Principle of corrosion

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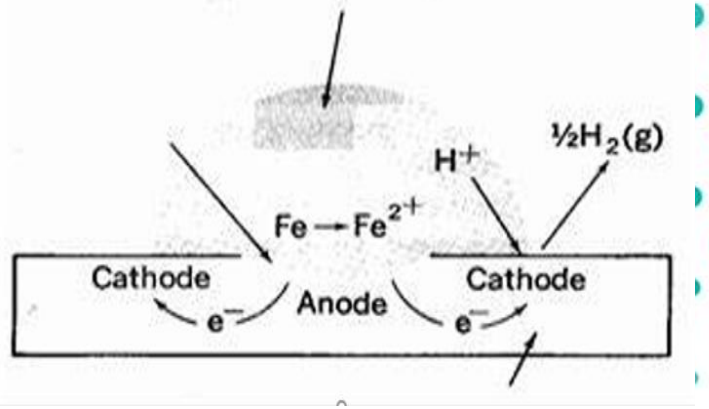
Contents:

What is The Corrosion?

- Introduction & principle …

Corrosion is the deterioration and loss of a material and its critical properties due to chemical, electrochemical and other reactions of the exposed material surface with the surrounding environment.

Corrosion of metals and nonmetals takes place due to the gradual environmental interaction on the material surface. The structures and facilities of different materials are affected by this interaction. Even the ambient air, laden with moisture and oxygen, can start this process, known as rusting, on steel surfaces.



Corrosion Occurs:

How & forms…

- Corrosion is an electrochemical reaction that appears in several forms, such as chemical corrosion and atmospheric corrosion, When acidic substances (including water) come in contact with metals, such as iron and/or steel, rust begins to form. Rust is the result of corroding steel after the iron (Fe) particles have been exposed to oxygen and moisture. When steel is exposed to water, the iron particles are lost to the water's acidic electrolytes. The iron particles then become oxidized, which results in the formation of Fe^{++}. When Fe^{++} is formed, two electrons are released and flow through the steel to another area of the steel known as the cathodic area. Oxygen causes these electrons to rise up and form hydroxyl ions (OH). The hydroxyl ions react with the Fe^{++} to form hydrous iron oxide $Fe(OH)_2$ which is oxidized to $Fe(OH)_3$, better known as rust.

Corrosion in pipes:

- **pH Levels**
- **Chemical Minerals**
- **Velocity**
- **Bacteria**
- **Sediment**
- **Oxygen Level**.

Classification:

Classified & mechanisms…

- The corrosion process is classified on the basis of mechanisms.

(i)Dry corrosion (or) Chemical corrosion
(ii)Wet corrosion (or) Electro chemical corrosion

- **(i) Dry Corrosion (or) Chemical Corrosion**
- This type of corrosion occurs through direct chemical action of dry gases (or) corrodents such as oxygen, halogen, H2S, SO2, etc.

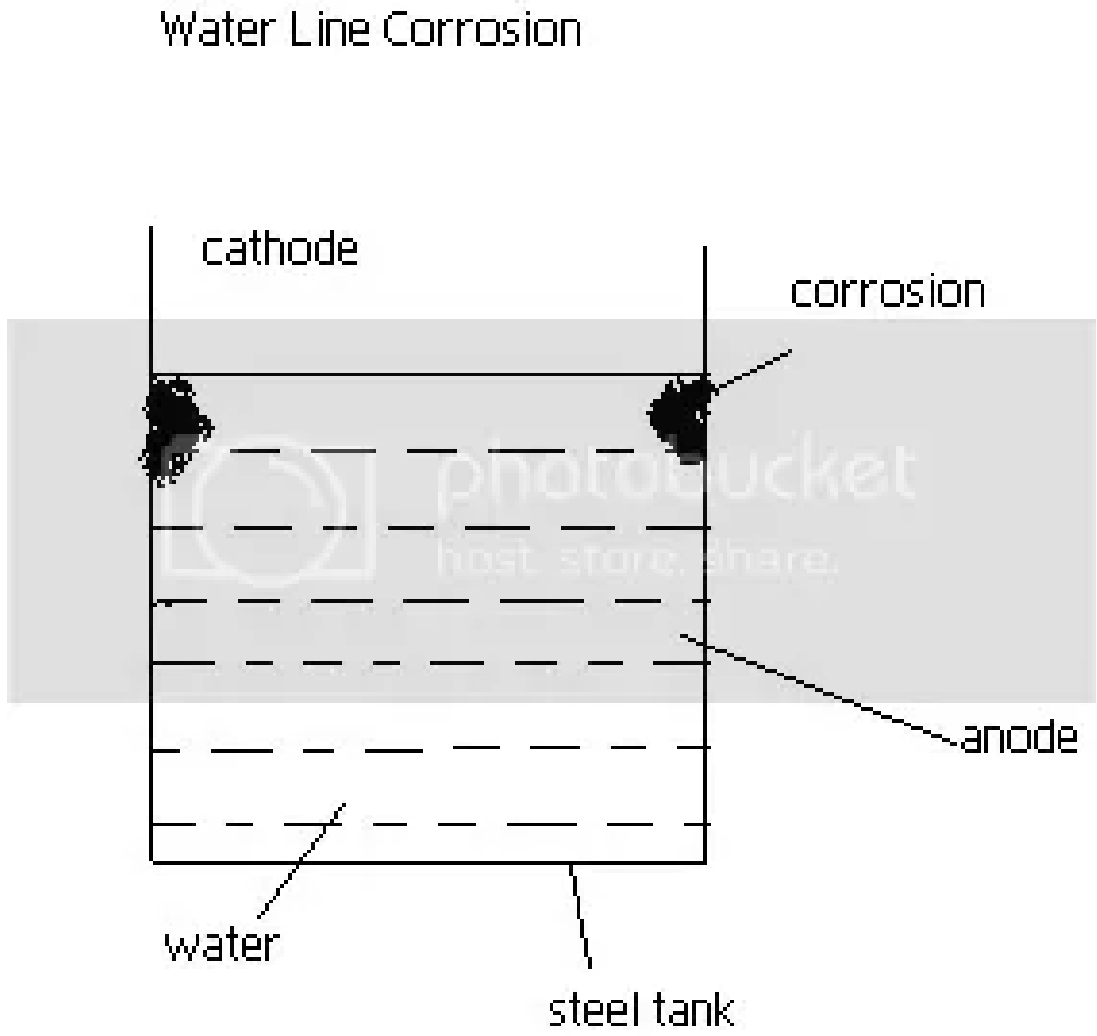
- **(ii) Wet Corrosion (or) Electrochemical Corrosion**
- This type of corrosion occurs when,(i) The conducting electrolytic liquid is in contact with metal.(ii) Two dissimilar metals are partially dipped in the electrolyte.

Water line corrosion:

Relation with water…

Waterline corrosion can happen to materials in contact with water. Waterline corrosion occurs when one portion of a base material is submersed in the water and another portion is in contact with the air. This creates a differential of the amount of oxygen in contact with the material's surface above and below the waterline and results in a corrosive reaction.

Waterline corrosion occurs because of the differential in oxygen concentration between the atmosphere and the water. This happens because the portion of the substrate exposed to higher amounts of oxygen (the area exposed to air) becomes a cathode, while the portion of the substrate exposed to less oxygen (the area in contact with water) becomes an anode. The creation of an anode and a cathode allows oxidation to occur. This ultimately causes the area of the substrate submersed in water to become oxidized and corrode.



Microbiological Corrosion:

Corrosion & Microorganisms…

- There is a relationship between microorganisms and the oxidation process Because of metabolic activity of various micro-organisms lead to Corrosion called Microbiological Corrosion. The micro-organisms can develop and propagate in an environment in the presence (or) absence of oxygen. Therefor they are termed as aerobic corrosion and anaerobic corrosion.

Types of micro-organism (microbiological corrosion):

- **I)-Aerobic micro-organism (aerobic corrosion)**
- **a) Sulphur bacteria (e.g., thiobacillus)**
- It oxidizes Sulphur present in their cells to give sulphoric acid, which attack the metals like iron. This type of bacteria grows in acidic conditions of pH from 0 to 1.
- **b) Iron and manganese micro-organisms**
- These bacteria's live by taking into their cells iron and manganese ions. The bacteria digest them in the presence of oxygen, forming insoluble hydrates of iron and manganese dioxide, which are then thrown out their bodies. Iron bacteria's grow in stagnant or running water at 5 to 40oC and pH from 4 to10.

II) Anaerobic micro-organisms (Anaerobic corrosion)

a) Sulphate reducing bacteria's

(e.g., sporovobrio desulphuricous)

They are responsible for anaerobic corrosion of iron and steel. They require sulphate and oxygen for their nourishment. The optimum conditions for their growth are 25-30^{o}C and pH from 5 to 9.

III) Film forming micro-organisms

Example (Bacteria's, fungi, algae & diatoms)

This type of micro-organisms form microbiological film on an iron surface, which can take acids, salts and gases from the surface of iron, leading to the formation of local biological concentration cells and consequent corrosion.

Sulfur Reducing Bacteria (SRB) & Corrosion:

- Microbiologically induced corrosion is a type of corrosion that degrades metal by biological organisms (such as bacteria). Sulfate-reducing bacteria (SRB) is a type of microbiologically induced corrosion. The presence of SRB is commonly found in various attributes of the oil and gas industry—places as deep as the wells on an offshore oil plant, all the way into the refineries. SRB can occur in any aqueous environments or soil and is a common problem in oil and gas industry facilities due to the omnipresent nature of microbes and corrosive by-products in the pipelines. SRB utilizes hydrogen to corrode the metal and depolarizes the metal surface due to the hydrogen sulfide product.

Crude line corrosion:

Hydrocarbons components & Corrosive…

Crude oil, as a mixture of all sorts of hydrocarbons, is not corrosive. However, there are some impurities and components often found in crude oil that could cause corrosion in pipelines, vessels and refinery equipment such as atmospheric columns, overhead lines, exchangers and condensers.

- **The Corrosive Components That Can Be Found in Crude Oil**

➢ Carbon Dioxide (CO2)

➢ Brackish Water (Chlorides)

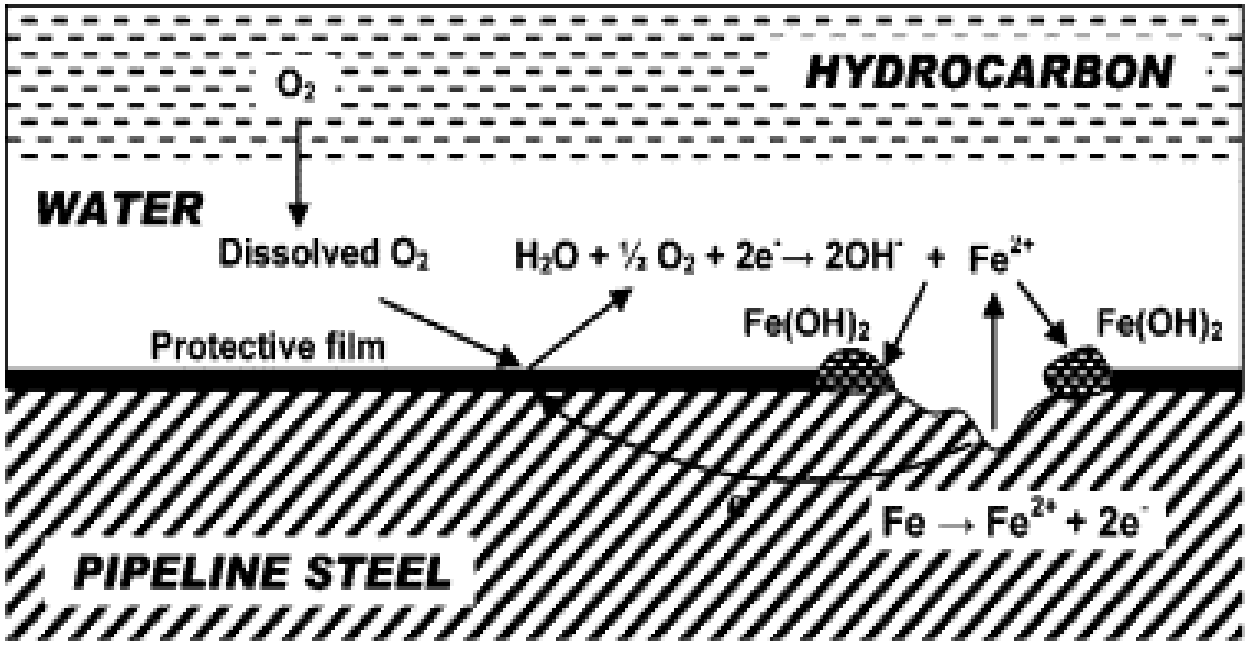
➢ Phantom Chlorides (Organic Chlorides)

➢ Organic Acids

➢ Sulfur

➢ Bacteria

➢ Hydrogen Sulphide (H2S)



Corrosion control methods:

The corrosion is controlled by the following methods:

- Sacrificial anodic protection
- Impressed current cathodic protection
- Control of corrosion by modifying the metal
- Corrosion Inhibitors

Thank you