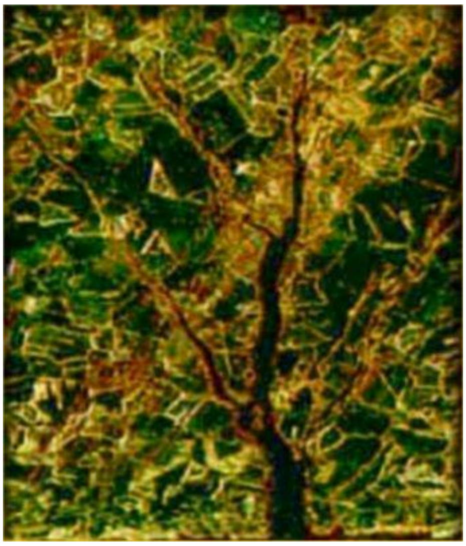
Different Types of Corrosion

- Recognition, Mechanisms & Prevention

Environmental Cracking

Recognition of Environmental Cracking



What is environmental cracking? Environmental cracking refers to the brittle fracture of a normally ductile material in which the corrosive effect of the environment is a causative factor. Environmental cracking is a broad term that includes corrosion fatigue, high-temperature hydrogen attack, hydrogen blistering, hydrogen embrittlement, liquid metal embrittlement, season cracking, caustic embrittlement, stress-corrosion cracking, stepwise cracking, sulfide corrosion cracking and sulfide stress cracking.

Historically, "season cracking" was first used to describe the cracking phenomenon of brass cartridges in the presence of ammonia; "caustic embrittlement" was used to describe the cracking of riveted mild steel boiler plates. The two terms were collectively known as "stress corrosion cracking" which was in turn replaced by "environment-sensitive cracking" or "environmental cracking". This broad term reflects the role of environment plays in the cracking process and the terms now covers all the following:

- *caustic cracking*
- *stress corrosion cracking*
- *hydrogen blistering*
- *hydrogen embrittlement*
- *hydride embrittlement*
- *hydrogen-induced cracking (stepwise cracking)*
- *hydrogen stress cracking*
- *sulfide stress cracking*
- *liquid metal cracking*

Mechanisms of Environmental Cracking

What causes environmental cracking? Environmental cracking results from the conjoint action of three components:

- (1) a susceptible material;
- (2) a specific chemical species (environment) and
- (3) tensile stress.

For example, copper and its alloys are susceptible to ammonia compounds, mild steels are susceptible to alkalis and stainless steels are susceptible to chlorides.

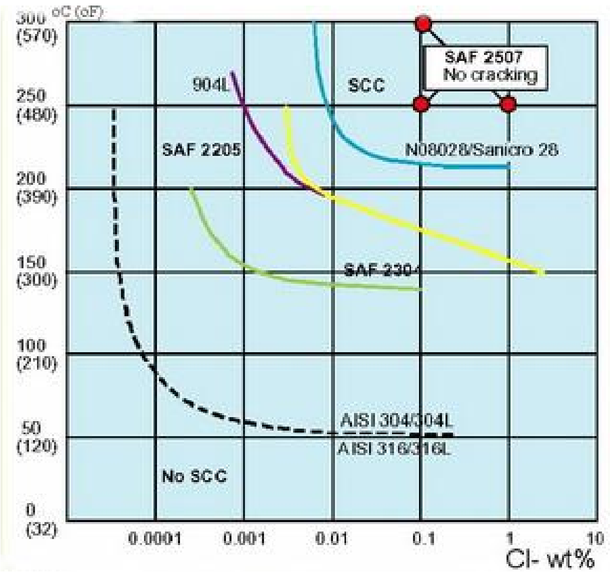
There is no unified mechanism for environmental cracking in the literature. Various models have been proposed which include the following:

- Adsorption model: specific chemical species adsorbs on the crack surface and lowers the fracture stress.
- Film rupture model: stress ruptures the passive film locally and sets up an active-passive cell. Newly formed passive film is ruptured again under stress and the cycle continues until failure.
- Pre-existing active path model: Pre-existing path such as grain boundaries where intermetallics and compounds are formed.
- Embrittlement model: Hydrogen embrittlement is a major mechanism of environemntal cracking for steels and other alloys such as titanium. Hydrogen atoms diffuse to the crack tip and embrittle the metal.

Prevention of Environmental Cracking

How to prevent environmental cracking? Environmental cracking can be prevented through:

- Control of stress level (residual or load) and hardness.
- Avoid the chemical species that causes environmental cracking.
- Use of materials known not to crack in the specified environment.
- Control temperature and/or potential



For more details on Environmental Cracking

Where can I learn more about environmental cracking? 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)
Environmental Cracking (HB/HIC/SWC/SOHIC/SSC/SZC/HSC/HE/SCC): Recognition, Mechanisms and Prevention (5 days)
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 environmental cracking, our NACE certified Corrosion Specialist is able to help. Contact us for a quote.