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NACE INTERNATIONAL

Acoustic video imaging uses ultrasound to create corrosion maps

An inspector scans the bottom of a storage tank with the acoustic video imaging system. Photo courtesy of Imperium, Inc.

Ultrasonic testing (UT) is commonly used for in-service nondestructive evaluation (NDE) of pipes, storage tanks, and other industrial equipment to detect structural defects due to corrosion. The technique employs ultrasonic technologies that use a transducer or sensor to generate high-frequency sound waves that propagate through an object, bounce off its inner surface, and reflect back to the sensor to provide information about the object's subsurface. Basically, a flaw in the material such as a crack or material loss causes an irregularity in the path of the propagating sound waves and is detected by the nature of the sound waves reflected back from the surface of the flaw.

UT technologies can generate a variety of scans, including A-scans that provide one-dimensional information in the form of amplitude charts typically used to determine material thickness, and C-scans that produce two-dimensional images of the substructure where material flaws can be visually identified.

An ultrasonic corrosion mapping technology has been developed by imaging technology firm Imperium, Inc. (Beltsville, Maryland). According to Robert Lasser, CEO of Imperium, "Industry is facing corrosion issues that are stemming from aging infrastructure. There is a need for a simple, real-time diagnostic tool for in-service inspections. The complexity of advanced techniques has resulted in a shortage of qualified technicians who can quickly detect subsurface defects over large areas."

The corrosion mapping technology utilizes a handheld acoustic video imaging system that can simultaneously perform a continuous series of both C-scans and A-scans to capture two-dimensional ultrasonic images of a material's subsurface structure as well as one-dimensional thickness measurements, and record them as a video. The series of scans are stitched together to form a comprehensive, large-area scan or corrosion map. The resulting image map can be used to visually identify areas of potential corrosion such as material loss, pits, and cracks in pipes, storage tanks, and other equipment, and quantify the anomalies with corresponding wall thickness measurements. The image map can be printed, as well as electronically stored and/or wirelessly transmitted as a portable network graphics (PNG) file, and used in future analyses to determine the rate of corrosion.

The acoustic video imaging system can be used as a screening device to quickly scan areas for signs of corrosion, and the resulting corrosion maps provide a record of areas where additional corrosion testing should be focused, says Lasser. "It's meant to be very simple and doesn't require extensive training and expertise to operate," he notes, adding that 16 h of training is normally required to be certified to use the equipment. The system is comprised of two components: an ultrasonic probe, which comes in contact with the surface of the object to be to inspected and generates the ultrasonic scans, and the control unit, a touchscreen device with a graphical user interface (GUI) that drives the system and displays the resulting video images.

To capture a video image of a particular piece of equipment, the user sprays water on the object and touches it with the probe. As the probe is moved over the object, it continuously transmits sound

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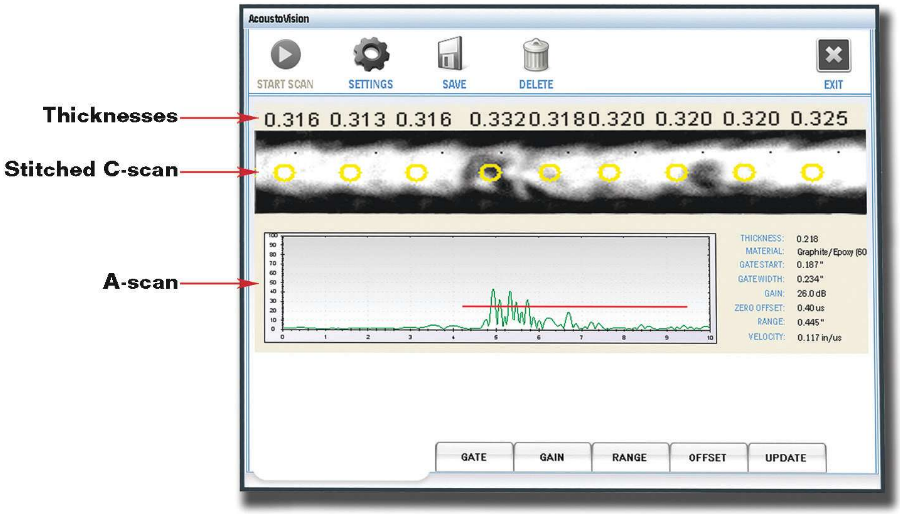

The touch screen of the imaging system's control unit shows thickness measurements, a stitched C-scan image, and an A-scan. Each individual C-scan has a yellow circle, and the thickness readings above the stitched C-scan image correspond to the yellow circles. Tapping a yellow circle on the touch screen will display the A-scan for that particular point. Image courtesy of Imperium, Inc.

waves through the surface of the object, which are reflected back to the probe from the back side of the object and transformed into subsurface imagery. The resulting images are immediately displayed in real time on the touch screen.

"Except for the fact that the probe must contact the target with some water or gel, the system works very much like an optical camera," says Lasser. An optical camera relies on a light source such as a flash or ambient light to create an image. The light scatters when it hits an object, and the camera lens collects the scattered light and focuses it on a medium that captures an image of the object, such as film or a charged coupled device (CCD) in the case of a digital camera. Instead of a light source, he explains, the acoustic video imaging system uses an ultrasound source (transducer) to generate high-frequency sound waves (5 MHz) that strike an object and then scatter. The acoustic lens in the system collects the scattered waves and focuses them on an ultrasound-sensitive detector array that creates a high-resolution, C-scan image of the object's subsurface structure.

The patented microelectronic detector array, which is similar in operation to a CCD imaging array used in standard video cameras, compiles the ultrasonic images into a video, Lasser comments. The detector array, comprised of 120 by 120 pixel elements (14,400 pixels), produces a 1- by 1-in (25.4- by 25.4-mm) field of view and a spatial resolution of 600 μm, which can resolve pits as small as 1-mm wide as well as distinguish individual 1-mm diameter pits that are side by side. He notes that the detector array is capable of generating and recording continuous, real-time C-scan images with a video presentation rate of 30 frames per second (similar to a conventional camcorder), with each frame containing an individual C-scan image. A curvature-correction acoustic lens recently developed by Imperium captures more of the scattered ultrasound waves, which has a flattening effect on the image when the camera scans a curved surface. The resulting C-scan images are sharper and clearer, which makes it easier to visually identify material anomalies. The imaging system also includes an external dual-element transducer to conduct continuous, high-quality A-scans of materials between 0.125- and 1.5-in (3- to 38-mm) thick.

An encoder wheel that adapts to both flat and curved surfaces, including pipes that are 8 in (203 mm) and larger in diameter, is attached to the probe to track its position on the surface, which enables the imaging system to scan and produce an ultrasonic image every 0.5 in (13-mm) as it is moved across a surface. A proprietary software algorithm stitches the 1-in square images together to form a panoramic image map of an area up to 18- by 18-in (457- by 457-mm). The area can be viewed either in real time as it passes over the material, or as a panorama. Output can be saved as a video, snapshots of the 1- by 1-in field of view, or a stitched panoramic view.

The acoustic video imaging systems can inspect materials that are able to transmit ultrasound waves and can be used on surfaces at temperatures up to 200 °F (93 °C). The system can also inspect steel surfaces through coatings such as fusion-bonded epoxy or polyethylene. In laboratory and field tests, the imaging system has detected corrosion in steel to depths of 1.5 in. The system has been commercially available since May 2012.

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