Inspecting seamless tubes with phased array using the gapless inspection method

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Abstract

The seamless tube manufacturing process can generate flaws in various angles around the longitudinal axis of the tube. These flaws, primarily created during the lamination process, can cause the tube to fail while in use, potentially leading to serious economic and social impacts. For this reason, seamless tube manufacturers maintain high quality requirements for their products. Automated phased array rotating tube inspection systems (RTIS) provide accurate flaw detection in multiple discrete orientations and are now required to meet the stringent quality standards required by the industry. However, this inspection method assumes that the manufacturing process generates flaws at discrete angles, which is not always the case. To improve the quality control of seamless tube manufacturing, homogenous flaw detection over a broad range of oblique angles is required. This paper presents an innovative calibration and inspection method specifically designed to obtain high homogeneity inspection over a wide range of flaw angles during the inspection of seamless tubes.

1. Introduction

Seamless oil country tubular goods (OCTGs) consist of drill pipe, casing, and tubing which are all subject to important loading conditions. To avoid failure while in use, these tubes must be inspected to identify any flaws that could have been generated during the manufacturing process.

2. Challenges

Seamless tube manufacturers maintain stringent quality standards for their products. Current automated phased array ultrasonic testing (PAUT) rotating tube inspection systems (RTIS) assume that the manufacturing process generates flaws at certain discrete angles, which is not always the case.

To cover a range of oblique flaw orientations, the current method requires several notches at different angles. Calibration is then performed on each notch individually.

3. Solution

The gapless inspection method manages to overcome the hurdle of calibrating for flaw detection without a reference notch for each oblique orientation. The gapless method uses only one transmitting angle and a high number of receiving channels to cover a range of oblique defects.

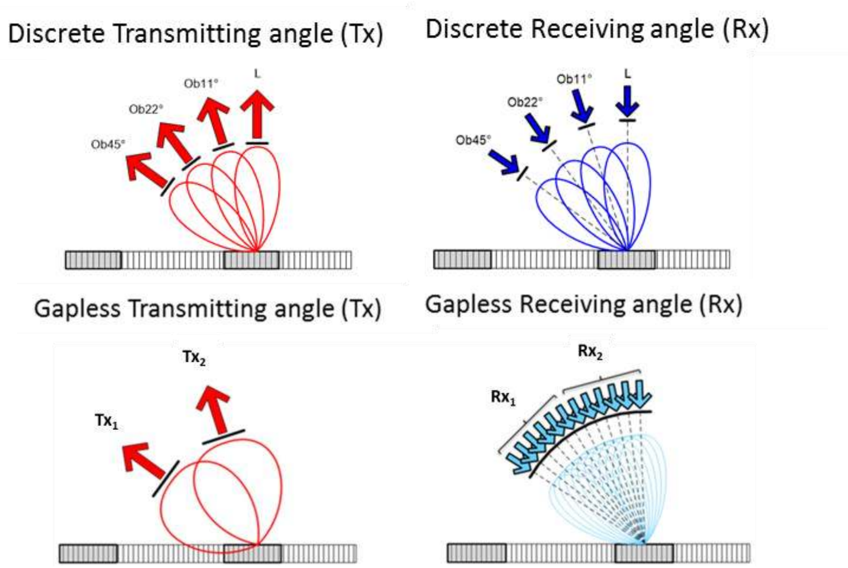

Figure 1. Discrete versus gapless coverage

Using the same calibration pipe currently used to calibrate discrete oblique orientation, the method scans each artificial notch with a single transmitter and a high number of receivers using a single aperture. During this high-resolution scan, the amplitude response of each notch is plotted for each receiver. Based on the amplitude response for each notch a normalization curve is calculated. The normalization curve represents the most likely amplitude response for all receiving angles (Rx). In other words, this curve provides the 'virtual notch' response for each angle in the desired angular detection range.

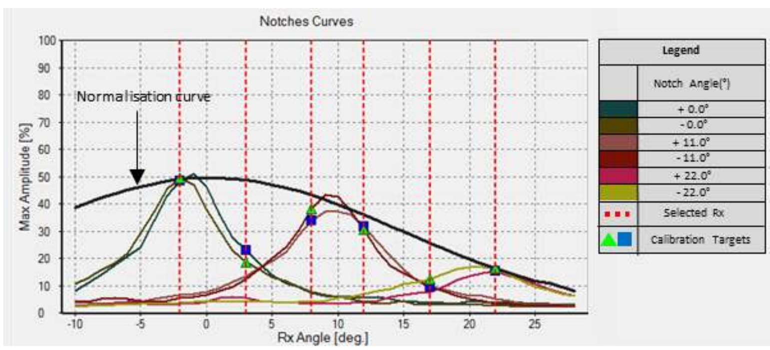

Figure 2. Projected notch response

Calibration targets for the selected receiving channels, as illustrated in figure 3, are automatically calculated so the calibration sequence and results displayed are not modified compared to the existing discrete oblique inspection method using phased array.

This method can be used to predict calibration results and validate them with simple tests, so even medium-skilled operators can perform this task. It is systematic, automated, and repeatable.

4. Results

The normalization curve in figure 3 is set at a constant calibration level (black line), setting the offset gain required for each receiving channels. The calibration targets are also displayed, using the maximum crossing between a notch curve (solid line) and the Rx channel position (red dotted line).

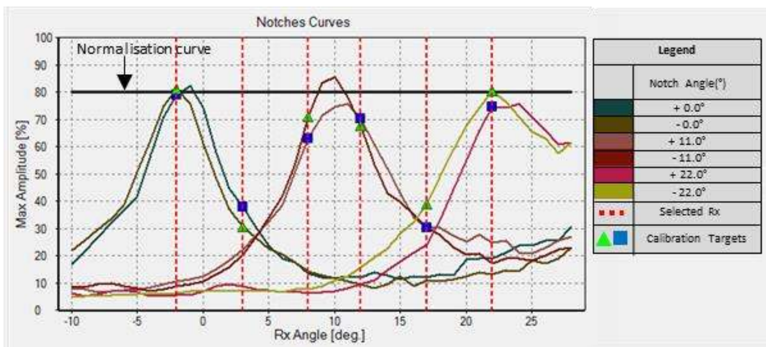

Figure 3. Normalization curve and calibration targets

Each receiving channel is calibrated using only the existing notch and can be displayed in 2D using a top turn device. This 2D visualization enables users to set up many defects at the same axial position, reducing the calibration time.

5. Conclusion

In conclusion, the gapless calibration and inspection method addresses the growing requirements of major oil & gas companies for more robust quality control of OCTG tubes in manufacturing. The method proposed here enables the detection of flaws in multiple directions that can be generated during the manufacturing process (lamination, heat treatment) and reduces the potential for pipe failure.