

Non destructive inspection of tube and pipe welds

Non Destructive Testing (NDT) has been implemented for some time now but recent advances in laser based inspection systems provide an additional approach to NDT as a means of quality control.

Non-destructive testing (NDT) of welds has been implemented on Tube and Pipe mills as part of standard quality assurance and control processes for some time. Both the traditional testing techniques of Eddy Current Testing (ECT) or Ultrasonic Testing (UT) allow for in-line testing of formed and welded tubes and pipes, finding a number of weld defects and discontinuities at various mill speeds. As powerful as these technologies are, they can still be somewhat complex to set-up, are sensitive to external conditions in the mill, and require multiple probes to obtain reliable data. Even when these issues are addressed, there still are some specific weld defects that they are unable to properly detect. Recent advances in laser based inspection systems provide a new approach of Non Destructive Inspection (NDT) as an additional means of quality control that can be implemented on a tube or pipe mill to complement the traditional NDT methods.

Advantages of Non Destructive Inspection

Laser based inspection technology is a relatively new method of Non Destructive Inspection of the weld bead on formed and welded tubes and pipes. Xiris Automation Inc. has developed an NDT system using Machine Vision technology (known as the WI2000p) that complements some of the traditional NDT techniques by performing NDT to find specific weld defects related to the surface



Weld Inspection System user interface

profile of a weld. Certain weld defects found in precision welded stainless steel tube manufacturing such as Mismatch (typically, a Linear Misalignment as defined in IEC-13919-1) or small, gradually changing defects (e.g. deflections or bead irregularities), are very difficult to measure using anything but a surface contour measurement technique. The Mismatch parameter reflects the vertical differences between the two halves of the tube/pipe as they come together during the welding process: After welding, the actual

mismatch can only be measured with an NDT tool that is capable of profiling the surface of the tube. Traditional UT or ECT tools are unable to provide good, reliable measurement data for these types of defects because they are neither qualitative (i.e. unable to determine what feature is out of control) or quantitative (i.e. unable to accurately measure the size of an anomaly). Certain other specific weld defects such as Undercut and Sunken welds are often lumped together into one classification known as "Sunken

welds" by traditional NDT equipment as they are unable to distinguish between these defect types.

However, an NDT system, such as the WI2000p, can provide qualitative and quantitative information for each defect, being able to differentiate between the defect types.

Principle of measurement

The NDT system is based on triangulation measurements using a laser plane and a camera whose optical axis is offset to the

axis of the laser plane (by the "offset angle"). The resulting image shows a "cut-away" profile of the top section of the tube as if it was cut at the offset angle to the normal of the tube surface.

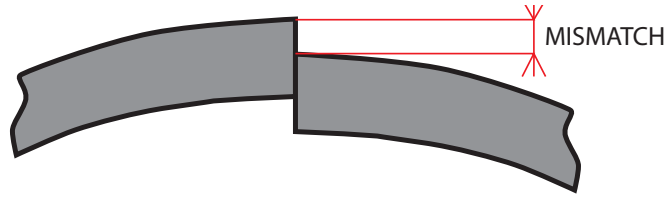
Weld Inspection System User Interface

If a tube is ideally round, the laser image will represent a section of an ellipse. By knowing the position of the actual laser profile, the ideal expected profile and the size of the pixels in the image, the System can calculate various profile defects, including Mismatch, Weld Height, Deflection, Roll Angle, Sunken or Undercut welds.

While NDT systems are powerful defect detection systems, they are not a whole scale replacements for either Eddy Current Testing (ECT) or Ultrasonic Testing (UT) systems.

However, they do not share some of the inherent shortcomings of the traditional NDT systems, such as ECT and UT, including:

- Sensitivity to external conditions that can influence the measurement's precision: The ECT and UT systems' precision is



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influenced by coupling factors between their probes and the tube, the relationship between the tube diameter and defect location, and the electromagnetic characteristics of the material itself.

- Requirement for multiple probes to obtain reliable measurement data in real-time: Statistics show that the most prone to defect presence is the weld area itself, so the logical positioning of the probe should be in the heat-affected zone (HAZ). NDT systems such as the WI2000p use a single sensor to acquire images of the tube's weld profile at the HAZ compared to the need for several probes used by most ECT and UT systems to ensure the HAZ is covered.

- Inability to measure gradual changes. NDT systems such as the WI2000p are able to make complete, absolute measurements of the contour of the weld in real time without comparing a measurement to a successive measurement. Therefore, those defects that gradually move out of tolerance are best detected with NDT systems, whereas UT or ECT systems will only detect something if there is a sudden anomaly in the tube structure or geometry.

- Inability to make qualitative or quantitative measurements. NDT systems generate an image of the profile of the tube contour and are therefore able to determine when a tube welding process is out of control, providing detail as to which feature, and by how much, that feature is out of control. This ability allows for better process control as the operator is able to determine more accurately which parameters are moving out of control and by how much.

- Difficult installation and set-up: Often, on a typical tube mill, there

is some roll in the weld seam from side to side. Both UT and ECT systems are very sensitive to the position of the weld seam. Therefore, they require precisely located probes in relation to the point of inspection of the weld. Through the inherent design of an inspection system, the WI2000p acquires an image of the profile and can keep operating even if the weld seam location moves back and forth ("Weld Roll"), due to its ability to detect weld quality with the same resolution, anywhere in its field of view. Overall, an NDT system such as the WI2000p offers an excellent option for tube mill owners / operators that want additional, real-time defect

detection of weld features beyond what traditional NDT systems can provide. However, it does not replace the need for other NDT technologies as they still can provide certain inspections beyond the contour of a weld. By measuring the outside contour of a weld, an NDT system can operate on any type of material, regardless of its reflectance or magnetic properties, using a single head to perform the measurement. Very often NDT systems are installed as a final check at the end of the production line. However, an NDT system can be placed right after the weld box, where it can be used in a more proactive manner, warning operators what is changing in their welding process so that they can perform corrective action before significant scrap occurs.

More information on the Xiris Cameron Serles Xiris Automation Inc
www.xiris.com/tube/



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