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A NEW METHODOLOGY FOR ESTIMATING SURFACE HEAT FLUX FROM IN-DEPTH SENSORS

Abstract

A transformative inverse methodology is presented for estimating surface heat fluxes that accounts for sensor characteristics and positioning through a series of calibration runs. The concept produces a novel calibration convolution integral equation that is devised from the heat equation and generalized sensor models. Both the physics of heat conduction and sensor characteristics are inclusive in the integral equation for the unknown surface heat flux. The mathematical development is elucidated indicating that fundamental physics and mathematics are entrenched in the final calibration integral equation. Mathematical functions are eliminated in lieu of calibration data streams. Sensor properties such as capacitance, contact conductance and conductive lead losses are embedded in the convolution statement. These effects are often overlooked in inverse heat conduction but can have a substantial adverse effect on accuracy of the predicted surface heat flux. In fact, predictions will tend to be delayed in time and attenuated in magnitude. Preliminary simulations using both semi-infinite and finite depth (plate) geometries are presented showing favorable results for practical implementation.