Bartel Metallurgical LLC
The Strength of Experience

Subject: Eight Forms of Corrosion

This is the first of eight primers which introduce the forms of corrosion likely to be encountered in the petrochemical, refining, fertilizer, and other industries. The eight forms have been used for decades to describe, by appearance, the common degradation mechanisms in metals and alloys.

1. Uniform Corrosion

Uniform corrosion is the most common form of attack and is preferrable to other corrosion types. The preference for uniform corrosion is related to an owner-operators ability to monitor and trend the rate of attack. Because uniform corrosion can be trended, it is easier to manage inspection intervals and determine equipment life. Uniform corrosion is typically encountered in atmospheric exposures, high temperature applications, and acidic process streams. When a corrosion allowance is assigned to a component, uniform corrosion is the assumed form of attack. When owner-operators assign a corrosion allowance, it can vary from zero to an eighth inch or even thicker based on the component and the material of construction.

Uniform corrosion is dependent on factors such as temperature, pH, pressure, velocity, dissolved species, and impurities. If you have heard the adage that each 10°C rise in temperature doubles the corrosion rate, it is used in relation to uniform corrosion. However, like all general rules there are occasions where increasing temperature can be beneficial, such as when it decreases the drying time in outdoor applications. The effect of pH is illustrated by a graph of iron corrosion in oxygenated water where between a pH of 4-10 the corrosion rate is modest and stable, above pH 10 the rate of attack declines, and below pH 4 the rate of attack markedly increases. Pressure will alter the dew point, or gas solubility, resulting in higher or lower corrosion rates. Low velocity or stagnant conditions can increase corrosion and higher velocity can remove a protective film increasing attack or improve the transport of corrosion inhibitors and decrease attack. Dissolved gases, salts, metal ions and other contaminants can act as inhibitors or contributors to the rate of attack.

Corrosion tables and iso-corrosion charts are available and provide data in units of mils, or millimeters, per year (mpy or mm/y), and others. When using corrosion tables and iso-corrosion charts, be mindful of the factors which determine the rate of uniform corrosion. Published data should be used primarily as a screening tool to disqualify, rather than qualify, a metal or alloy as most data was generated during short exposures, with reagent grade chemicals free of impurities, and little or no agitation. As a result, the corrosion data is unlikely to represent your process conditions accurately enough to make an informed material selection. Thorough corrosion data does exist for widely produced and used products such as sulfuric acid, and there is also data developed during long term, in-plant, exposures. NACE, API, MTI, DECHEMA, and other resources are available to owner-operators which provide material selection information related to uniform and other forms of corrosion.

Owner-operators must also control the factors which effect uniform corrosion during operation. Operational changes due to increased production rates, turndown due to economic conditions, upsets, and others can result in increased corrosion. To manage the corrosion, owner-operators will utilize process safety management (PSM), integrity operating windows (IOWs), risk based inspection (RBI), and other programs.

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