Analysis of Guided Waves for Inspecting Finned Tubes in Heat Exchangers

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Finned tubes have become widely utilized in heat recovery system generators (HRSG) located within combined-cycle power plants, primarily due to their enhanced heat exchange efficiency. Nevertheless, the analysis of guided wave dispersion within these finned tubes presents a complexity that hinders their utility in guided wave inspections. In this research, Floquet periodicity is employed to investigate the dispersion characteristics of these guided waves. The numerical solutions reveal dispersion curves that encompass both propagating guided wave modes and localized resonant vibrations occurring at the edges of the fins. These resonant modes intersect with the propagating modes, leading to energy dissipation and a reduction in the long-distance inspection capabilities of the guided waves. Numerical analysis unequivocally illustrates that the group velocities of guided wave modes are notably slower when compared to those observed in plain tubes. The periodicity and height of the fins modify the dispersion behavior of the propagating guided wave modes, resulting in a narrowing of the pass band for each mode. To facilitate defect and corrosion detection and monitoring in finned tubes, a comparative analysis of torsional and longitudinal guided wave modes is conducted, both through numerical simulations and experimental procedures. The experimental findings, gathered using electromagnetic acoustic transducers (EMATs), corroborate the numerical predictions of guided wave propagation within finned tubes, thereby confirming the precision of the anticipated results.