PRESENCE OF ORGANIC ACIDIC MEDIUM

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**ABSTRACT:** - Studied iron metal alloy by non electrochemical techniques (weight loss method) and electrochemical techniques by polarization techniques. Polarization studies showed the corrosion current and corrosion potential in organic acidic medium in the presence of corrosive inhibitor.

**KEYWORD:** Iron metal alloy corrosion, non electrochemical techniques, potentiodynamic polarization.

### I. NTRODUCTION:

Organic acids constitute a group of the most important reactive chemicals of industry today. Billions of pounds of acetic acid are produced in the United States every year to provide the precursors for numerous products from aspirin to the recovery of mineral<sup>I-III</sup>. Acetic acid is best manufacture of cellulosic fibers, commercial plastics, agricultural chemical, dyes, plasticizer, certain explosives, ester solvents, metal salt, and pharmaceutical such as aspirin<sup>IV-VI</sup>. Sulfa drugs, vitamins, and as a precursor for a host of other organic compounds used in the preparation of drugs. Other organic acids are produced in such smaller volume, but constitute important chemicals for the preparation of compound used daily in our lives<sup>VII-X</sup>. The reactive acid group present in this organic molecule is responsible for their wide use as ready building blocks for many commercial compounds<sup>XI-XIII</sup>. Research efforts to provide these chemicals in greater quality at less cost have paralleled their increasing importance. A multitude of processes have been commercialized for the production of acetic, acrylic, adipic, lactic and the higher acids. The volume and use of corrosive by product formic acid has continually increased<sup>XIV-XVIII</sup>. In all of these processes, iron containing alloys are standard materials of construction to withstand the corrosive environment and maintain product purity<sup>XIX-XXV</sup>. Corrosion data reported throughout this bulletin must be interpreted as providing valuable information regarding the relative corrosion resistance of the various alloys in specific environments and modes of testing. Retesting of the alloys, particularly those containing chromium, under the same apparent conditions may provide variations in corrosion rates of two to three times<sup>XXVI-XXIX</sup>. However the relative resistance of the various alloys normally

remains the same. Corrosion data for alloys in all of the many organic acids are reported when they are available. Extensive data for the more common acids encountered are reported. In addition data for representative homologues of the various types of organic acids are reported<sup>XXX-XXXVI</sup>.

Iron is the most important engineering and construction material in the world. It is used in every aspect of our lives, from automotive manufacture to construction products, from iron toecaps for protective footwear to refrigerators and washing machines and from cargo ships to the finest scalpel for hospital surgery<sup>XXXVII-XLI</sup>. There are several thousand iron grades published, registered, or standardized worldwide<sup>XLII</sup>, all of which have different chemical compositions, and special numbering systems have been developed in several countries to classify the huge number of alloys. In addition, all the different possible heat treatments, microstructures, cold forming conditions, shapes, and surface finishes mean that there are an enormous number of options available to the iron user. Fortunately, iron can be classified reasonably well into a few major groups according to their chemical compositions, applications, shapes, and surface conditions. Corrosion problems have received a considerable amount of attention because of their attack on materials. The use of inhibitors is one of the most practical methods for protection against corrosion. Several works have studied the influence of organic compounds containing nitrogen on the corrosion of iron in organic acidic media.

## II. EXPERIMENTAL METHOD:

### II.I MATERIALS:

Material having compositions of 0.08% Phosphorous, 0.27% Silicon, 0.01% Aluminum, 0.04% Manganese, 0.15% Carbon, 0.04% Sulphur and the remaining Iron were used for the electrochemical polarizations.

### II.II WEGHT LOSS METHOD:

The weight loss measurements enable us to illustrate the importance of the environment in the process of rusting, weight loss method is non-electrochemical, and the rate of corrosion is determined by the conventional weight loss technique. using this technique, the loss of a metal due to corrosion is measured by exposing the metal specimen of known area to the corrosive environment for a particular period and finding the difference in weight before and after exposure The expression 'mils per year' (mpy) is the most widely used way of expressing the corrosion rate, Corrosion rate is calculated using the formula,

$$\text{Corrosion Rate (mpy)} = \frac{534 W}{DAT}$$

Where,

W = Weight loss in mg.

D = Density of the specimen in g/cm.

A = Area of the specimen in sq.

T = Exposure time in hours.

The weight loss measurements were carried out by weighing the prepared material before and after immersion for 24,48,72,96,120 hours in 50 ml various concentration of organic acidic solutions (formic acid, acetic acid and propionic acid) in the presence and absence of various concentrations of Amoxicillin and variable concentration of oxygenation. From the weight loss data, the percentage inhibition efficiency (IE %) was calculated at different concentrations at 30° C using following equation.

$$IE\% = 100 \times \frac{W_0 - W_{\text{corr}}}{W_0}$$

Where,

IE% : Inhibition efficiency

$W_{\text{corr}}$  : corrosion rates of iron with inhibitor

$W_0$  : corrosion rates of iron without inhibitor

### II.III ELECTROCHEMICAL METHOD:

In order for an electrochemical process to take place, there must be an anode, a cathode, as well as both an ionic and electrical conduction path between the two. When performing a DC polarization scan, as will be discussed in this application note, the ionic conduction path is provided through the solution separating the working and counter electrodes, while the electrical conduction path is provided through the potentiostat. This potentiostat is then used to control the driving force for electrochemical reactions taking place on the working electrode. The magnitude of this driving force in turn dictates which electrochemical processes actually take place at the anode and cathode, as well as their rate. Electrons flow from the anode to the cathode through the electrical path described above. As such, the anode is typically thought of as the negative electrode, and the cathode as the positive. At the anode, oxidation takes place.

### III. RESULT AND DISCUSSION:

#### III. I WEIGHT LOSS METHOD:

From observation it reveals that, corrosion rate iron and weight loss of iron are decreases in presence of organic inhibitor (Amoxicillin). Corrosion rate of iron and weight loss of iron are maximum in fully saturated oxygenation as comparative to saturated oxygenation and absence of oxygenation in absence of organic inhibitor Amoxicillin. Also corrosion rate and weight loss of iron are decrease in absence of oxygenation and saturated oxygenation as comparative fully saturated oxygenation in presence of organic inhibitor Amoxicillin. Inhibition efficiency of corrosion rate and weight loss of iron is increases in concentration of amoxicillin increases in organic acidic solution.

Acid	O <sub>2</sub> fully Saturate d	O <sub>2</sub> Saturate d	O <sub>2</sub> Absen t	O <sub>2</sub> fullySaturat ed (Inhibitor)	O <sub>2</sub> Saturate d (Inhibitor)	O <sub>2</sub> Absent (Inhibito r)
HCOOH	0.18	0.16	0.15	0.15	0.12	0.13
CH <sub>3</sub> COOH	0.24	0.22	0.21	0.21	0.20	0.20
CH <sub>3</sub> CH <sub>2</sub> COO H	0.15	0.14	0.14	0.12	0.12	0.11

**Table No. I Weight loss of iron in gm. (24 Hours in 0.1N Solution)**

Acid	O <sub>2</sub> fully Saturate d	O <sub>2</sub> Saturate d	O <sub>2</sub> Absen t	O <sub>2</sub> fullySaturat ed (Inhibitor)	O <sub>2</sub> Saturate d (Inhibitor)	O <sub>2</sub> Absent (Inhibito r)
HCOOH	0.22	0.21	0.21	0.20	0.20	0.19
CH <sub>3</sub> COOH	0.32	0.31	0.30	0.28	0.27	0.25
CH <sub>3</sub> CH <sub>2</sub> COO H	0.20	0.19	0.19	0.18	0.16	0.13

**Table No. II Weight loss of iron in gm. (48 Hours in 0.1N Solution)**

Acid	O <sub>2</sub> fully Saturate d	O <sub>2</sub> Saturate d	O <sub>2</sub> Absen t	O <sub>2</sub> fullySaturat ed (Inhibitor)	O <sub>2</sub> Saturate d (Inhibitor)	O <sub>2</sub> Absent (Inhibito r)
HCOOH	0.24	0.22	0.23	0.21	0.21	0.20
CH <sub>3</sub> COOH	0.35	0.34	0.34	0.31	0.31	0.30
CH <sub>3</sub> CH <sub>2</sub> COO H	0.24	0.23	0.22	0.21	0.21	0.20

Table No. III Weight loss of iron in gm. (72 Hours in 0.1N Solution)

Acid	O <sub>2</sub> fully Saturate d	O <sub>2</sub> Saturate d	O <sub>2</sub> Absen t	O <sub>2</sub> fullySaturat ed (Inhibitor)	O <sub>2</sub> Saturate d (Inhibitor)	O <sub>2</sub> Absent (Inhibito r)
HCOOH	0.26	0.24	0.24	0.23	0.22	0.22
CH <sub>3</sub> COOH	0.40	0.41	0.40	0.38	0.37	0.36
CH <sub>3</sub> CH <sub>2</sub> COO H	0.22	0.21	0.22	0.19	0.18	0.18

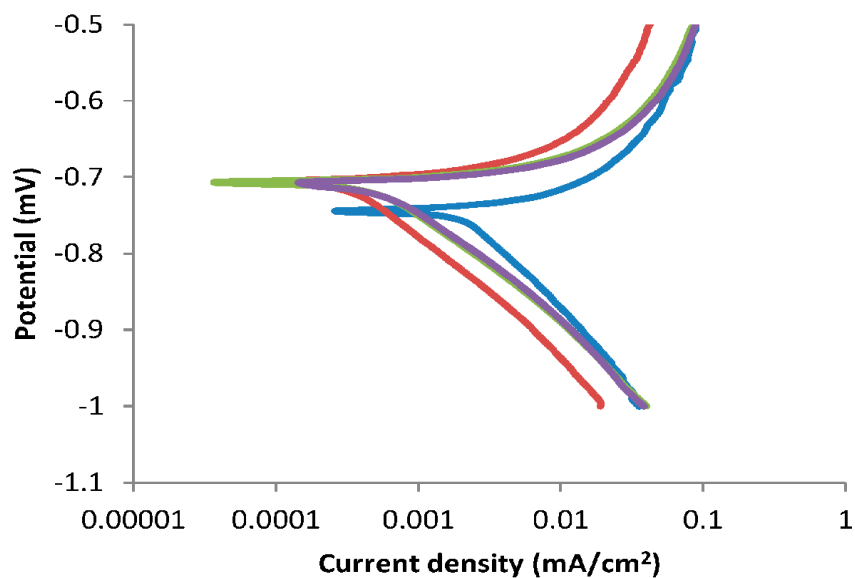
Table No. IV Weight loss of iron in gm. (96 Hours in 0.1N Solution)

Acid	O <sub>2</sub> fully Saturate d	O <sub>2</sub> Saturate d	O <sub>2</sub> Absen t	O <sub>2</sub> fullySaturat ed (Inhibitor)	O <sub>2</sub> Saturate d (Inhibitor)	O <sub>2</sub> Absent (Inhibito r)
HCOOH	0.30	0.29	0.27	0.27	0.25	0.24
CH <sub>3</sub> COOH	0.48	0.45	0.43	0.42	0.43	0.41
CH <sub>3</sub> CH <sub>2</sub> COO H	0.28	0.29	0.28	0.26	0.25	0.24

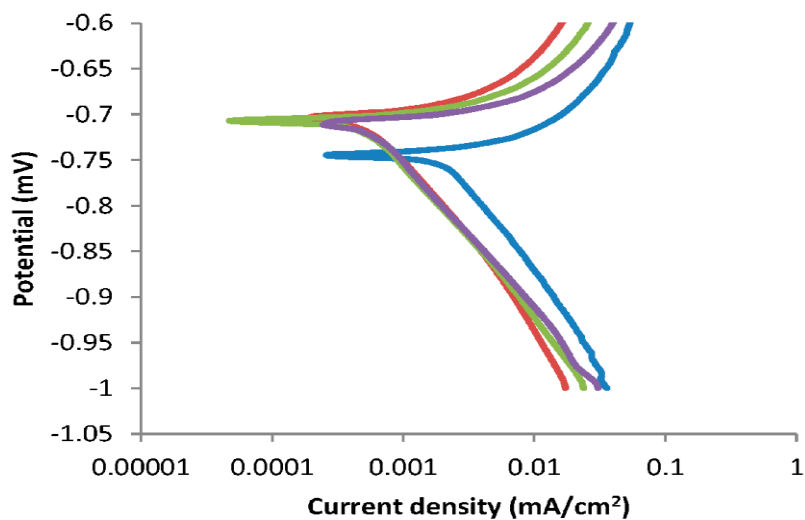
Table No. V Weight loss of iron in gm. (120 Hours in 0.1N Solution)

### III.II POTENTIODYNAMIC POLARIZATION STUDY:

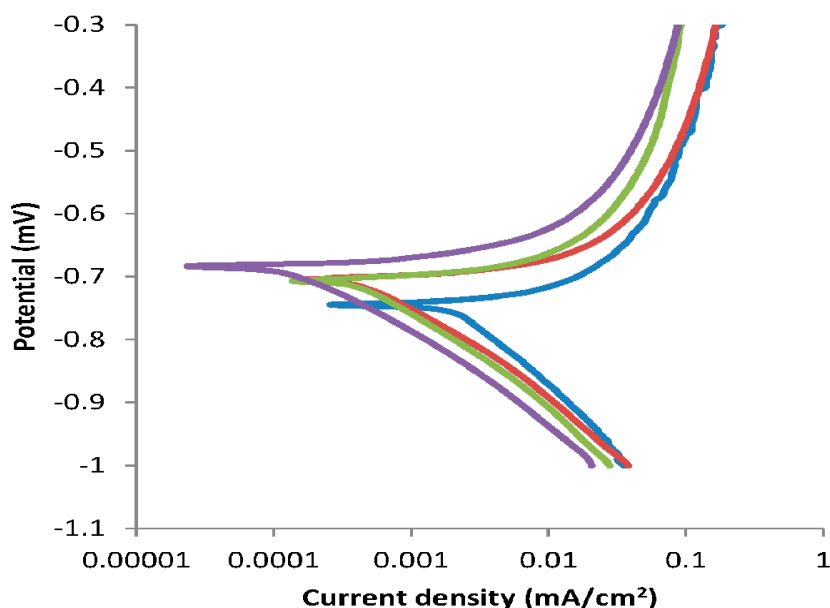
From the observation of plots and table in potentiodynamic polarization study corrosion potential increases progressively by increasing the concentration of inhibitor amoxicillin in organic acidic (formic acid acetic acid and propionic acid) solution and corrosion current decreases progressively by increasing the concentration of inhibitor amoxicillin. By using the inhibitor amoxicillin control the corrosion of metal alloys in organic acidic (formic acid acetic acid and propionic acid) medium. In plots I to III there is no passivation can be observed only decreases the rate of corrosion of iron in presence of inhibitor.



**Plot No. I Potentiodynamic polarization curve of iron in formic acid**



**Plot No. II Potentiodynamic polarization curve of iron in acetic acid**



**Plot No. III Potentiodynamic polarization curve of iron in propionic acid**

<b>Formic Acid</b>	<b>Corrosion Current <math>I_{corr}(\mu A cm^{-2})</math></b>	<b>Corrosion Potential <math>E_{corr}(V_{SCE})</math></b>	<b>Inhibition Efficiency IE (%)</b>
Blank	640	-0.51	0
0.10 gm	21.2	-0.55	96.9
0.20 gm	19.3	-0.58	96.9
0.30 gm	18.6	-0.59	97.0

**Table No. VI Potentiodynamic polarization parameter of iron in formic acid**

<b>Acetic Acid</b>	<b>Corrosion Current <math>I_{corr}(\mu A cm^{-2})</math></b>	<b>Corrosion Potential <math>E_{corr}(V_{SCE})</math></b>	<b>Inhibition Efficiency IE (%)</b>
Blank	661	-0.50	0
0.10 gm	22.9	-0.52	96.5
0.20 gm	21.0	-0.54	96.8
0.30 gm	19.8	-0.56	97.0

**Table No. VII Potentiodynamic polarization parameter of iron in acetic acid**

<b>Propionic Acid</b>	<b>Corrosion Current <math>I_{corr}(\mu A cm^{-2})</math></b>	<b>Corrosion Potential <math>E_{corr}(V_{SCE})</math></b>	<b>Inhibition Efficiency IE (%)</b>
Blank	642	-0.45	0
0.10 gm	18.9	-0.47	97.0
0.20 gm	17.8	-0.48	97.2
0.30 gm	17.6	-0.51	97.2

**Table No. VIII Potentiodynamic polarization parameter of iron in propionic acid**

#### IV CONCLUSION:

From above result and discussion of corrosive behavior of iron alloy with variable oxygen concentration in presence of organic acidic medium, the corrosion rate of iron is maximum in organic acidic medium in absence of corrosive inhibitor and corrosion rate of iron is minimum in organic acidic medium in presence of corrosive inhibitor, it means that the amoxicillin is acts as a good corrosive inhibitor. Corrosion rate of iron in fully saturated oxygenation in organic acidic medium is maximum and corrosion rate of iron in absence of oxygenation in organic acidic medium. In electrochemical method corrosion rate of iron in potentiodynamic polarization techniques the corrosion current decreases and corrosion potential increases continuously means that the corrosion rate of iron decreases in organic acidic medium in presence of corrosive inhibitor.

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