Lesson 01

Introduction to Corrosion and Protection Methods

Metals play a vital role in modern life — they are used in buildings, bridges, vehicles, pipelines, and countless industrial applications. However, most metals have a natural tendency to deteriorate over time when exposed to air, moisture, or chemicals.

This undesirable process is known as **corrosion**.

Corrosion is one of the major problems in industry, leading to the loss of materials, reduced efficiency, structural failures, and high economic costs. For example, the rusting of steel bridges or the degradation of pipelines can cause safety hazards and expensive repairs.

Understanding how and why corrosion occurs is therefore essential for engineers, scientists, and technicians. By studying corrosion mechanisms, types, and influencing factors, we can select proper materials and design effective protection methods.

Different corrosion protection techniques — such as coatings, cathodic protection, inhibitors, and alloying — are applied to prevent or reduce the rate of corrosion and extend the service life of metallic structures.

In this lesson, we will discuss:

1. The definition and causes of corrosion
2. The main types of corrosion
3. The methods used to protect metals from corrosion

What is corrosion

Corrosion is the **chemical or electrochemical** deterioration of a material (usually a metal) due to reaction with its environment. It converts metal into more stable compounds (oxides, hydroxides, salts), weakens structures, and causes economic and safety problems.

Factors Affecting Corrosion

Corrosion behavior depends on a number of factors, which are classified into three groups:

1. Environmental factors corrosive:

o Concentration of reagent.

o Oxygen level

o Medium pH

o Temperature

o Pressure

2. Factors metallurgical

o Alloy composition

o Production processes

o Impurities

o Heat treatment

o Mechanical treatment

3. Factors defining conditions of employment

o Surface finish

o shape of parts

o use of inhibitor

Corrosion Types

By its definition and mechanism, it can be seen that corrosion is a really complicated process. It can develop in many directions for just one metal, depending on its surrounding environments. Hence, studying and evaluating different types of corrosion is also a complex task. There are various ways of classification that were discussed among engineers:

1- Chemical Corrosion

It's agit a pure chemical reaction on the surface of the material and a gas or un liquid non-electrolyte. For example, the oxidation of the air conditioner at a higher temperature the oxygen in the air is a chemical corrosion.

2- Electrochemistry Corrosion

This is an electrochemical reaction on the surface of the metal and a liquid electrolyte. It is accompanied by the formation of piles that use the electrical circulation fence.

3- Biochemistry Corrosion

This is the attachment of metal materiel bacteria, in particular in the canalizations. enter and serve. In effect, the metabolism of development of certain bacteria provoque the formation of sulfuric acid that affects the metal.

Corrosion Inhibitors

1. Introduction

Corrosion is the gradual destruction of metals due to chemical or electrochemical reactions with their environment. It leads to material loss, structural failure, and economic damage in many industries.

One of the most effective ways to control corrosion is the use of **corrosion inhibitors** — chemicals that reduce the corrosion rate of metals when added in small quantities to the corrosive medium.

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2. Definition of inhibition

A **corrosion inhibitor** is a substance that decreases the rate of corrosion of a metal surface. Chemical compounds may be used which when added in small concentrations to an aggressive environment, are able to decrease corrosion of the exposed metal.

These substances act by forming a protective layer on the metal or by changing the electrochemical reactions that cause corrosion.

Classification of Corrosion Inhibitors

Corrosion inhibitors are substances that are added in small amounts to the corrosive medium to stop or slow down electrochemical corrosion reactions on a metal surface are an attractive area of research because of their usefulness in various industries. Most organic inhibitors are absorbed onto the metal surface by displacing water molecules on the surface and forming a pressurized barrier.

Corrosion inhibitors can be divided into two main categories:

1. **Inorganic Inhibitors:**

These are usually salts or compounds such as chromates, phosphates, silicates, borates, and molybdates. They work mainly by forming insoluble protective films or oxide layers on the metal surface, preventing further attack.

- Examples: Sodium chromate (Na_2CrO_4), Sodium molybdate (Na_2MoO_4), Zinc phosphate ($Zn_3(PO_4)_2$).

2. **Organic Inhibitors:**

These compounds contain elements such as nitrogen (N), sulfur (S), or oxygen (O) that can donate electrons to the metal surface. They adsorb onto the metal, forming a hydrophobic protective film that blocks corrosion agents.

Examples: Amines, imidazoles, thiourea…

3. **Green (eco-friendly) inhibitors:**

- Derived from natural sources such as plant extracts, amino acids, and biodegradable materials.
- They are non-toxic, renewable, and environmentally safe.
- Example: extracts from Moringa oleifera, Aloe vera, or tea leaves)

Conclusion

Corrosion inhibitors play a vital role in protecting metals from degradation and improving their durability.

The growing concern for environmental protection has encouraged the development of **green corrosion inhibitors**, which offer sustainable and eco-friendly solutions for industrial corrosion control.

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