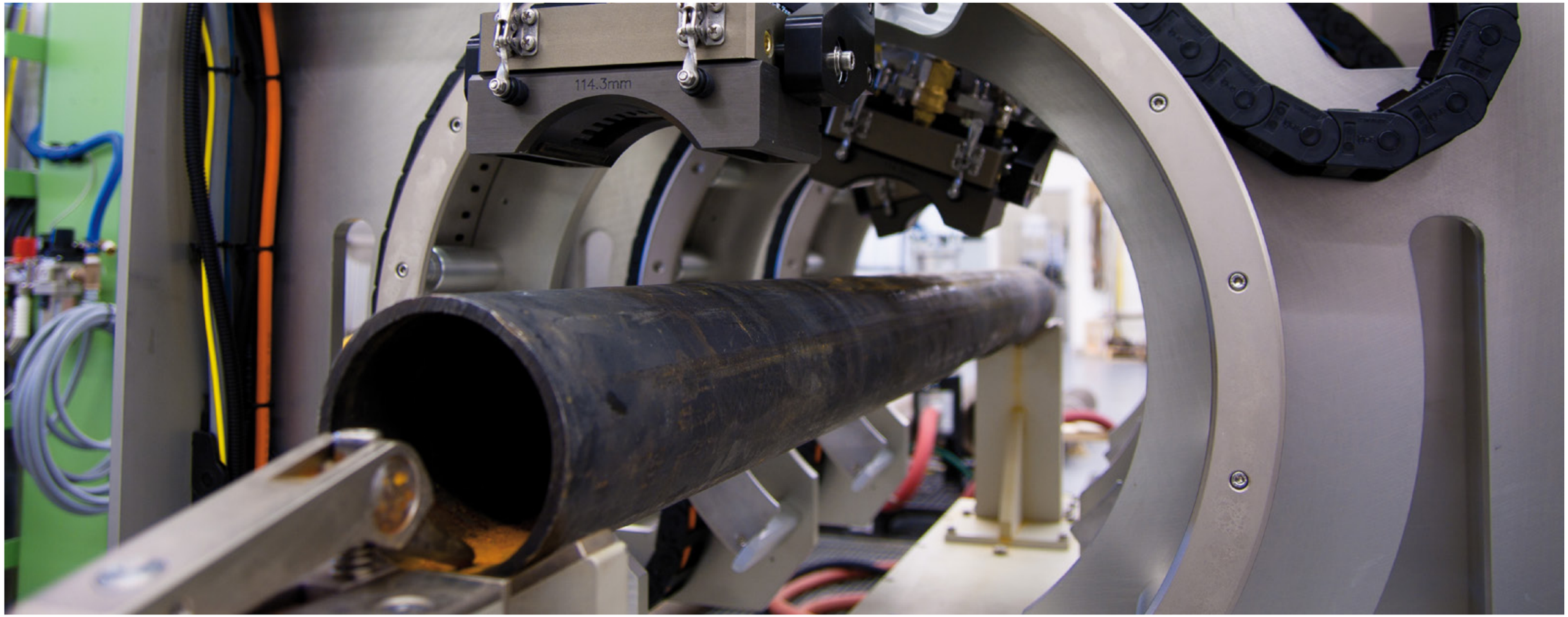
DETECTING DEFECTS

by Larry Adams, senior editor

Finding flaws and imperfections in a tube or pipe is made easier using new inspection technologies



A defect in a tube or pipe may not be the easiest to find. It might be hidden in the dark internal passageway of a tube. A weld might have a microscopic crack, the seam may not have been aligned properly, or the bead height from side to side may be mismatched.

While the potential problems are broad and the nondestructive techniques for discovering them vast and varied, rooting out these problems might come down to "seeing" them whether that means literally visualizing them, having their surfaces mapped out in a 3-D view, or tracking the peaks and valleys of signals bouncing on a computer screen.

TPM looks at three companies with technologies that shed a spotlight on these problems. Some of the technologies work in small diameter tubes with applications including the medical device and fuel injection industries. Other equipment helps welders keep their torch and seam in alignment or use automated processes to find even small defects on large pipes.

Large pipe inspection

Olympus Corp. offers a variety of inspection technology, including an inline system that uses phased-array technology to inspect the weld seam and the heat-affected zone (HAZ) of electrical resistance welded (ERW) tubes.

The Olympus mechanical solution for ERW pipe inspection is based on a small, automated, gantry-type bridge that positions the inspection head ▸

"This inspection system is designed to detect flaws on tubes while measuring wall thickness."

Francois Laflamme, sales manager, Olympus NDT Canada, a subsidiary of Olympus Corp.

The gantry aligns the tube with the Olympus phased-array ERW pipe inspection system.

inline or offline when performing inspections, automatic calibrations or maintenance operations. The head rotation capability allows each probe independent movement from -120 to +120 degrees for weld tracking.

The ERW system utilizes phased-array technology, which is a linear electronic scan performed by moving the acoustic beam along the axis of the array without any mechanical movement. The beam movement is performed by time multiplexing the active elements. Time multiplexing is the act of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern.

According to François Laflamme, a sales manager at Olympus NDT Canada Inc., a subsidiary of Olympus Corp., the phased-array technology uses curved phased-array probes oriented perpendicular to the tube axis. It inspects the weld area by scanning it while the tube is moving under the probes.

"This inspection system is designed to detect flaws on tubes while measuring wall thickness," he says, adding that the ERW system can detect external and internal longitudinal defects, through-drilled holes with depths as small as 1/32 in. and side-drilled holes.

The inline system performs the final inspection prior to cutting the pipe. During manufacturing processes, such as welding, annealing, cooling and sizing, imperfections can be found inside the weld or the HAZ around it. These flaws can grow during the rest of the process. This system helps ensure that no flaws over a certain depth are present in the pipe.

The ERW system detects small flaws, which are typically natural defects, such as penetrator defects and lack of fusion, using the two water wedges that are dedicated to flaw detection. However, the system is also able to detect major disturbances in the welding process using its weld profiling water wedge, which is capable of monitoring the scarfing tool for the internal weld bead.

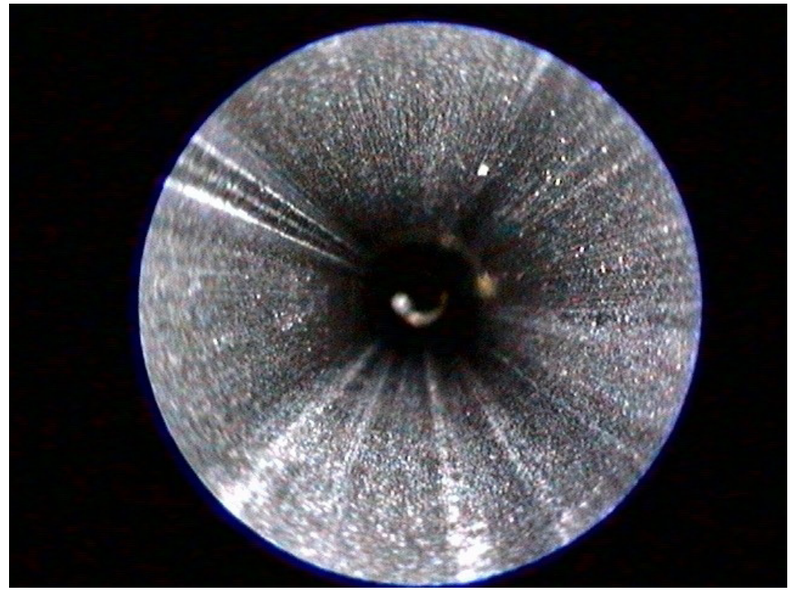
"The water wedge has four degrees of freedom so the wedge constantly adapts to the tube's movement," Laflamme explains. "It is also equipped with an Aqualene elastomer membrane that maintains a permanent water column inside the wedge. Only a thin film of water is required between the membrane and the tube's surface to achieve perfect coupling between the probe and the inspected product. Maintaining an undisturbed water path inside the wedge yields high repeatability on small defects."

The automated system is also equipped with an eddy current ring probe, which detects scarfing windows, butt welds between coils and any major discontinuities in the tube. When such elements are detected by the ring, a signal is sent to the programmable logic control (PLC) and the water wedges are automatically raised to prevent damage.

Aircraft parts manufacturer Kreisler Mfg. checks the welds of parts as early in the process as it can.

Gradient Lens offers 80 models of borescopes in different sizes and in rigid and flexibles models.

This image captured by a camera attached to a Gradient Lens borescope shows the effects of a weld and drawn process.



Compared with conventional ultrasonic testing, phased-array testing has several advantages including the ability to inspect a larger area of the tube with only one probe (per scanning direction). In addition, the length of the inspected weld zone can be adjusted simply by changing a few parameters; no mechanical changes on the inspection head are needed. It also offers better reliability of detection owing to the large weld area that is covered with constant amplitude (sensitivity).

A gantry system enables the inspection head to move to three positions: maintenance, calibration and inspection. On the calibration bench, the sensitivity of the probes is equalized using known reference defects. The bench is also used for the calibration check procedure. The calibration tube is capable of moving forward and backward at speeds up to 1 m per sec., reproducing inspection conditions at the real production line speed.

Feedback between the system and the PLC uses a patented algorithm that is based on time-of-flight analysis. It performs automatic detection of the scarfing area and sends feedback to the PLC.

"This is the key feature of the system because this feedback helps ensure that the inspection is always performed on the weld and heat-affected zone," he says. "If the weld line drifts slightly from its current position, the algorithm sends a signal to the PLC, which then adjusts the position of the water wedges through independent rotational movement."

Keeping in alignment

Xiris Automation Inc. offers video cameras that help welders see their work as they go as well as automated, inline inspection of large pipe welds.

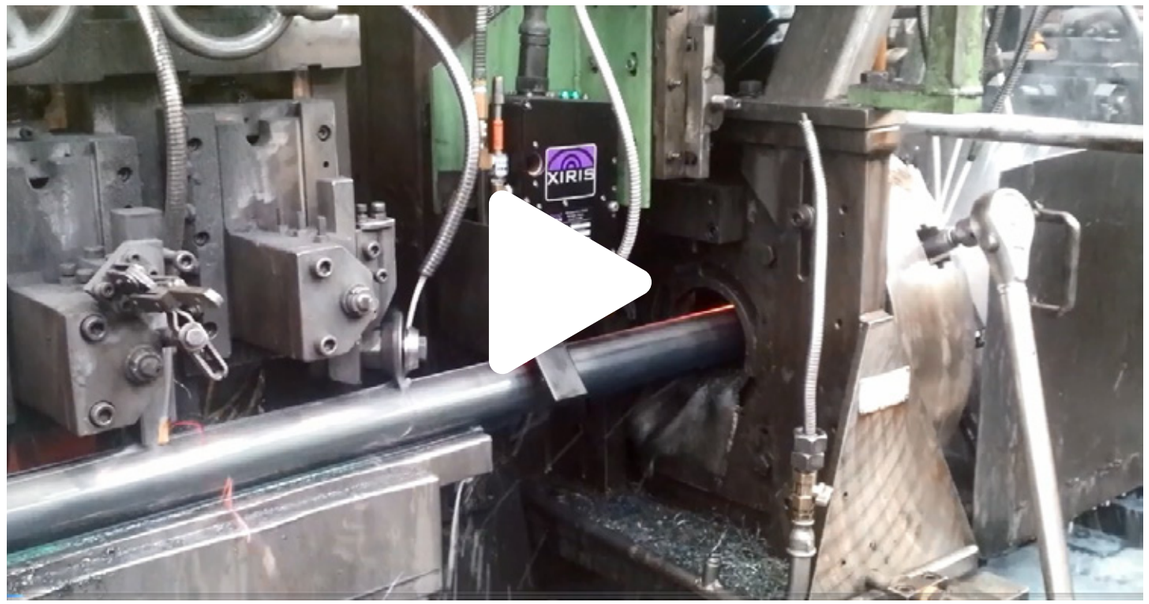
According to Cornelius Sawatzky, sales representative for Xiris, the company's weld cameras are designed to withstand the bright light created while welding.

"Instead of an operator trying to peek and see what's going on with the weld and potentially damaging his eyes, they can comfortably see it from a screen and usually from a safer working environment," he says.

The camera features a sensor that can handle a much larger range of light. A regular video camera typically has a range of light in the 55 to 60 decibels (dB) range, says Sawatzky, but this camera works in the 120- to 140-dB range.

Weld alignment is one of the key factors welders are looking to monitor ▸

Video showing TIG welding torch movement.



This inline, automated system uses triangulation to generate a 3-D map of the surface to check for weld defects.

in situ, and Sawatzky says welders are trying to ensure that the seam and the torch are aligned. In addition, the camera helps the welder monitor the condition of the torch and watch for dross or contamination coming out of the molten metal.

In addition to the weld cameras, the company offers the new WI-3000 laser-based inspection system for large and heavy wall pipes. Employing a redesigned sensor head with high resolution, the system is the larger version of the WI-2000 inspection system for smaller tubes.

The new system has a field of view that ranges from 35 to 100 mm across, allowing for detection of a variety of defect types. Typically installed right after the weld head on pipe mills, the WI-3000 provides an early warning system to detect defects in the weld area and the forming of the pipe. With a measurement resolution down to 30 microns, the system is able to detect critical defects that are difficult to detect using other forms of testing equipment.

According to Sawatzky, to detect these issues, a large beam is projected across the weld seam area and then, through triangulation, a 3-D map of the surface of the weld area is generated. Software takes various measurements such as how well the left and right side of the bead align.

The most important issues for which people are inspecting include mismatch, bead height and the freeze line.

"When it's making those measurements, if a side is not high enough or the left- and ride-side walls don't align properly, then the software can make alerts on that as well," says Sawatzky. "It can alert the operator that he should come and adjust the machine."

“With a measurement resolution down to 30 microns in size, the system is able to detect critical defects that are difficult to detect using other forms of testing equipment.”

Cornelius Sawatzky, sales representative, Xiris Automation Inc.

Eyes like a hawk

For measuring small diameter tubes, Gradient Lens Corp. offers the Hawkeye Borescope, which comes in 80 different models and includes rigid and flexible borescopes and models with camera and video capabilities.

According to Doug Kindred, Gradient’s president and chief scientist, rigid borescopes are an appropriate choice for straight, small diameter tubes. Tubes with bends might require flexible systems that utilize fiber optics.

Kindred adds that, for Gradient, inspecting tubes 1/4 to 1/2 in. in diameter are the company’s bread and butter. Applications in that size range include medical products and fuel systems for the automotive and aircraft industries.

“We manufacture borescopes anywhere from 0.5 to 8 mm in diameter,” he says. “‘For us, 8 mm is a big scope.”

According to Kindred, the company works in three primary market applications: machining, where burrs in the cross holds are commonly found; metal castings, where residual sand can leave voids that impede fluid flow or cause leakage; and welding, where stresses from welded and drawn processes can affect fluid flow.

One Gradient customer used a borescope to inspect the inside of a tube with welded fittings on each end.

“The tube had a strong heat-affected zone that appeared as a lot of colors,” Kindred explains. “Overheating caused the coloring, which led to a rejected part because of the color and because an overheated weld is not as strong.”

Another customer, Kreisler Mfg. Corp., provides precision tube and pipe assemblies and manifolds used in the aerospace and industrial gas turbine markets. Inspecting an orbital weld in a titanium tube with a Hawkeye Borescope video system allows for easier viewing and provides image capture capability.

Gradient’s biggest seller is the HawkeyeV2 Videoscope, which contains a brighter, higher resolution and more durable camera. The new 5-in. LCD screen provides detailed close-up views, has a 2X zoom function, mirror-image capability and easy-to-use intuitive controls.

“We’ve designed a new articulation mechanism, and increased the range to ±150 degrees,” Kindred says, adding that the videoscope is available in diameters of 4 and 6 mm and lengths of 1.5, 3 and 6 m.■

GRADIENT LENS CORP.

OLYMPUS CORP.

XIRIS AUTOMATION INC.