Different Types of Corrosion

- Recognition, Mechanisms & Prevention

Hydrogen Embrittlement (HE)

Recognition of Hydrogen Embrittlement

What is hydrogen embrittlement? Hydrogen embrittlement (HE) is a process resulting in a decrease of the toughness or ductility of a metal due to the presence of atomic hydrogen. Hydrogen embrittlement has been recognized classically as being of two types.

The first, known as internal hydrogen embrittlement, occurs when the hydrogen enters molten metal which becomes supersaturated with hydrogen immediately after solidification.

The second type, environmental hydrogen embrittlement, results from hydrogen being absorbed by solid metals. This can occur during elevated-temperature thermal treatments and in service during electroplating, contact with maintenance chemicals, corrosion reactions, cathodic protection, and operating in high-pressure hydrogen.

Mechanisms of Hydrogen Embrittlement

What causes hydrogen embrittlement? In the absence of residual stress or external loading, environmental hydrogen embrittlement is manifested in various forms, such as blistering, internal cracking, hydride formation, and reduced ductility. With a tensile stress or stress-intensity factor exceeding a specific threshold, the atomic hydrogen interacts with the metal to induce subcritical crack growth leading to fracture. In the absence of a corrosion reaction (polarized cathodically), the usual term used is hydrogen-assisted cracking (HAC) or hydrogen stress cracking (HSC).

In the presence of active corrosion, usually as pits or crevices (polarized anodically), the cracking is generally called stress-corrosion cracking (SCC), but should more properly be called hydrogen-assisted stress-corrosion cracking (HSCC). Thus, HSC and electrochemically anodic SCC can operate separately or in combination (HSCC). In some metals, such as highs-strength steels, the mechanism is believed to be all, or nearly all, HSC. The participating mechanism of HSC is not always recognized and may be evaluated under the generic heading of SCC.

Prevention of Hydrogen Embrittlement

How to prevent hydrogen embrittlement? Hydrogen embrittlement can be prevented through:

- Control of stress level (residual or load) and hardness.
- Avoid the hydrogen source.
- Baking to remove hydrogen.

For more details on Hydrogen Embrittlement

Where can I learn more about hydrogen embrittlement? More details on environmental cracking are included in the following corrosion courses which you can take as in-house training courses, course-on-

demand, online courses or distance learning courses:

Corrosion and Its Prevention (5-day module)
API 571 Damage Mechanisms Affecting Fixed Equipment in the Refining and Petrochemical Industries (5 days)
Corrosion, Metallurgy, Failure Analysis and Prevention (5 days)
Marine Corrosion, Causes and Prevention (2 days)
Materials Selection and Corrosion (5 days)
Stainless Steels and Alloys: Why They Resist Corrosion and How They Fail (2 days)

If you require corrosion expert witness or corrosion consulting service on hydrogen embrittlement, our NACE certified Corrosion Specialist is able to help. Contact us for a quote.
