HOMC Guided wave inspection for pipes

A Dhvani Research Application Note

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NDT OF INDUSTRIAL COMPONENTS

HIGHER ORDER MODE CLUSTER GUIDED WAVE NDT SOLUTION

Pipelines running through every nook and corner in a process industry are analogous to the nervous system of the human body. It facilitates transportation of critical and precious commodities from one Centre of activity to another which may involve kilometers and kilometers of traversal. Breakage in a single line will involve catastrophic implications like in the worst case an unexpected shut down which is a night mare to any industry specialist and involves a lot of money and effort. Pipelines are supported by using pipe supports at fixed intervals in almost every overhead running rack to avoid sagging. These pipe supports are over stressed by the weight of the pipelines including the materials they transport as well as localized mechanical and thermal stresses which may by introduced at the time of fixing the pipes to these supports. Most of the industries to cope for the additional wear possibility at these locations introduce an additional sacrificial pad or simply an additional metal pad welded at these locations which in most of the cases are tack welded. Once these are welded the invisible region remains a no man's land and no inspection technologies till date can be utilized for the inspection of this region. Our solution HOMC guided wave based inspection is an apt tool developed for these purposes in responses to the year's long calls of the process industries. The crevice region of pipes, at the support locations, is more prone to corrosion due to the presence of water, air, and minerals as well as additional local contact stresses. There are several types of corrosion that are found to

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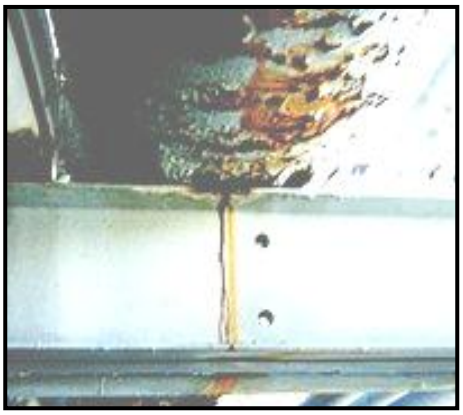
occur. The more common types include the wide area corrosion that leads to wall thickness reduction, and the pitting corrosion leading to through thickness pin hole damage.

Corrosion at Pipe support locations

Among the various type of corrosion in the pipelines, the pinhole-type pitting corrosion (localized in nature) is considered to be of prime importance due to the degree of difficulty of detection and the increased risk for causing leaks. The pipe surface at these support locations may appear to be normal during visual inspection of the visible surface (i.e. top and side region of pipe), while the condition of the pipe in the hidden region (i.e. bottom portion), where it is in contact with the support cannot be evaluated. These pipelines carry hazardous chemicals and gasses such as hydrocarbons in refineries and the presence of small leak or rupture in lines may lead to a catastrophic situation. Hence, these lines have to be inspected periodically to assess the damage before any catastrophic failure occurs.



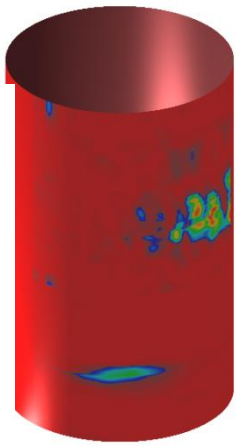
Corrosion at Pipe support locations leading to leaks

A higher order cylindrically guided ultrasonic wave was used for the detection and sizing of hidden pitting type corrosion in the hidden crevice regions (between the pipe and the pipe-supports) without lifting or disturbing the structural layout arrangement of the pipelines. The higher order circumferential guided waves were generated using a piezoelectric crystal based transducer, located at the accessible top region of the pipes, in a pulse-echo mode. By studying the experimental parameters such as dispersion, particle displacement, and wavelength of the ultrasonic guided wave modes, an appropriate higher order mode was selected for excitation using an appropriately designed acrylic angle wedge that conforms to the pipe's outer curvature. A manual pipe crawler was designed with a provision for holding the wedge and the essential hardware like data acquisition card, encoders etc. were integrated with the system so that the corrosion was mapped in real-time during the scanning of the pipes.

Acrylic wedge which incorporates the transducer

TYPICAL PIPE INSPECTION SCANNING IMAGES

The scanning is carried out using specially designed robots precisely calibrated to avoid false calls.

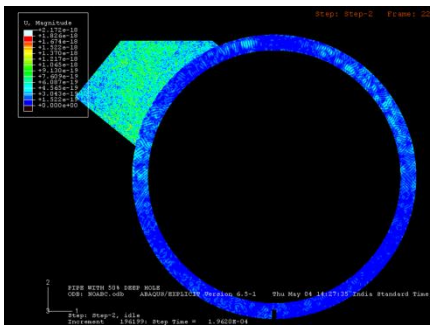


Advantages Of Using HOMC for Inspection

- Live inspection of inaccessible regions and components
- No special surface preparation is required
- Increased speed and decreased cost of inspection
- Can detect pitting corrosion holes in the range of 3 mm diameter
- High resolution capability allows detection of in-line defects
- Corroded region can be imaged for metal loss
- Entire inspection equipment is compact and portable

HOMC SIMULATION ON PIPES

The image shown below is of a simulation carried out on a pipe depicting the actual functioning of HOMC guided waves on pipes. Here the waves are generated using specially designed acrylic wedges



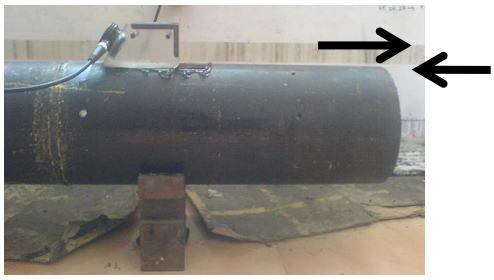
MICROBIAL CORROSION

Microbial influenced corrosion refers to the influence of microorganisms on the kinetics of corrosion processes of metals, caused by microorganisms adhering to the interfaces which are usually called biofilms. Prerequisite for MIC is the presence of microorganisms. As in the case of process industry or especially refineries there are pipelines that run long distances that carry materials like say crude oil. This is not a refined product and the presence of impurities cannot be avoided. These impurities include water which is a major stimulant for this type of corrosion as this contains lots of microorganisms. This is a major concern as these type of corrosion is found to be the root cause of 6'o' clock corrosion which is worrying oil majors across the globe. The image given below is of a sample showing microbial corrosion and the area where it grew into a pin hole has been highlighted. The solition is also given below

The beauty of a technology is when it's not localized to a particular application. The same technology is employed for different applications like Tank Annular Plate scanning, Railway Feet weld inspection etc . For pipes another application is when we are generating axial HOMC instead of circumferential HOMC. There may be cases where most people follow a simple process of wrapping composites throughout around the pipe circumferentially whenever a leakage is located. The real disaster is while doing so that region is shut down for further inspection which makes to wait for a failure to occur. The same technology can be employed for similar axial applications which also gives accurate and precise defect detection.

AXIAL HOMC SOLUTION

The images shown below are of the axial HOMC solutions. The first image shows the direction of propagation of HOMC guided waves inside the test coupons and the second image shows the technique employed for the same



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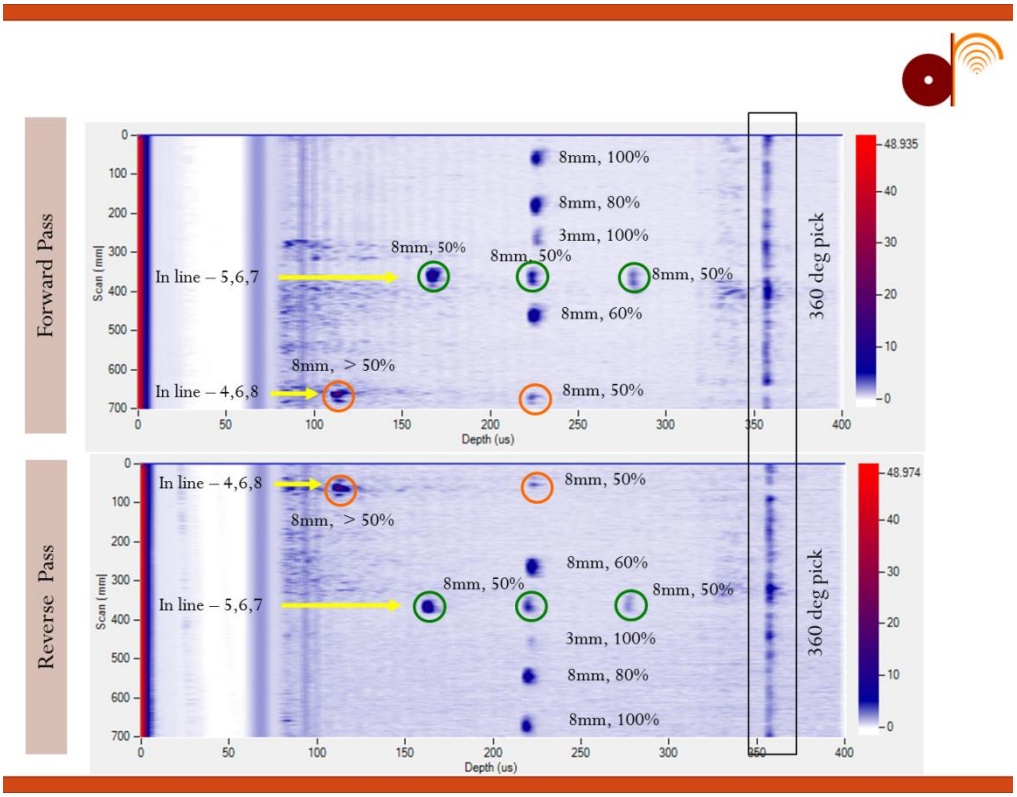

Inspection B Scan Images showing defects. Forward pass is inspection in one direction and reverse pass is inspection in the reverse. Both conform the repeatability of scans.

For more information please contact:

Ms. Sujatha Chakravarthy
Managing Director
Dhvani Research and Development Solutions Pvt Ltd.
01J, First Floor, IITM Research Park,
Kanagam Road, Taramani, Chennai 600 113 INDIA
Email: sujatha.c@dhvani-research.com
Tel/Fax: +91-44-6646-9880

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