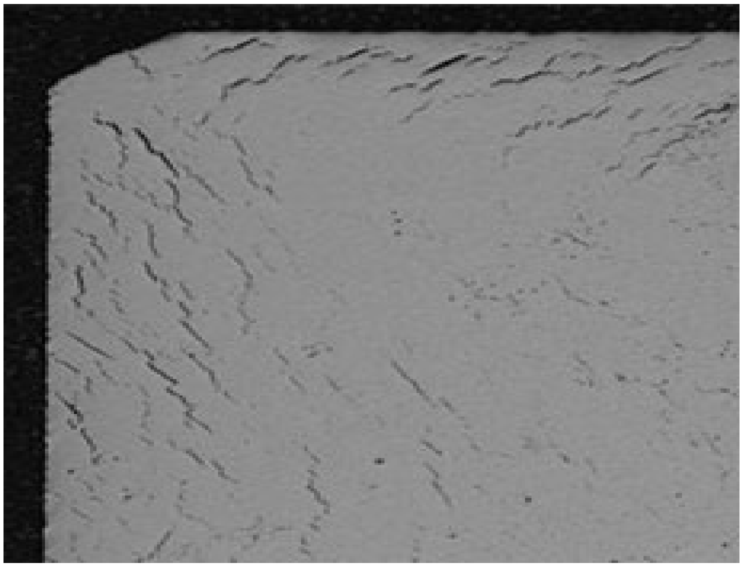
HTHA DETECTION

In this issue:

Introduction

High Temperature Hydrogen Attack (HTHA) is an insidious condition that can occur in process equipment exposed to hydrogen at elevated temperatures (at least 400F or 204C), under dry conditions, when hydrogen disassociates into nascent (atomic) hydrogen, which is then driven into the steel by the temperature and pressure of the environment. The atomic hydrogen then reacts with unstable carbides in steel to form methane gas, which accumulates in the microstructural grain boundaries, eventually leading to cracking. This is often hazardous as the equipment usually contains hydrocarbons at high pressures and temperatures.

.



Susceptible Areas

HTHA affects carbon and low alloy steels but is most found in carbon steel and carbon-1/2 Mo steel that is operating above its corresponding Nelson Curve limits. Areas that are hotter, often near the outlet nozzle of catalytic equipment or the inlet nozzle of an exchanger that is cooling the process, are areas of concern for HTHA. Welds often suffer from HTHA degradation as well.

Prevention/Mitigation

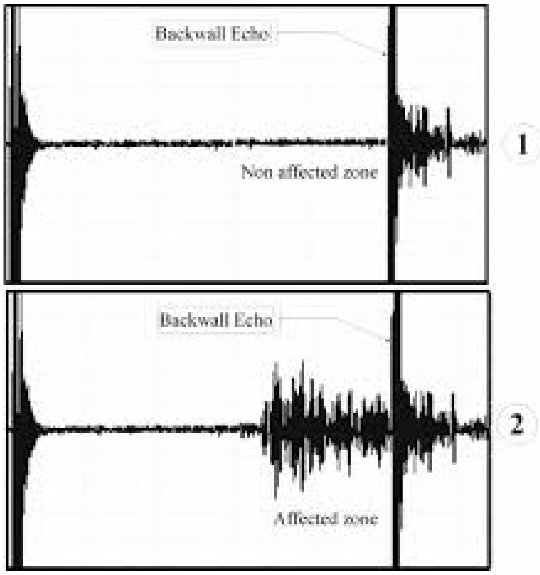
Typically HTHA can be avoided by choosing the proper alloy steel or stainless-steel cladding to resist the combination of hydrogen partial pressure and temperature, or by adjusting the operating conditions to stay below the Nelson Curve limit for the existing materials of construction.

Inspection Techniques

A corrosion or materials specialist, experienced in HTHA, should be consulted for identifying susceptible equipment, selecting inspection locations, and estimating remaining life of equipment in this service.

Inspection techniques for finding advanced stages of HTHA at the surface include WFMT, MT, UT and in-situ metallography (e.g., field metallographic replication).

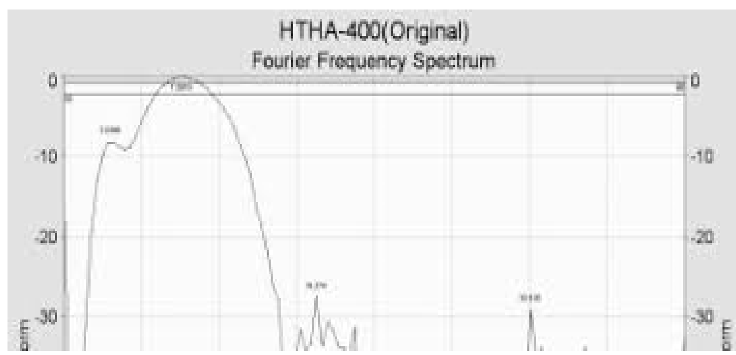
Advanced ultrasonic backscatter testing (AUBT) Along with some further verification techniques like Velocity Ratio, PAUT TFM, Spectrum Analysis and TOFD has been successfully used to find earlier stages of HTHA.

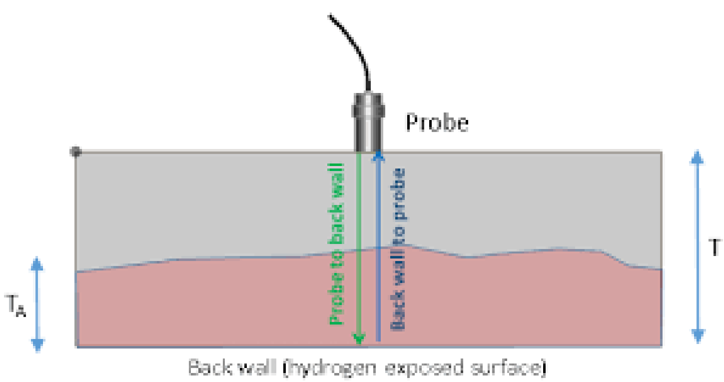


Advanced Ultrasonic Backscatter Testing (AUBT)

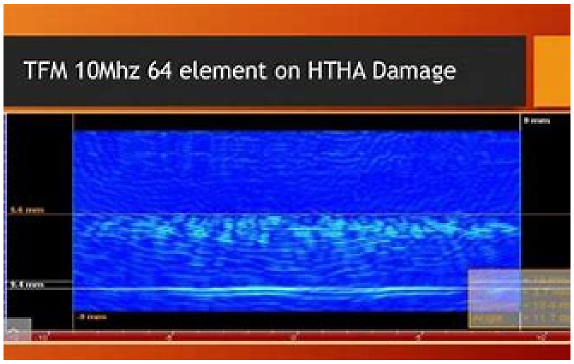
Advanced ultrasonic backscatter testing (AUBT) used primarily to determine damage progression through the wall. It works with materials of any geometry with or without cladding.

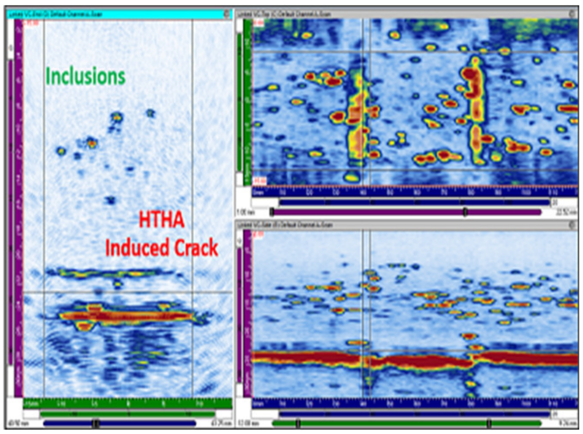
Spectrum analysis which helps to determine the degree of HTHA; it is sensitive to fissures and is independent of the measurement system.





The velocity ratio measurement which differentiates between fissures and other internal defects. It is not affected by material geometry, back wall surface condition, or the measuring system.





PAUT (Total Focusing Method- TFM)

The PAUT (TFM Technique) is Combining different examination techniques is key for HTHA detection, and API's recommended practice (API RP 941) is evolving towards this. Phased Array Ultrasonic Testing (PAUT) has been recognized as one of the best techniques for HTHA inspection.

As for the Total Focusing Method (TFM), it enables an improved characterization of indications, and ultimately allows making the distinction between HTHA damage and other types of defects.

Time of Flight Diffraction

Time of Flight Diffraction (TOFD) offer rapid screening of large areas with a high Probability of Detection (POD) due to its capacity to sense small back-scattered signals.