Fluid-borne Noise Reduction in AE Testing Using SH Wave Sensors

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Real cracks emit stress wave energy in the form of all three types of fundamental guided wave modes: Symmetric (S), Antisymmetric (A), and Shear Horizontal (SH), in varying degrees and with varying directionality based on the flaw orientation, crack mode, and three-dimensional stress state. Conventional acoustic emission (AE) sensors are designed to only detect the Lamb-type guided waves (S and A waves) emitted by flaws, which is sufficient for many applications. However, AE testing on structures submerged in or in contact with fluids can introduce additional complexities. The presence of mechanical equipment in contact with the fluid, as well as flow noise, creates a complex acoustic environment, resulting in noise contamination across a broad frequency range for conventional AE sensors. Often, the detection thresholds are increased to address the presence of this fluid-borne noise, and in many cases, higher-frequency AE sensors are employed to shift the maximum sensitivity above the lower frequency range in which the noise is typically most severe. These approaches to conducting AE testing in noisy environments can result in significantly reduced sensitivity during the examination. To address this limitation, SH AE sensors, which are tailored for shear-horizontal guided wave detection, have been evaluated to determine if they can significantly reduce the effect of environmental noise due to such sources. The SH AE sensors utilize a unique circumferentially polarized piezoelectric shear ring to achieve omnidirectional shear horizontal wave sensitivity and a comparatively lower Lamb wave sensitivity. Since fluids cannot support shear wave energy, it stands to reason that the fluid-borne noise will generate primarily non-shear type noise in the structure under test. Comparative studies between conventional and SH sensors confirm the benefits of SH sensors for AE testing applications in which fluid-borne noise effects the structure under test; the SH AE sensors can be used in conjunction with, and, possibly, in lieu of conventional AE sensors to improve AE test results for such applications.