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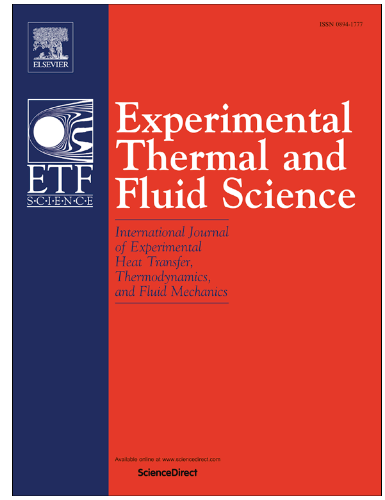

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Calibration of a Plate Sensor for Determination of Total Heat Transfer into a Surface with a Spatially Varying Heat Flux

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Abstract

This study presents an investigation of the calibration of a plate sensor for determination of the total surface heat transfer into a stainless steel plate with a spatially variable heat flux. The total surface heat transfer is determined through use of the calibration integral equation method (CIEM) which is an elegant way of relating "input to output" for a conduction heat transfer process. The calibration data consists of a measured uniform heat transfer input to the surface of the plate along with the measured temperatures from five thermocouples installed at the same specified depth just below the back face of the plate. It is demonstrated that the calibration data set obtained from a uniform heat flux test can be used to predict the total surface heat transfer for a time and spatially varying heat flux input to the plate using the average of the measured thermocouple temperatures. The CIEM was modified by rescaling the time domain to account for the temperature dependent thermal diffusivity and rescaling the surface heat transfer to account for the temperature dependent thermal conductivity. Three calibration tests with uniform surface heat flux inputs and six reconstruction tests with time dependent spatially varying heat flux inputs were conducted. Pairs of calibration and reconstruction test data were used to investigate eighteen test cases. Accurate predictions of the total surface heat transfer into the calibrated plate sensor were obtained regardless of the spatial distribution of the surface heating, the calibration test data or the measurement noise magnitude in the reconstruction temperature.

Keywords: total surface heat transfer sensor, sensor calibration, calibration integral equation, two-dimensional heat conduction

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