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Teel Pipe: Small Diameter Gas Pipe In-Line Inspection

January 27, 2022

Background

Teel Pipe produces coil and stick GAS pipe for sizes ≤1.00CTS on a specialized line using a SIKORA X-RAY 6000 PRO series measurement device for continuous in-line inspection of the pipe.

SIKORA AG, headquartered in Bremen, Germany, is the supplier of this technology and have been producing inline measurement and control products since 1973. Teel has been using X-ray technology for in-line inspection of our products since 2016. Teel selected this technology for use in highly regulated markets because of the ease of operation and data acquisition for quality control as well as the ease of operator interface.

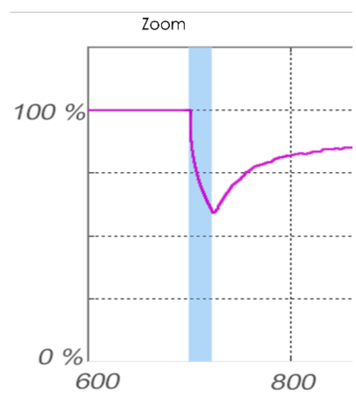
SIKORA Technology To Perfection

Inspection Process

The SIKORA X-RAY 6000 PRO uses X-rays instead of sound for measurement and data collection. The use of X-rays means the data is not subject to issues from water quality or part temperature as ultrasonic devices are. While in operation, the X-RAY 6000 PRO captures data on the pipe three times per second. This cycle is completed in a very short aperture time of 3ms - 6ms or less, which eliminates any vibrational impact. The device uses linear X-ray sensors with >3,000 pixels to ensure highest accuracy.

Data collected includes OD, ID, ovality, wall thickness, minimum wall thickness, concentricity, and eccentricity. The values are correlated to offline inspection reports for final part dimensions to take account of any shrinkage.

The logic of the inspection cycle utilizes intensity to determine its measurements. As the X-rays travel through the pipe, the material causes attenuation with crisp start and stop points. The start and stop points of high attenuation are represented graphically in the image at right and correspond to wall thickness. The distance the radiation travels through the pipe wall is inverse to the intensity.



→A short distance results in high intensity and a strong signal

→A long distance results in low intensity and a weak signal

The areas shown in the graph are created for two axes showing four distinct wall segments. These walls are measured in real time as the process is running. On a product running 25 feet per minute, or five inches per second, a three measurement per second frequency results in a

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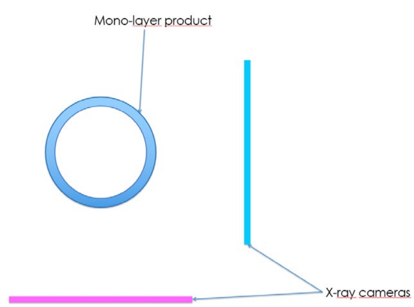
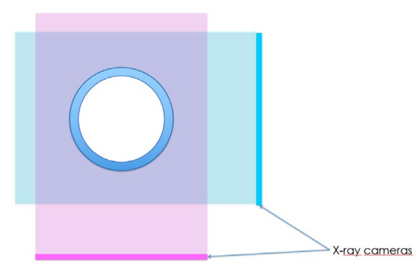
scan every 1.66” of the pipe. This scan is captured and averaged with three other scans to provide a value for the wall thickness. This data is then processed to determine average and minimum wall thicknesses. The averaging of scans is needed to create a best-fit model for inner and outer wall.

Post capture analyzing, which also happens in real time, fits the wall measurement points into two overlapping rectangles. These rectangles each have an ellipse fit into them using a best-fit method and the tangent points of the defined rectangles. One ellipse is the outer wall of the pipe, and the second ellipse is the inner wall of the pipe. The analysis of these two ellipses allows the maximum and minimum wall thicknesses to be determined within a few degrees of accuracy compared to physical measurements of the pipe. It also allows the wall thickness at any point of the part (360°) to be determined with high accuracy.

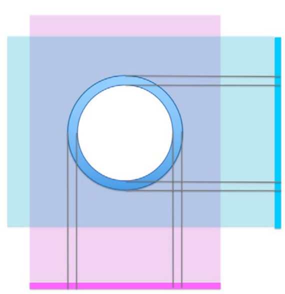
A Visual Step-Through of the Process



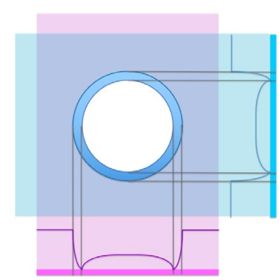
1-We start with the object and the X-ray cameras.



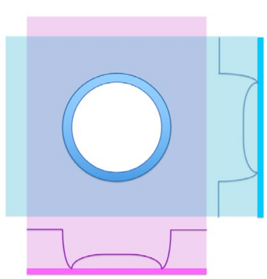
2-The system flashes (3Hz). Cameras measure the intensity.



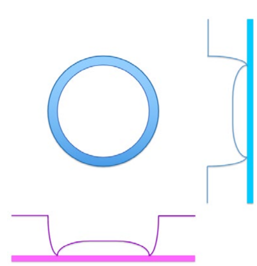
3-Grey lines mark the areas, where changes will appear.



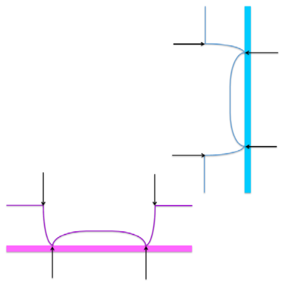
4-Attenuation causes a change of intensity on the cameras.



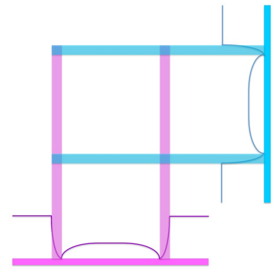
5-Shown intensity- curves are the result of changed intensity.



6-Shown intensity- curves are the result of changed intensity

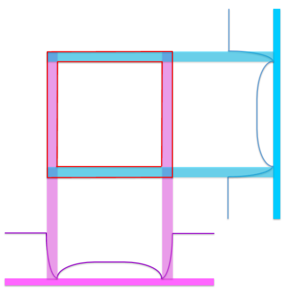


7-Points where changes in attenuation appear are clearly identified

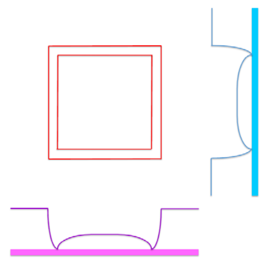


8-The width of each intensity-drop defines a beam.

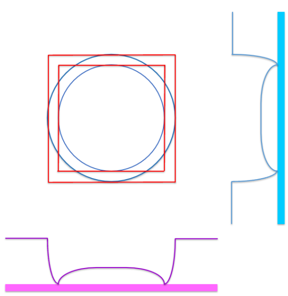
A. Juncture of the 4 beams defines a rectangle.
B. (Here a rectangle with similar side-lengths = square)



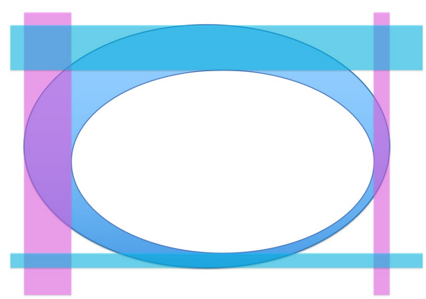
9-This rectangle consist of an inner- and outer rectangle.



10-This rectangle consist of an inner- and outer rectangle.



11-The rectangles define two circles
-> the inner and outer Ø tangent points

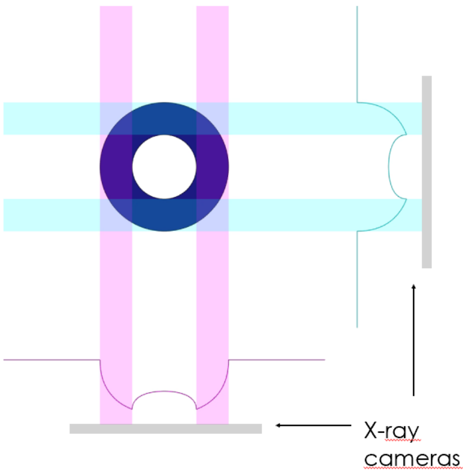


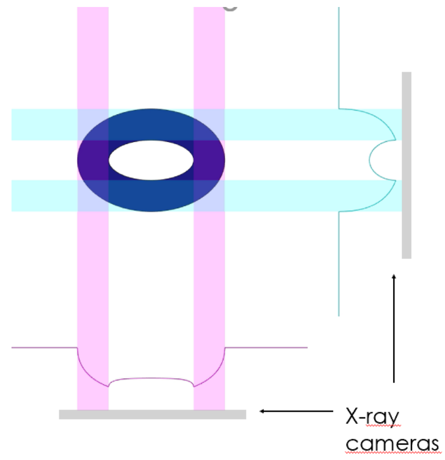
12-If the ellipse is not perfectly round, we see a more realistic example as above:

A. Position of both ellipses are clearly defined.
B. Eccentricity and ovality can clearly be identified
C. This allows determination of the wall-thickness at every point.

Ellipse Model Ovality

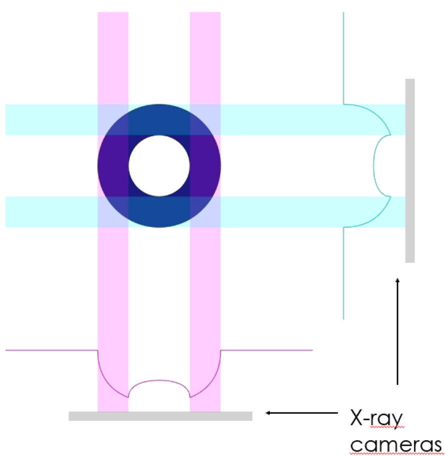
Model of Ovality capture showing the difference in long and short axes in the pipe using the correlating low or high intensity signal. This will determine the ovality using a standard max minus min calculation.

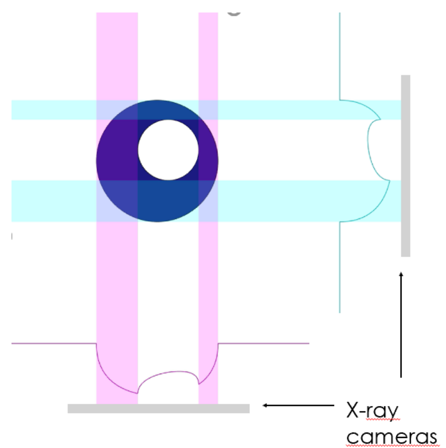




Ellipse model - Eccentricity

Model of Eccentricity capture showing the difference in long and short distance and the correlating low or high intensity signal. This will determine the area of minimum wall thickness and the relative center point of the two ellipses.





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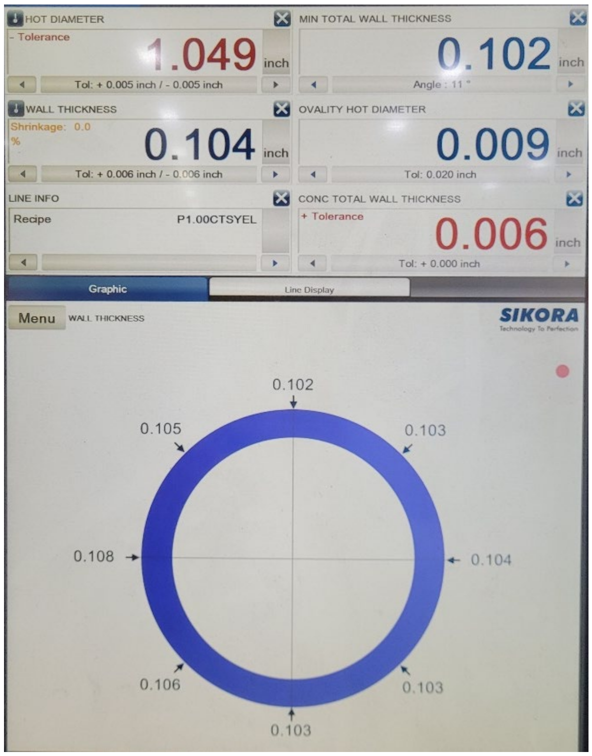
Summary

The X-ray inspection method measures the differences in low and high intensity signal. This shows wall thickness and uses ellipse-based analysis to model the pipe wall. The process outlined completes a full cross-sectional analysis of the pipe product (in 360°). Using elliptical data combined with eccentricity models enables a SIKORA X-RAY 6000 PRO to determine the min wall thickness location on the pipe within a resolution of 1°. The data can be accessed, saved, and stored for future reference.



Digital Display of Output in use at Teel – upper right component illustrates the Min. Total Wall Thickness as an example.

Diagrams courtesy of Sikora USA. For more information, please go to X-RAY 6000 PRO - Sikora

Please contact Teel Pipe for any questions on content or for more information on pipe.

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