1-7 Higher Accuracy in the Inspection of Heat Exchanger Steam Generator Tubes of Nuclear Fast Reactors

—Suppression of Sodium Adhesion ECT Signal Achieved by Numerical Simulations—

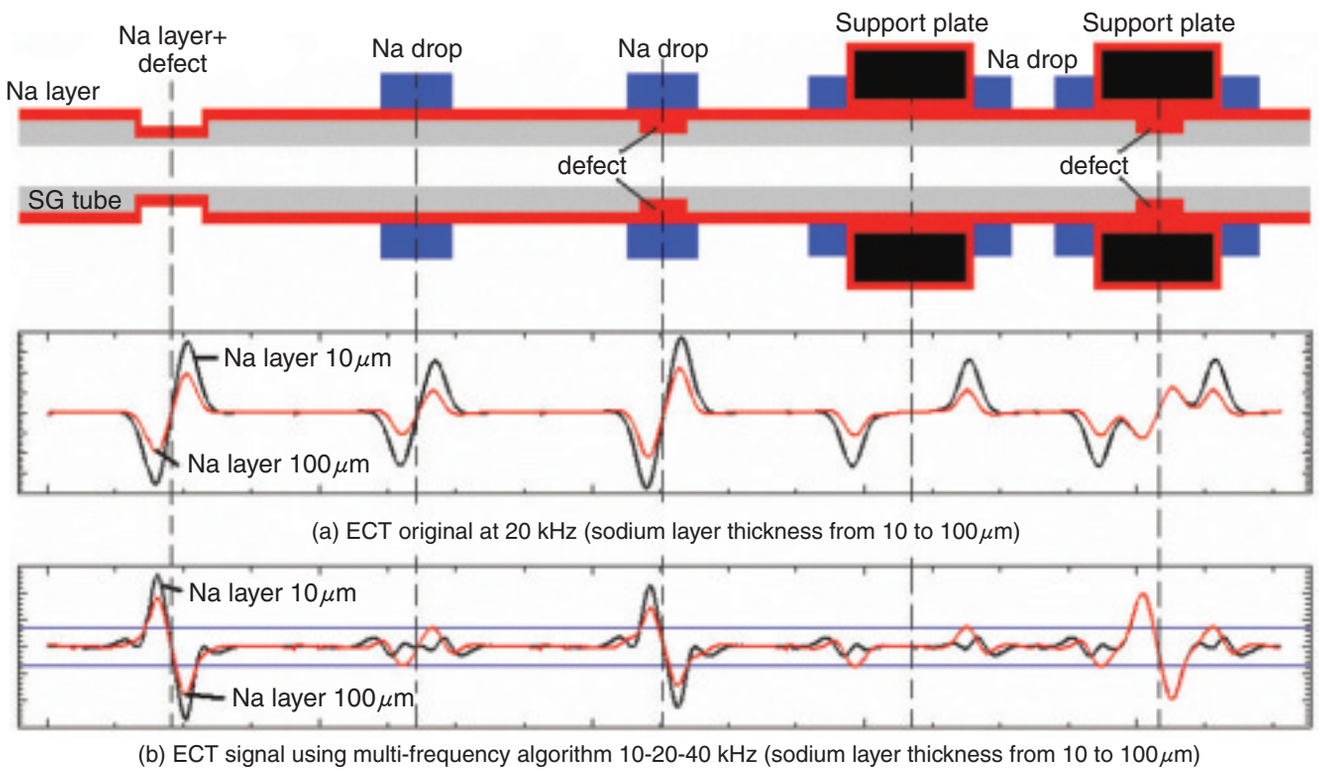

Fig.1-19 Comparison between the original ECT signal and multi-frequency ECT algorithm signal

In nuclear fast breeder reactors (FBR), liquid sodium is used as an intermediate heat-transfer fluid, and only the steam generator (SG) tube wall separates the steam-water inside of its pipe and the liquid sodium flowing outside it. Earlier defect detection, before wall penetration occurs, during the in-service inspection (ISI) is required to increase the safety of SG tube component in order to avoid the powerful chemical reaction between water and sodium. The SG tubes integrity are checked on a regular basis using either ultrasound or eddy current testing (ECT).

In the ECT, the ECT coils are inserted inside of the SG tubes and by monitoring the changes in their impedance variations in SG tube thickness can be detected. However, sodium is highly electrically conductive, and its presence on the outer tube surface can interfere with the electromagnetic disturbance signal from existing defects. The unknown sodium signal is accurately modeled, using numerical simulations to estimate the range of the signal when sodium layer adhesion thickness varies between 10 and 100 μm. A tuned multi-frequency ECT algorithm was constructed, using numerical simulations, for the specific ECT inspection probe which is able to suppress the signal from sodium structures such as: layers of unknown thickness or drops.

This algorithm acts as a filter, being able to delete also the support plate (SP) signal and possible sodium drops located nearby and extract and enhance only the defect signal. The result of the developed multi-frequency ECT algorithm is shown in Fig.1-19 where signals from sodium structures and SP signals are reduced, independently of sodium layer thickness.

Accurate numerical ECT simulations are an effective tool to indicate and develop ways to enhance ECT inspection, even when dealing with unknown sodium structures, increasing therefore the safety of SG tubes.

Reference

Mihalache, O. et al., Analysis of Defect Detection in Steam Generator Tubes of FBR, Under Support Plates and in the Presence of Sodium, Using Multi-Frequency Eddy Currents Algorithm, Proceedings of 15th International Conference on Nuclear Engineering (ICONE15), Nagoya, Japan, 2007, ICONE15-10211, in CD-ROM.