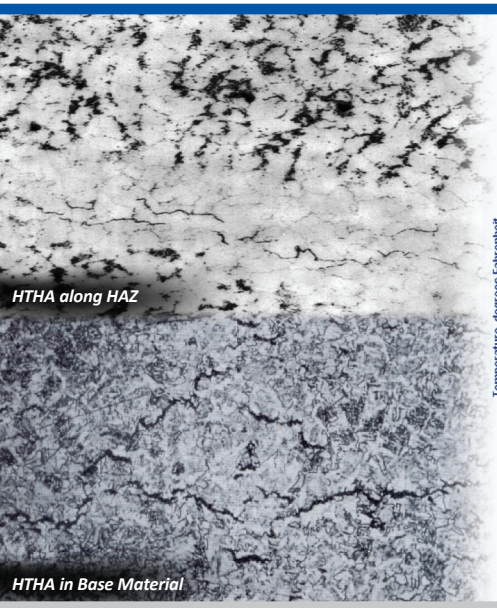
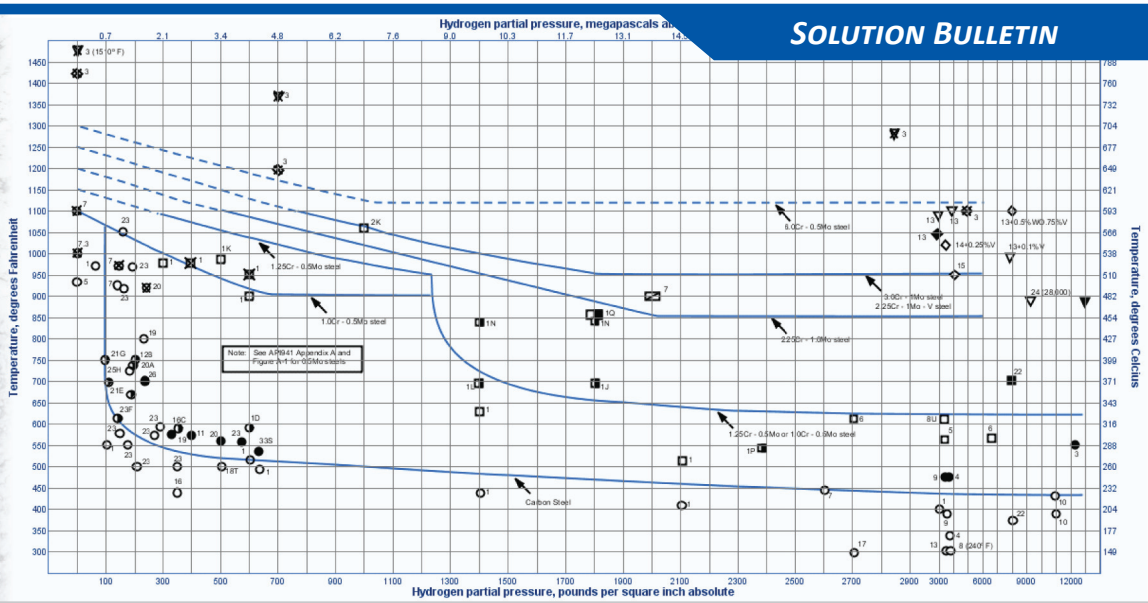
MISTRAS
Asset Protection Solutions | Services Division

SOLUTION BULLETIN

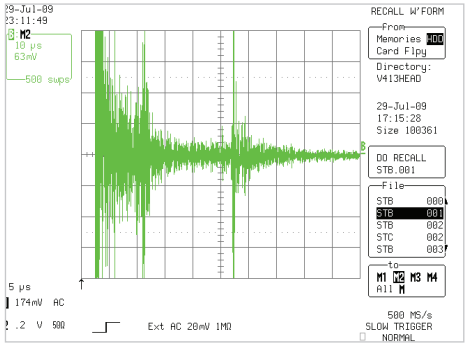


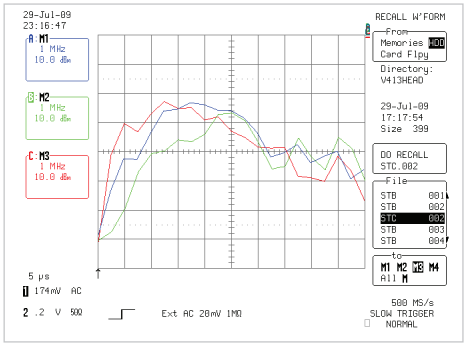


HTHA | High Temperature Hydrogen Attack

High temperature hydrogen attack (HTHA) can occur when steel is exposed to atomic hydrogen (H) at elevated temperatures and pressures. Under these conditions, some hydrogen molecules (H2) break apart into individual hydrogen atoms (H). Individual hydrogen atoms can diffuse into steel at high temperatures and react with carbon (C) in the steel, forming methane (CH4). Because methane molecules are too large to diffuse through steel, the methane accumulates, forming extremely high pressure bubbles which connect to create micro-fissures at grain boundaries. In advanced stages of HTHA, fields of micro-fissures connect to form cracks. The chemical combination of carbon and hydrogen results in decarburization of the steel. Decarburization is the loss of carbon from the steel, reducing the strength of the metal.

Industry codes and standards rely on data compiled in the American Petroleum Institute (API) Recommended Practice 941 to determine combinations of hydrogen partial pressures and temperatures for which HTHA is not expected to occur (See chart at Top). The Nelson curves were developed from industry experience and have been adjusted over time to reflect new reports of HTHA. For a given type of steel, combinations of hydrogen partial pressure and temperature below the Nelson curve are considered safe.





Since several parameters influence a material's susceptibility to HTHA, our Asset Integrity Management group (AIMS) reviews & coordinates efforts with your process team to develop a comprehensive inspection plan that identifies equipment with the highest risk, thereby reducing the danger of any catastrophic events. The planning work can be done well in advance of a turnaround, so that all necessary factors are considered.

MISTRAS utilizes several NDE techniques to determine the presence and the severity of HTHA. The primary inspection techniques are the Advanced Ultrasonic Backscatter Technique and Advanced Backscatter Spectral Analysis. These techniques use proven ultrasonic technologies that evaluate the frequency dependence, velocities and several other factors to help determine which assets may have been affected by HTHA. Further investigation involves the use of metallographic replications to evaluate the microstructure as well as the other material properties.

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