The Corrosion

Corrosion is the degradation of a material's properties due to chemical or electrochemical reaction with its environment. In general, metallic corrosion produces soluble metal ions in water in its initial stage, and subsequently, these metal ions develop into solid corrosion precipitates such as metal oxides and hydroxides. The ability to manage corrosion is a crucial aspect of utilizing materials effectively and efficiently to address these challenges. Metallic corrosion is one of the problems often encountered in industrialized society, hence it has been studied comprehensively since the industrial revolution in the late eighteenth century·

The three main reasons for the importance of corrosion are economic reasons, including the objective of reducing material losses that result from the corrosion of piping, tanks, metal components of machines, ships, bridges, and so on. The second reason is the safety of operating equipment, and the third reason, conservation, applies primarily to metal resources. The most common form of corrosion is aqueous metallic corrosion in which the material is a metal or metal alloy, and the environment is an aqueous solution.

Types of corrosion

Corrosion, generally is may be divided into two types: wet corrosion and dry corrosion. Dry corrosion where the corrosive environment is a dry gas. It is also frequently called chemical corrosion and the best-known example is high temperature corrosion which occurs at high temperatures (above the boiling point of water), and in the absence of an aqueous phase.

At low temperatures (below the boiling point), material corrodes due to the presence of an aqueous phase (wet corrosion). Wet corrosion is influenced by pressure, temperature, and the compositions of aqueous, gaseous, and oil phases. In refineries and petrochemical plants, the amount of water is usually small, but corrosion is high and is localized at regions where the aqueous phase contacts the metal. The water may contain dissolved hydrogen sulfide (H_2S), carbon dioxide (CO_2), and chloride ions (Cl^-). Corrosion may occur even when the produced water content is as low as 0.1%, or corrosion activity may not begin until after several years of production. Refineries and petrochemical industries employ a variety of film-forming inhibitors to control wet corrosion. Most of the inhibitors are long-chain nitrogenous organic materials, including amines and amides.

Electrochemical Corrosion (Wet Corrosion)

Corrosion processes are mostly electrochemical**,** where the metal (anode) transfer electrons to the cathode and undergoes a valance change from zero to a positive value with electrolyte presence. These components: an anode, a cathode and an electrolyte can be called corrosion cell (Galvanic cell). The general reaction that occurs at the anode is the dissolution of metal as iron:-

$$Fe \longrightarrow Fe^{+2} + 2e^{-} \quad \text{..... (1)}$$

This reaction occurs at the anode, and loss of electrons (oxidation). In the other words, electrons lost at the anode flow to the cathode.

Cathodic reaction in general in acidic solutions, is typically the reduction of hydrogen ions to hydrogen gas, as shown in equation:-

$$2H^{+} + 2e^{-} \longrightarrow H_2 \quad \text{..... (.2)}$$

But cathodic reaction varies according to the environmental nature, therefore, the reduction reaction which may occur at the cathode is the reduction of oxygen as shown in the equation:-

$$O_2 + 4e^{-} \longrightarrow 2O^{-2} \quad \text{..... (.3)}$$

Difference between chemical corrosion and electrochemical corrosion

Conditions of chemical corrosion are as following :

1. Chemical corrosion occurs in the dry state .
2. The direct chemical attack by the environment.
3. Even a homogeneous metal surface will be corroded.
4. Corrosion products accumulate in the same spot where corrosion occurs.
5. Uniform corrosion takes place.

Conditions of electrochemical corrosion are as follows:

1. Electrochemical corrosion occurs in the presence of moisture or electrolyte.
2. The setting up of a huge number of tiny galvanic cells.
3. A heterogeneous metal surface or a homogeneous metal surface with bi-metallic contact is an important condition for this type of corrosion.
4. Corrosion occurs at the anode where products gather at the cathode.
5. Pitting is frequen an occur especially when the anode area is small.

Types of corrosion cells

1. **Galvanic Cells**: They are cells that convert chemical energy into electrical energy. In other words, the cells are reversible and non-reversible, consisting of two different electrodes in a potential reduction.
2. **Concentration Cells** :These are galvanic cells consisting of the same element immersed in the same solution but with different concentrations, where there is no interaction cell, because what happens on the anode will be reflected on the cathode.
3. **Electrolytic Cell**s: This type of cells work to convert electrical energy into chemical reactions and these cells are a non-reversible.