High-Speed Phased Array Ultrasonic Testing of Standard-Walled and Heavy-Walled Seamless Tubes with Improved Oblique Defect Detection

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Since its introduction in the early 2000's, the PAUT technique with linear arrays has demonstrated to be a robust, highly versatile solution to cope with the high-performance requirements (in terms of sensitivity, repeatability and productivity) for many mills producing OCTG and Line Pipes. Combined with precise mechanical scanning in a testing portal (gantry) configuration (rotating tube, linear probe movement), this solution eventually became the standard, adopted by major tube manufactures and ultrasonic system suppliers. One novelty of this technique was the possibility of ultrasonic beam steering for oblique defect detection. This could be performed by means of the same probe used for longitudinal defect detection in a narrow angle-range and by separate arrays for higher angles. Depending on the throughput requirements, the oblique defect detection capability was restricted to a number of definite directions and/or to a narrow range. The manufacturing process, especially for quenched and tempered heavy-walled tubes, could potentially generate discontinuities of every orientation requiring to extend the oblique defect detection angular range. A novel extension of the linear Phased Array technique for oblique defects up to ±75° on standard and heavy-walled steel tubes is presented in this paper. Excellent test results with high sensitivity and reliable SNR could be achieved on the whole extended defect orientation and dimensional ranges. For heavy-walled tubes, the optimization of the incident angles and the use of mode-converted waves for the detection of internal/external defects is essential. The best-possible acoustical solution, particular highly-sensitive Phased Array probes and probe-holders with fast coupling capability have been developed. A specific scan-plan for wall thickness measurement and for transverse and laminar defects detection has also been afforded. Several parallel modules of a state-of-the art PAUT electronics are employed. Parallel firing and multiple parallel computations in "Fast-Scan" mode are key features that consent high testing speed. Therefore, high sensitivity, repeatability and productivity is provided for the entire extended defect orientation and dimensional ranges. A Testing Machine is being developed by KARL DEUTSCH at the time of abstract submission, and it is scheduled to go into operation at TMK-ARTROM at the end of the year 2021.