Application Note

DETECTING HIGH TEMPERATURE HYDROGEN ATTACK (HTHA) BEFORE IT'S TOO LATE

Aging infrastructure found in the petrochemical and industrial sectors are all vulnerable to cracking after being exposed to cyclic loading and fatigue stress. But there's another prevalent defect that results under unique circumstances.

1

THE CHALLENGE

High Temperature Hydrogen Attack is a defect of concern, and it is difficult to detect with conventional ultrasonic testing due its very small size, especially in its early stage.

2

THE SOLUTION

An advanced, portable tool capable of all ultrasonic techniques required to pinpoint HTHA: TOFD/TULA, PAUT and TFM with an intuitive software for fast configuration.

3

THE BENEFITS

Protecting assets and safety, with confidence in the inspection results: detecting early stage HTHA requires sophisticated equipment, but operators cannot afford to struggle with complex software.

The Challenge

After the infamous 2010 Tesoro Anacortes Refinery disaster, a fatal accident from a heat exchanger explosion, industry has turned a spotlight on the original culprit: High Temperature Hydrogen Attack (HTHA). HTHA occurs in an environment containing hydrogen and high temperatures, typically in low alloy steels. High temperatures change the atomic form of hydrogen which makes it permeate into the steel, react with carbon, and form methane. Because the methane gets trapped in the metal, it ends up creating a microscopic bubble at the grain boundaries in the steel; this is stage one. As bubbles start to grow, they start to coalesce as stage two, ultimately leading to fissures and cracking at stage three. HTHA commonly occurs in welds and Heat Affected Zones (HAZ) in materials that never received heat treatment. Many refinery owners have started additional inspections for HTHA after the component failure that was not anticipated to be susceptible to high temperature hydrogen attack. However, HTHA defects are very small and it is quite difficult to detect with conventional ultrasonic testing (UT) or any other volumetric non-destructive testing method.

The Solution

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, while Time of Flight Diffraction (TOFD) and TULA (TOFD ultra low angle) offer rapid screening of large areas with a high Probability of Detection (PoD) due to its capacity to sense small back-scattered signals. 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. This type of inspection is usually performed with a single axis encoded scanner and optimized probes for the application.

Eddyfi Technologies offers advanced flaw detectors like the M2M Gekko® which are regularly used to characterize HTHA cracking.

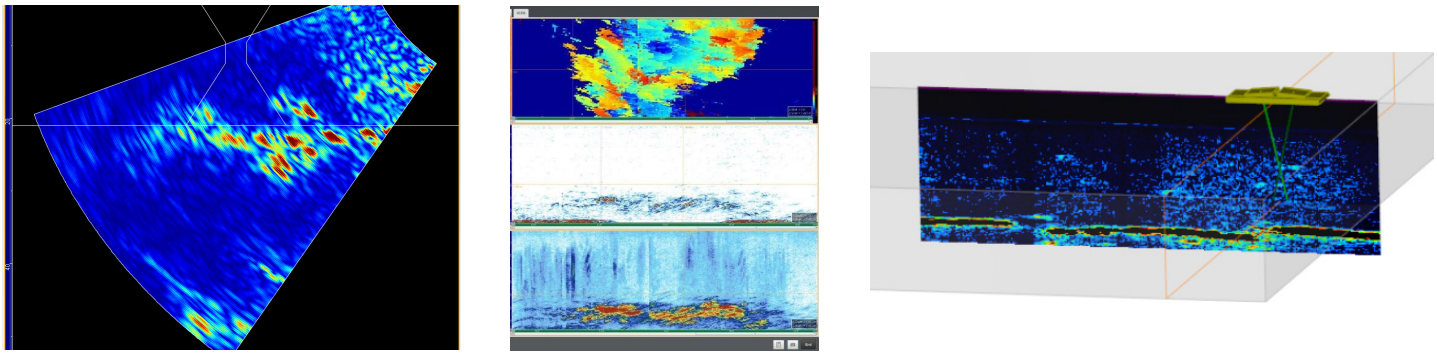
The proposed solution includes:

- Gekko units to handle high channel count dual probes, high resolution sector scanning, live TFM, TOFD/TULA, intuitive software configuration, and automatic time corrected gain (TCG);
- 1-axis scanner for data encoding and defect positioning;
- Linear, DLA and DMA probes and wedges kit.

From left to right: M2M Gekko® flaw detector, 1-axis scanner, PAUT-TFM probes

The Benefits

Benefiting from the intuitive interface of Capture™ (the embedded control software) inspectors can setup and configure TOFD, TULA, linear, DLA and DMA high channel count phased array probes in a couple clicks without the use of third-party software. Automatic TCG is available for dual probes which also translates into less configuration time required. This solution is based on advanced ultrasonic techniques available in real-time, so that operators can optimize PAUT, TFM and hybrid method settings for the best inspection results. The result is simple: confidence in the inspection data and in the safe operation of critical assets.



From left to right: 64-element focused imaging HTHA progressing to macro-cracking in the HAZ, 64-element TFM imaging HTHA indications, TOFD ultra-low angle (TULA) imaging of HTHA clusters

www.eddyfi.com

info@eddyfi.com

Eddyfi Technologies

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