



Subject: Eight Forms of Corrosion

This is the seventh 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.

7. Erosion-Corrosion

Erosion-corrosion (E-C) is attack from the combined action of erosion and corrosion which produces greater metal loss than either factor would singly. E-C can often be identified by distinct surface patterns such as sand dunes, gullies, comet tails, horseshoes, and others. When E-C is actively occurring, the damaged surfaces will be free of deposits and corrosion products. When E-C is dormant or intermittent, deposits and corrosion products will usually be present.

General factors which influence E-C include flow velocity, turbulence, two-phase flow, solid particle concentration, solid particle hardness, solid particle impact angle, and galvanic coupling. While higher velocities are generally unfavorable, increased velocity can also reduce E-C through more effective transport of inhibitors and oxidizing species which repair surface films. Solid particle testing indicates that a 20-30 degree impact angle results in higher metal loss on ductile metals and a 70-90 degree angle is more damaging to brittle materials.

Metallurgical factors which influence E-C include the tenacity of the protective (passive) film, prior heat treatment, hardness, and the natural corrosion resistance of the alloy to the environment. Though higher hardness is generally favorable in applications of pure erosion or abrasion, it is not as clear cut in E-C applications. Poor behavior of hardened materials in E-C applications are often related to a less stable protective (passive) film, i.e., a decrease in the natural corrosion resistance.

E-C is commonly found in pumps, valves (especially flow control, choke, and partially open valves), blowers, agitators, turbines, cyclones, bends-tees-elbows in piping systems, orifice plates, and impingement plates. E-C occurs in fertilizer production, oil production such as after fracking due to proppant, refinery units such as hydroprocessing reactor effluent systems, power plants, and others.

There are also a few specific types of E-C which fall outside the broad definition. Those specific types include:

- Hydrogen grooving – Occurs in steel storage tanks handling concentrated sulfuric acid whereby rising hydrogen bubbles remove the protective, yet soft, iron sulfate film.
- Fretting corrosion – Occurs when relative motion occurs between closely mating surfaces. Often occurs at hub-to-shaft assemblies, bearing-to-shaft assemblies, and bolted joints.
- Cavitation – Occurs because of rapid, repeated, vapor bubble collapse. In some cases, cavitation can produce audible noise which sounds like the pumping of gravel. Cavitation damage is normally in the form of steep sided or sharp-edged pits. Oftentimes cavitation is related to a lack of pump suction pressure (head), turbulent flow causing local pressure fluctuations, and operation near the liquid boiling point.

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