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While many questions still surround this widespread and widely studied problem, there are a number of control measures you can take to help minimize losses from it in your operations.

Stress-corrosion cracking (SCC) is one of the most prevalent—and one of the most studied—forms of metallic materials failure. This phenomenon is responsible for significant economic losses in many industries and operations, including chemical and petroleum processing, nuclear and fossil fuel power generation, pulp and paper production, underground pipelines and commercial and military aircraft. Materials subject to SCC include mild and low alloy steels, stainless steels and alloys based on nickel, copper, aluminum, titanium or magnesium. (As discussed later in this article, a related process is hydrogen embrittlement [HE].)

Although SCC has received more fundamental study than any other form of corrosion-related attack, many questions still remain. This article is a brief introduction to the topic. It will review a few of the important characteristics of SCC, as well as some related cracking processes in common materials, and show how these results can be used to help minimize loses. References provided at the end of the article list some sources for more in-depth inquiries.

Keep in mind that guaranteed SCC prevention is impossible. Unexpected combinations of the governing factors commonly occur and control measures are not 100% effective. Certain actions, however, can be taken to reduce the frequency of failures. As in many equipment reliability improvement areas, the keys to significant initial progress are first to gain awareness and then to apply known but often under-utilized information.

Table I. Combinations of Alloys and Corrosive Media Prone to Stress-Corrosion Cracking (SCC) or Hydrogen Embrittlement (HE)

Mild steels –
Nitrate, hydroxide, carbonate/bicarbonate, acidified cyanide and amine aqueous solutions; anhydrous ammonia; gaseous hydrogen at high temperature and pressure.

Low alloy steels –
Aqueous solutions with hydrogen sulfide and/or halide ions; gaseous chlorine, hydrochloric and hydrobromic acids; gaseous hydrogen or gaseous hydrogen sulfide (each at ambient temperature); sulfide impurities in aqueous solutions; arsenic, antimony or bismuth ions in aqueous solutions at ambient temperature. HE is a common cause.

Austenitic stainless steels –
Hot solutions with chloride and other halide ions; fluoride ions in aqueous solutions at ambient temperature if steel is sensitized; oxygen dissolved in water at temperatures above 570 F if steel is sensitized; hydroxide solutions if temperature is above 210 F; polythionic acids at ambient temperature if steel is sensitized.

Nickel alloys –
Inconel 600 alloys in polythionic acids at ambient temperature if alloy is sensitized and in hot NaOH; alloys 400 and B-3 in hydrofluoric acid.

Copper alloys –
Aerated aqueous ammonia solutions; amines in aqueous solutions; nitrogen oxides with moisture; sulfur dioxide gas with moisture.

Aluminum alloys –
Halide ions in aqueous solutions at ambient temperature for high-strength alloys; fuming nitric acid at temperatures above 210 F for high-strength alloys.

Titanium alloys –
(For industrial alloys Grades 1,2,9,12 & 28) – nitrogen tetroxide, fuming nitric acid; anhydrous methanol. (Higher-strength, aerospace alloy grades may also be susceptible to these same media plus aqueous halide solutions and certain organic compounds with halide ions.)

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