Accurate sizing of small defects in longitudinal welded tubes with a TFM technique

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Electric Resistance Welding (ERW) is widely used in metallurgy industry to join tubes. This process results in longitudinal welds that have to be inspected to ensure the durability of the component. Inline Phased Array (PA) Ultrasonic Testing (UT) or conventional UT technologies are generally used to detect cracks and laminations which are located in the strip edge, or which can be generated by the ERW. These techniques are efficient to detect and characterize standard cracks (with depth, length and orientation well defined). Nevertheless, some smaller and multidirectional defects can be created during the manufacturing process and are a possible root of future crack formation. The detection of this type of defect is possible with an additional UT system which consists of a conventional ultrasound inline system working in multi-skips with shear waves. This technique is able to report the potential presence of a multidirectional defect inside the weld part but cannot assess its size. As a consequence, manufacturers have to reject blindly tubes that could satisfy the acceptance requirements. Over the past years, the Total Focusing Method (TFM) has demonstrated excellent defect sizing capabilities in various cases. In this paper, we propose to use the TFM for the detection and sizing of small multidirectional defects in tubes. The proposed algorithm is used in immersion and is adapted to a predefined surface (tube shape) to achieve proper reconstruction. TFM data contain signals from all transmitter-receiver pairs which represent a wide variety of exploitable information (longitudinal and shear modes, mode conversions, etc.). For this application, we are particularly focused on shear waves in direct mode which interact with multidirectional defects with a various range of angles. This allows us to collect specular reflections from the defects, which greatly facilitates their sizing and characterization. The proposed method achieves proper detection and sizing of 0.3 mm multidirectional defects at various depths inside the weld. This technique will be used offline in the plant in order to realize prove-up tests when tubes are rejected with conventional method.