Corrosion Basics

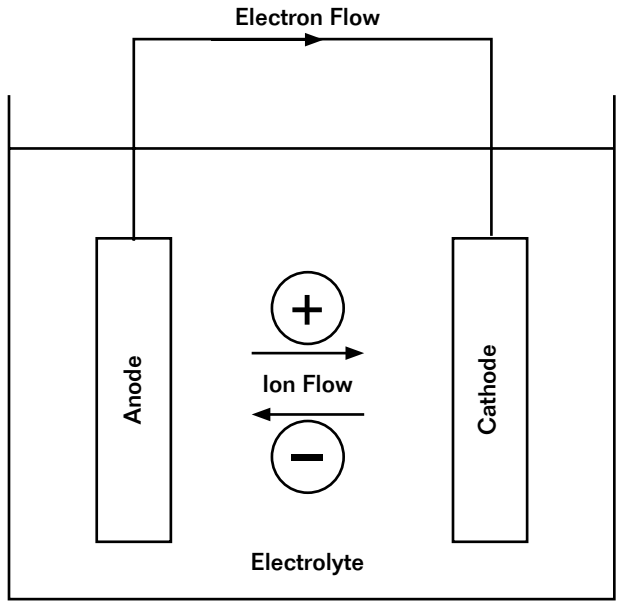
Understanding the basic principles and causes of corrosion

Principles of Electrochemistry Applied to Corrosion

Although corrosion can take several forms, the mechanism of attack in aqueous environments involves some aspect of electrochemistry. There is a flow of electricity from certain areas of a metal surface to other areas through a solution capable of conducting electricity, such as seawater or fresh water. The term anode is used to describe that portion of the metal surface that is corroded and the term cathode is used to describe the metal surface from which current leaves the solution and returns to the metal.

A solution capable of conducting electricity is called an electrolyte. Its ability to conduct electricity is due to the presence of ions. These are positively or negatively charged atoms or groups of atoms in solution (Figure 1). Pure water contains positively charged hydrogen ions (H+) and negatively charged hydroxyl ions (OH–) in equal concentration. The electrolyte forming a corrosive environment may be any solution, rain, or even moisture condensed from the air. It can range from fresh water or salt water to the strongest alkali or acid.

Figure 1



Electrical current flows through the electrolyte to balance the flow of electrons in the metal. In this case, the carriers of the electrical current are ions in the electrolyte. Anions (negatively charged ions) flow toward the anode and cations (positively charged ions) flow toward the cathode. Figure reproduced from NACE International *Basic Corrosion Student Manual,* p. 2.9.

Electrochemical Reactions

An electrochemical reaction is defined as a chemical reaction involving the transfer of electrons. It is also a chemical reaction that involves oxidation and reduction. Because metallic corrosion is almost always an electrochemical process, it is important to understand the basic nature of electrochemical reactions. The discoveries that gradually evolved in modern corrosion science have, in fact, played an important role in the development of a multitude of technologies we enjoy today.

Briefly, then, for corrosion to occur there must be a formation of ions and release of electrons at an anodic surface where oxidation or deterioration of the metal occurs. There must be a simultaneous acceptance at the cathodic surface of the electrons generated at the anode. This acceptance of electrodes can take the form of neutralization of positive hydrogen ions or the formation of negative ions. The anodic and cathodic reactions must go on at the same time and at equivalent rates. However, corrosion occurs only at the areas that serve as anodes.

This article is adapted from *Corrosion Basics—An Introduction, Second Edition,* Pierre R. Roberge, ed. (Houston, TX: NACE International, 2006), p. 27-31.