CORROSION TYPES
CHAPTER 4
1) UNIFORM CORROSION

LECTURER
SAHEEB M. MAHDI
Types of corrosion

It is convenient to classify corrosion by the forms in which it manifests itself, the basis for this classification being the appearance of the corroded metal. In most cases the naked eye is sufficient, but sometimes magnification is helpful or required. Valuable information for the solution of a corrosion problem can often be obtained through careful observation of the corroded test specimens or failed equipment. There are eight forms of corrosion.

1) **Uniform or General Corrosion**

It is uniform thinning of a metal without any localized attack. This kind of corrosion happen mostly in one phase materials and is unformed throughout the surface. Corrosion dose not penetrate very deep inside. This kind of corrosion can be happened in most environments, such as dry and wet atmospheres, acids, brines … etc.

**Uniform Attack** is a form of electrochemical corrosion that occurs with equivalent intensity over the entire exposed surface and often leaves behind a scale or deposit.
Mechanism of uniform Corrosion

Corrosion mechanism in aqueous solution has been amply demonstrated. In atmospheric corrosion which also exemplifies uniform corrosion, a very thin layer of electrolyte is present. It is probably best demonstrated by putting a small drop of seawater on a piece of steel. On comparing the atmospheric corrosion with aqueous corrosion, the following differences are observed: On a metal surface exposed to atmosphere, only a limited quantity of water and dissolved ions are present, whereas the access to oxygen present in the air is limited. Corrosion products are formed close to the metal surface, unlike the case in aqueous corrosion, and they may prevent further corrosion by acting as a physical barrier between the metal surface and environment, particularly if they are insoluble as in the case of copper or lead. The following is a simplified mechanism of aqueous corrosion of iron. At the anodic areas, anodic reaction takes place:

\[
Fe \rightarrow Fe^{+2} + 2 \text{e}^{-} \quad \text{(anodic reaction)}
\]
At the Cathodic areas, reduction of oxygen takes place:

\[
O_2 + 2H_2O + 4e \rightarrow 4OH^- 
\]

The OH ions react with the Fe\(^{++}\) ions produced at the anode:

\[
Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2 
\]

With more access to oxygen in the air, Fe(OH)\(_2\) oxidizes to Fe(OH)\(_3\) and later it loses its water:

\[
4Fe(OH)_2 + O_2 + 2H_2O \rightarrow 4Fe(OH)_3
\]

Ferrous hydroxide is converted to hydrated ferric oxide or rust by oxygen:

\[
4Fe(OH)_2 + O_2 \rightarrow 2Fe_2O_3\cdot H_2O + 2H_2O
\]

Rust (Fe\(_2\)O\(_3\).H\(_2\)O) is formed halfway between the drop center and the periphery which is alkaline. The electrons flow from the anode (drop center) to cathode (periphery in the metallic circuit. As shown in the figure below.
Rust is a generic term to describe a series of different oxides, \( \text{Fe(OH)}_2 \), \( \text{Fe(OH)}_3 \), \( \text{FeO(OH)} \), \( \text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O} \) that forms when iron corrodes. The common form of Rust is a Red products: \( \text{Fe}_2\text{O}_3 \). Rust forms due to a reaction between the iron and water; either water condensing from air or rain. The oxygen in the air dissolves in the water and causes rust to form. There are always two distinct chemical reactions in a corrosion process, the basic is:

1) Anodic Dissolution of Metal (Iron) that goes into solution (water)

\[ \text{Fe} \rightarrow \text{Fe}^{2+} + 2e^- \]

2) Cathodic Reduction of Oxygen dissolved in water

\[ \text{O}_2 + 2\text{H}_2\text{O} + 4e^- \rightarrow 4\text{OH}^- \]

The final reaction is:

\[ \text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe(OH)}_2 \]

This oxide will then further reacts with oxygen to give the final red product: \( \text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O} \)
Examples include general rusting of steel and iron and the tarnishing of silverware. The life of equipment can be accurately estimated.

Uniform corrosion can be prevented or reduced by:

1) proper materials, including coatings.
2) inhibitors.
3) Cathodic protection.

General corrosion of the reactor vessel head
(note: this exterior general corrosion was indicative of a much more serious local corrosion problem due to a leak in the pressure boundary)