PENFLEX

ENGINEERING BULLETIN #138

Causes and Prevention of Hydrogen Embrittlement

A form of stress corrosion cracking, hydrogen embrittlement is the loss of a metal's ductility and subsequent inability to maintain its load bearing capacity due to the absorption of hydrogen.

As a result, metal will crack or fracture under stresses less than yield strength. The difference between anticipated and actual stresses that lead to failure is determined by various factors including the amount of hydrogen absorbed.

Several forces must be in play to create a situation where hydrogen embrittlement is present. First, a susceptible material. Second, exposure to hydrogen. Lastly, stress on the component. Failure due to hydrogen embrittlement cannot happen without the presence of all three.

Embrittlement Process

Even at room temperature, steel can absorb hydrogen atoms. Once absorbed, the atoms recombine to form hydrogen molecules. Over time, these molecules diffuse throughout the metal and form bubbles at grain boundaries. The bubbles exert pressure which weakens the metal, eventually reducing ductility and tensile strength.

Situations leading to hydrogen absorption

The likelihood of hydrogen absorption can increase with various manufacturing and operational processes involving heat. This is due to solubility of hydrogen.

When it comes to metal hose, welding presents an opportunity for hydrogen absorption. At Penflex, we use TIG welding on stainless steel. While this approach to welding isn't known for inducing hydrogen absorption, we still take precautions to prevent it. This includes material preparation and post-weld cleaning to remove any residual carbon content.

Once in use, hydrogen absorption can occur when a component is exposed to chemicals or if it has experienced some kind of corrosion. While we seldom encounter hydrogen embrittlement, the applications where premature cracks likely occurred as a result of it involved hydrogen gas.

Preventing hydrogen embrittlement

Thicker materials with higher carbon content are often more likely to experience this kind of the stress corrosion. If hydrogen absorption is expected to occur during service, lower carbon steels might be considered. Penflex might offer L grade stainless steels—like 316L—in such circumstances.

Baking metals is a common means of removing hydrogen during the manufacturing process as is avoiding quick changes in temperature that might lead to condensation. It's also important to keep hose assemblies off the ground and protected from exposure to chemicals which might lead to corrosion and premature failure.

If you have any questions, please contact us.