1.3.33. 3D CHARACTERIZATION OF DEFECTS IN GUIDED WAVE MONITORING OF PIPEWORK USING A MAGNETOSTRICTIVE SENSOR

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Methods that apply guided wave technology for pipeline screening purposes have seen important technological improvements in the past years, gaining more and more popularity amongst industrial users. Existing commercial instruments use piezoelectricity or magnetostriction to generate guided acoustic waves in pipelines and for their further detection. Transduction principle, transducing material, geometrical configuration and spatial distribution of the transduction elements are only some of the main differences between the two technologies that make them suitable to different particular applications. Piezoelectric instruments (PZT) that are commercially available use multi-element Tx / Rx transducer collar, while magnetostrictive commercial systems (MCS) use a continuous Tx / Rx transducer strip bonded around the pipe circumference. These two configurations bring significant differences between the two systems in what wave generation and acquisition is concerned.

It is well known that a multitude of guided-wave modes exist in pipes that are inspected using guided-wave technology. For instance symmetrical wave modes like longitudinal or torsional are generated by the guided-wave instrumentation and echoes are evaluated to detect discontinuities in the pipe-wall like defects and imperfections in the pipe under inspection. On the other hand, the presence of asymmetrical wave modes like flexural modes indicates the presence of asymmetrical discontinuities that can be assimilated to defects.

The multi-element transducer collar configuration of the PZT systems allows a better control of the wave generation process like for instance the focalization of the transmitted guided wave for a better identification and characterisation of discontinuities. However, in some cases, depending on the number of elements distributed around the pipe circumference, asymmetrical wave modes can be generated. In the acquisition process, this configuration allows wave mode separation, thus asymmetrical modes generated by asymmetrical discontinuities (mainly defects) can be evaluated to clearly discriminate defects from the other pipe features. The configuration of magnetostrictive guided-wave systems can be described as a single continuous transducing element attached to the pipe and surrounding the circumference independently of the pipe size. With this configuration the generated wave mode is always symmetrical (torsional) and no asymmetrical modes are generated. In addition, less wave control can be achieved with a single channel transmitter. In the acquisition process, asymmetrical modes generated by defects can be observed with certain difficulty because of the use of a single receiver.

In this paper a new configuration for magnetostrictive systems is proposed. It uses the same continuous transducer as described earlier for the generation of symmetrical torsional waves while the acquisition system is formed of multiple acquisition elements that are uniformly distributed around the pipe circumference (fig.1). In addition, the capacity of the new acquisition system to perform mode separation will be demonstrated. In the first phase, mode separation procedure is explained using simulated data obtained with FEM commercial software. Next, the nature of the wave modes is confirmed by comparing wave velocity information with data available in literature and defects will be identified.

Fig. 1. GW acquisition system

Last phase consists in applying the procedure explained in the previous step to experimental guided wave signals. For this purpose several tests are performed on pipes available in laboratory but also on in-service pipelines. The first tests will consider defect-free pipes, in order to evaluate the amount of flexural waves that are due to the instrumentation in the phase of signal generation.

Further tests will be done after creating artificial defects. At this point, it will be demonstrated, that the new system is able to identify defects and to discriminate them from symmetrical features like welds or joints, by performing mode separation and evaluating the flexural wave mode echoes.