CORROSION

Corrosion is the process of decay on a material caused by a chemical reaction with its environment. The reaction is typically in the form of oxidation. Corrosion of metal occurs when an exposed surface comes in contact with a gas or liquid, and the process is accelerated by exposure to warm temperatures, acids, and salts. Most metals are susceptible to corrosion, but all materials are subject to degradation.

Corrosion is the destructive attack of a metal by chemical or electrochemical reaction with its environment.

Corrosion process is normally electrochemical, that is a chemical reaction in which there is transfer of electrons from one chemical species to another. Metal atoms characteristically lose or give up electrons in what is called an oxidation reaction. The site at which oxidation takes place is called the anode; oxidation is sometimes called an anodic reaction.

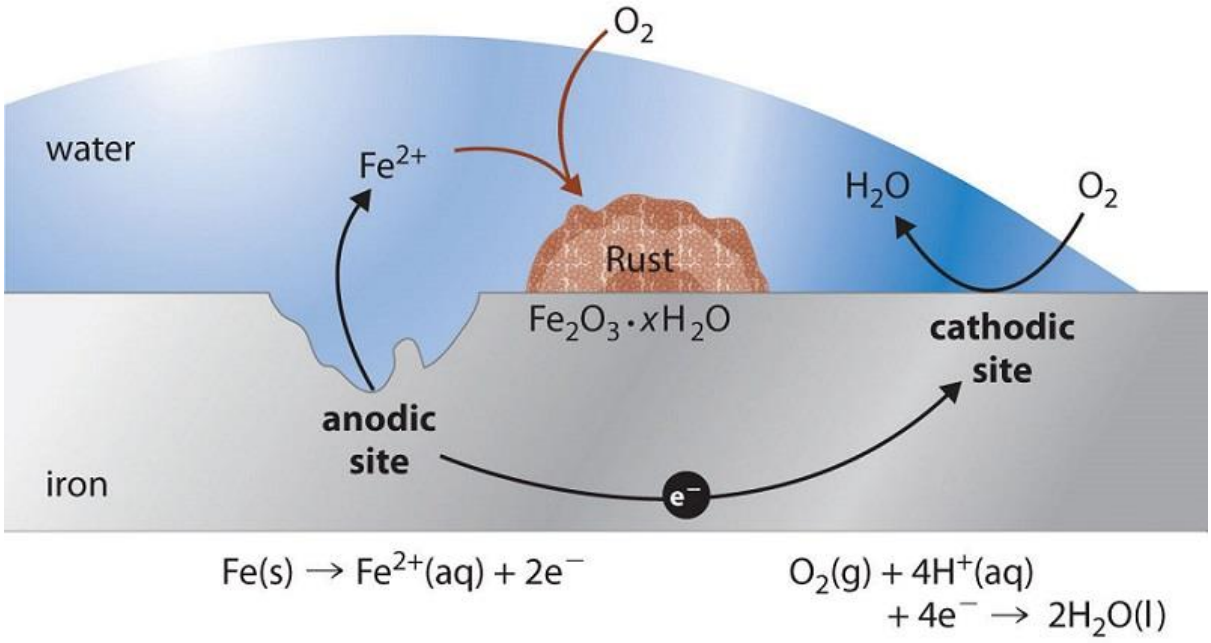
The electrons generated from each metal atom that is oxidized must be transferred to and become a part of another chemical species in what is termed a reduction reaction. The location at which reduction occurs is called the cathode.

Corrosion Mechanisms

Corrosion in aqueous solutions is the most common of all corrosion processes. Water, seawater, and various process streams in industry provide anaqueous medium. Moisture in the atmosphere and water in the soil accountfor the aqueous corrosion in these media. In all these cases, water is seldom present in pure form. Rather, various salts and gases remain dissolved in it,and their dissociation renders the water somewhat conducting. For all practical purposes, it acts as an electrolyte. The chemical nature of this electrolyte may be acidic, alkaline, or neutral.

The corrosion of the metal such as steel is representing as an electrochemical process which happens in stages. On the surface at anodic areas the initial attach happens, where the ferrous ions move into solution. The free electrons from the anode are starting to move through the structure of the metallic to the neighbouring sites of the cathodic on the surface, which they integrate with water and oxygen to produce the ions of the hydroxyl. Hydroxyl ions react with the ions of the ferrous to form ferrous hydroxide, which is more oxidised in the air to form oxide of the hydrated ferric, as shown in figure below.

- at cathode: $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O$
- at anode: $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$
- overall: $2Fe(s) + O_2(g) + 4H^+(aq) \rightarrow 2Fe^{2+}(aq) + 2H_2O(l)$



Rusting ” applies to the corrosion of iron or iron - base alloys with formation of corrosion products consisting largely of hydrous ferric oxides. Nonferrous metals, therefore, corrode, but do not rust.

Important corrosion types

Even though the fundamental mechanism of corrosion involves creation or existence of corrosion cells, there are several types or forms of corrosion that can occur. It should however be borne in mind that for corrosion to occur, there is no need for discrete (physically independent) anodes and cathodes. Innumerable micro level anodic and cathodic areas can be generated at the same (single) surface on which anodic (corrosion) and cathodic (reduction) reactions occur.

Each form of corrosion has a specific arrangement of anodes and cathodes and specific patterns and locations depending on the type can exist.

The most important types are

- Uniform corrosion.
- Galvanic corrosion, concentration cells, water line attack

- Pitting.
- Dezincification, Dealloying (selective leaching)
- Atmospheric corrosion.
- Erosion corrosion
- Fretting
- Crevice corrosion; cavitation
- Stress corrosion, intergranular and transgranular corrosion, hydrogen
- cracking and embrittlement
- Corrosion fatigue.

Corrosion can be classified in different ways, such as

- Chemical and electrochemical
- High temperature and low temperature
- Wet corrosion and dry corrosion.

Dry corrosion occurs in the absence of aqueous environment, usually in the presence of gases and vapours, mainly at high temperatures.

Electrochemical nature of corrosion can be understood by examining zinc dissolution in dilute hydrochloric acid.

$$Zn + 2HCl = ZnCl_2 + H_2$$

Anodic reaction is $Zn = Zn^{++} + 2e$ with the reduction of $2H^+ + 2e = H_2$ at cathodic areas on the surface of zinc metal. There are two half reactions constituting the net cell reaction.

Environmental effects such as those of presence of oxygen and other oxidizers, changes in flow rates (velocity), temperature, reactant concentrations and pH would influence rates of anodic and cathodic reactions.