U.S. Department of Transportation

Characterization Of Stress Corrosion Cracking Using Laser Ultrasonics DTPH56-06-T-0003

OPS ACCOMPLISHMENTS

Pipeline Safety Research and Development for Focus area:

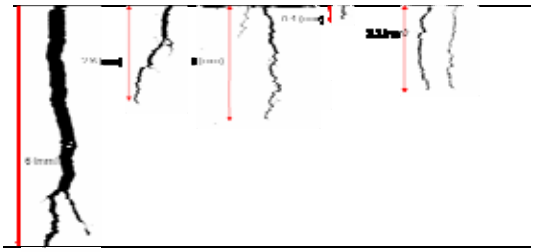
Direct Assessment

Challenge

Stress Corrosion Cracking (SCC) is a phenomenon where metals, when subjected to a combination of suitable loads, corrosive environment and susceptible metallurgy, develop crack-clusters that may lead to a failure.

Pipeline systems all-over the world are susceptible to stress corrosion cracking. Measurement of the length and depth of these crack-clusters can enable pipeline operators to take mitigative action and prevent failures, which may lead to damage to life, property and environment.
While measurement of isolated cracks is very possible using current technology, stress corrosion cracking occurs in closely spaced, highly irregular shapes, thereby rendering conventional technologies and techniques less reliable.

The primary challenge in measuring the depth of stress corrosion cracks is to develop a technology that can accommodate the tiny separation between the cracks.



1. **Typical SCC (top-view)**
2. **Typical SCC (cross-sectional view)**

Technology Description

This R&D effort is to accomplish the following tasks:
1)Performing simulations to study and understand the generation of ultrasound using lasers.
2) Performing simulations to study the interaction of laser-generated ultrasonic waves and crack clusters
3)Using the simulation results and subsequent laboratory tests to define and refine the optimum technique for measurement
4)Developing the specifications for the inspection system
5) Developing a prototype system to demonstrate the technique

Accomplishments

Accomplishments to date:

1. **Demonstrated strong agreement between finite difference simulations and experiments.**
2. **Demonstrated use of simulation results in identifying the optimum inspection technique**
3. **Identified "Time of Flight Diffraction" (TOFD) as the best technique as applicable to measuring the depth of Stress Corrosion Crack clusters.**
4. **Identified and demonstrated two different scan techniques that are applicable to Stress Corrosion Crack sizing.**
5. **Milestones completed on-time and on-budget.**

Contact

James Merritt

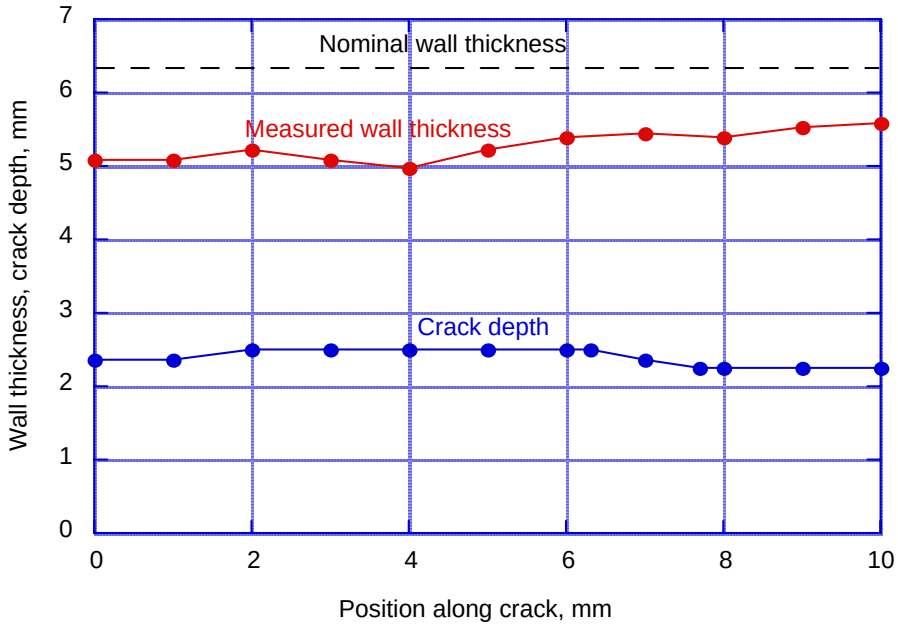
Contracting Officer Technical Representative (COTR)

(303) 683-3117

James.Merritt@dot.gov

Office of Pipeline Safety

Pipeline and Hazardous Materials Safety Administration



Partial scan of crack from SCC sample shown on Page 1. The measured crack depth is plotted (in blue) as a function of position along the crack. The same data can be used to measure the wall thickness (shown in red). Over a portion of the position range, the crack depth reaches 50% of the wall thickness.

Benefits

This research will advance pipeline safety by providing the pipeline operators with a reliable tool to measure the depth of Stress Corrosion Cracks in an efficient manner, thereby assisting them in taking appropriate measures to prevent, manage and mitigate Stress Corrosion Cracking in their pipelines.

Future Activities

In the remainder of this project, we will define the design specifications for the tool to implement the technique developed. We will then design, assemble and test a 'field-ready' prototype device to demonstrate its capabilities.

Partners in Success

- **Intelligent Optical Systems (www.intopsys.com)**
- **RTD Quality Services (www.rtdquality.use)**
- **Pipeline Research Council International (www.prci.com)**

INTELLIGENT OPTICAL SYSTEMS, INC.

RTD QUALITY SERVICES

U.S. Department of Transportation

For current information on this and other projects visit: http://primis.phmsa.dot.gov/rd/success.html