MODELLING OF TIME REVERSAL FOCUSING TECHNIQUES IN PIPES

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ABSTRACT

A finite element numerical model of time reversal focussing of pulsed guided wave modes in straight pipes is presented. In the model a pure longitudinal or torsional wave mode is launched down a pipe containing a surface-breaking planar defect of constant depth and orthogonal to the longitudinal axis of the pipe. All signals received from the defect and pipe end are computed. Then the pulse received by the defect is time reversed and sent again down the same pipe without the defect present. It is found in this simulation that the wave was focused on the region that previously contained the defect. Quantitatively the model predicts the increase in signal amplitude available for the interrogation of a defect as a result of the time reversal routine. In the final stage of the model the signal received by reflection of the time reversed defect echo is computed. The model is illustrated for an axisymmetric fundamental longitudinal wave mode with a 10 cycle 61 kHz pulse of Gaussian envelope launched in a pipe of 6 inch diameter and 0.28 inch wall thickness. These results were then compared with experimental data on the pipe. The increase in signal to noise ratio of the defect echo produced by time reversal was 4 (12dB) compared with the experimentally observed increase of 2.2 (6.8dB). Theoretically the signal to noise ratio improvement corresponds to a reduction in the area of the minimum detectable size of defect by a factor of 4. Generally, the use of modelling to predict experimental situations in which time reversal focussing will improve defect detection sensitivity, has been confirmed.