Material Compatibility Considerations for Hydrogen Applications

The mechanical properties of materials can be adversely affected by exposure to hydrogen. The extent of deterioration varies depending on factors such as the material type, the specific environmental conditions (e.g., hydrogen pressure and temperature), and the applied mechanical load. Consequently, careful material selection is crucial for items exposed to hydrogen, and designs must consider the potential decline in mechanical properties.

The exposure of metals to hydrogen can result in embrittlement, which can lead to significant reductions in tensile strength, ductility, fracture toughness, and accelerated fatigue crack growth. This, in turn, can contribute to the failure of pressure-containing components.

Metals, even those less resistant to hydrogen-induced deterioration, may still be employed if analysis of pressure-containing components indicates acceptable mechanical loading. Fracture mechanics is the commonly accepted method for demonstrating this.

Materials commonly used in hydrogen gas service for specific ranges of material characteristics (e.g., chemical composition and strength), mechanical loading, and environmental conditions are: **austenitic stainless steels, aluminum alloys, low-alloy ferritic steels, C-Mn ferritic steels,** and **copper alloys.**

Materials commonly avoided in hydrogen service are: **high strength ferritic steels, high strength martensitic steels, cast irons (including gray, malleable, and ductile), nickel alloys, and titanium alloys.**

For more in depth information regarding material compatibility see our eLearning Course and Webinar on the topic or visit the h2tools site for further reading.

Read more about this and other hydrogen safety topics at www.h2tools.org.
Please contact us at chs@aiche.org if you have a suggestion for a future topic.