INTRODUCTION

A corrosion process can be defined as the destructive attack of a metal or alloy by chemical or electrochemical reactions with its environment. The products of this process may be solid, liquid or gases. Both physical and chemical nature of the products are important, since they frequently influence the subsequent rate of reaction. The corrosion of metals represents a terrible wastes of both natural resources and money.

Corrosion of metals differs from that of other materials in that, it involves charge transfer (ions and electrons) and in most cases conducting solutions (electrolytes). Corrosion is therefore electrochemical in nature.

There are numerous methods for measuring the corrosion rate. These include weight loss, thermometric measurements[1], polarization[2], construction of electrocapillary curves[3], depression of polarographic maxima[4], determination of the electrode reaction parameters[5] and linear polarization measurements[6-9].

Corrosion of metals was classified according to the nature of corrosion reaction into:

1- Dry or chemical corrosion, in which the metal is converted to its oxide when the metal is exposed to a reactive gas or non-conducting liquids as for example, the high temperature oxidation of metal.

2- Wet or electrochemical corrosion; in which the formation of hydrous oxide film occurs when the metal is immersed in a conducting liquid containing dissolved reactive substance. The reaction is considered to take place at the metal-solution interface, due to the heterogenity on the surface, which creates local anodic and cathodic sites on the metal. Most of the known corrosion forms belong to this type of corrosion.

The corrosion process is affected by several factors. Among these factors are:

(i) Nature of the metal.	(ii) Nature of the environment
(iii) Electrode potential	(iv) Electrolyte concentration
(v) pH	(vi) Temperature
(vii) Nature of corrosion products	(viii) Amount of dissolved oxygen

The corrosion process could be retarded by using different method as the following:

1- Methods based on modification of procedure:

  a- By attention to design.

  b- By application of cathodic or anodic protections.

2- Methods based on modification of the environment:

  a- By de-aeration or adjusting the pH of the environment.

  b- By purification or de-humidification of air.

  c- By addition of corrosion inhibitors.

3- Methods based on modification of the metal:

  a- By addition of alloying elements.

  b- By heat treatment.

4- Methods based on protective coatings:

  a- Coating by a reaction product (chemical or electrochemical treatment of metal surface).

  b- Organic coatings (paints, resins, etc.)

  c- Inorganic coatings (enamels, cements).

  d- Metal coatings.

  e- Temporary protective.

Corrosion inhibition

The protection of metals against corrosion can be achieved either with inhibitors or with passivating agents[10]. An inhibitor can be defined as a compound that suppresses corrosion of metals regardless of which electrochemical reaction it affects. Passivators, on the other hand, are defined as compounds that reduce the corrosion rate via preferential retardation of the anodic dissolution of metals. In accordance with these definitions an inhibitor may or may not be a passivator but every passivator is an inhibitor.

Types of corrosion inhibitors:

Corrosion inhibitors can be classified according to their mechanisms of action as following:

1. Hydrogen evolution poisons:

There are substances such as arsenic and antimony ions, which specifically retard the hydrogen evolution reaction. Although the mechanism of inhibition is uncertain, it appears most probable that combination of the adsorbed hydrogen atoms is largely prevented by the inhibitor and thereby the formation of molecular hydrogen and its release from the metal surface. These substances are very effective in acidic solutions but are ineffective in environments where other reduction processes are the controlling cathodic reactions[11].

2. Scavengers:

These are substances, which act by removing corrosion reagents from solution. Examples of this type of inhibitors are sodium sulphite and hydrazine which remove dissolved oxygen from aqueous solution as follows:

$$2Na_2SO_3 + O_2 \longrightarrow 2Na_2SO_4 \qquad (1)$$

$$N_2H_4 + O_2 \longrightarrow N_2 + 2H_2O \qquad (2)$$

These inhibitors are often called negative inhibitors because they remove the undesirable species.

3. Filming inhibitors:

Many inhibitors[12] appear to act by producing a barrier, which isolate the metal from its environment. Such materials tend to be specific to either the anodic or the cathodic reactions but seldom to both and for this reason, they are known as anodic or cathodic inhibitors. However, each type can be recognized by its effect on the corrosion potential ($E_{corr.}$). The anodic filming inhibitors produce a shift of $E_{corr.}$ to more positive direction while the cathodic filming inhibitors shift $E_{corr.}$ to negative direction.

4. Vapor-phase inhibitors:

Vapor-phase inhibitors[13] are compounds, which have low significant vapor pressure (about 0.1-1.0mm Hg) and produce a vapor that has corrosion inhibiting properties. The inhibitors can therefore be used for the temporary protection of metals in corrosive atmospheres. They are essentially soluble filming inhibitors and include nitrite, benzoate and/or carbonate anions attached to a suitable heavy organic cation, e.g. dicyclohexyl ammonium nitrite.

5. Adsorption inhibitors:

These inhibitors represent the largest category of inhibitors. They are mainly organic compounds containing N, O and/or S atoms, through which they can adsorb on the metal surface. This adsorption is not specific to anodic or cathodic sites and would be expected to produce mixed inhibition. However, this is not always observed in practice. The classical examples of adsorption inhibitors are the aliphatic and aromatic amines, thiourea and various aldehydes. Chemisorption[14] usually occurs through electron donation to a metal surface.

Hoar[15,16] showed that inhibitor molecules influenced the anodic and cathodic reactions equally. He concluded that adsorption of inhibitor molecules reduce the number of reaction sites and inhibition becomes more predominate when the surface is covered with a monolayer film.

Corrosion behavior of C-steel in aqueous solutions:

The corrosion of Delta 37 C-steel in HCl solutions was investigated by weight loss, polarization and spectral analysis[17]. It was found that the corrosion rate increases with increasing acid concentration and immersion time. For low acid concentrations [HCl] ≤ 3.0M, the change in corrosion rate is small. However, for acid concentrations > 3.0M, the corrosion rate rises rapidly with increasing acid concentration. Darwish et al.[18] proposed the followed hypotehtical dissolution mechanism for iron in acid chloride solutions.

$$Fe + Cl^- \rightleftharpoons Fe(Cl)_{ads} + e \qquad (3)$$

$$Fe(Cl)_{ads} + H^+ \rightleftharpoons Fe(ClH^+)_{ads} \qquad (4)$$

$$Fe(ClH^+)_{ads} \rightleftharpoons FeCl^-_{aq} + H^+ + e \qquad (5)$$

In this mechanism the rate-determining step is the chemical adsorption step which forms a kind of ion pair at the electrode surface. So, one may assume that the mechanism of dissolution of Delta 37 C-steel in HCl solution involves halide inhibited mechanism. Furthermore, the products of corrosion process are iron ions. Also, the corrosion of steel is a function of H^+ ion concentration rather than Cl^- ion.