

# Corrosion Basics

*Understanding the basic principles and causes of corrosion*

## Corrosion and the Environment

*MP* first published a department in the early 1980s until 1991 on the basics of corrosion. The department was revived in 2001 in response to high reader interest expressed in surveys and correspondence to the editors. The column was excerpted from NACE International publications that included *Corrosion Basics—An Introduction* (L.S. Van Delinder, ed., 1984), and *Corrosion Prevention by Protective Coatings* (Charles G. Munger; L.D. Vincent, ed., 1999). Moving forward, *MP* editors will use the second edition of *Corrosion Basics—An Introduction* (Pierre Roberge, ed.), which was released in 2006; the Munger book for coatings-related topics; and other basic corrosion resources.

**The fact that corrosion does occur should not be cause for surprise. Almost all materials should be expected to deteriorate with time when exposed to the elements.**

Corrosion is a perfectly natural process, as natural as water flowing downhill. If water flowed uphill or remained stationary on a hillside, there may be cause for surprise, yet our human ingenuity can accomplish this by putting water in a closed container (pipe) and closing the bottom end, or merely freezing it.

Similarly, if iron or steel were exposed to air and water, rust would be expected to develop within a matter of hours. In fact, it would be surprising if the exposed iron did not corrode or rust. Of course, if copper, brass, aluminum, or stainless steel was substituted for iron, a given degree of corrosion might take longer, but

some corrosion would still be anticipated. Instead of forming rust (a form of iron oxide), some oxides of copper, aluminum, or chromium may form very slowly and coat the bare metal. This oxide coating, even if extremely thin, could form a partial barrier to continued attack and slow down the rate of corrosion almost to a standstill.

A surface-layer formation, whether it is oxide, carbonate, sulfate, or any other compound, is a major factor in corrosion resistance, particularly if the layer effectively separates the underlying metal from its environment. Such a naturally formed coating must be diffusion- and moisture-resistant to be effective. Ordinary iron does not naturally form an effective barrier; its rust permits oxygen and moisture to penetrate and continue rusting. Thus, unless precautions are taken, such as applying a protective coating over the surface, failure will eventually occur.

Some metals, such as stainless steel, titanium, or aluminum, are frequently left unpainted. This is not because these metals are inert, but because oxygen in the air helps develop a protective oxide

layer on the metallic surface. Although these oxide layers are so thin as to be invisible to the eye, they can be detected and their presence verified.

Some environments are more corrosive than others. Although there are exceptions, the following statements are generally accepted as facts:

- Moist air is more corrosive than dry air.
- Hot air is more corrosive than cold air.
- Hot water is more corrosive than cold water.
- Polluted air is more corrosive than clean air.
- Acids are more corrosive than bases (alkalis) to steels.
- Salt water is more corrosive than fresh water.
- Stainless steel will outlast ordinary steel.
- No corrosion will occur in a vacuum, even at very high temperatures.

Although it may be a surprise to some, there are instances when all of these statements, including the last one, are incorrect. This would indicate that broad, categorical statements should be considered to be suspect. There is essentially no statement regarding corrosion or the use of a material that does not have an exception.

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