Inverse models for transient wall heat flux estimation based on single and multi-point temperature measurements

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Abstract: Estimation of transient heat flux imposed on one of the surfaces of a solid medium, via an inversion algorithm, is presented. Three inversion models, utilizing temperature data obtained from thermocouples embedded inside the solid medium, are developed. These include: (i) one-thermocouple model, where Boundary Condition (BC) at one surface of the solid is known a priori; (ii) model incorporating a semi-infinite abstraction of the solid medium; and, (iii) two-thermocouple model, where the temperature data from the first thermocouple is used for inversion and the data from the second thermocouple is used as a remote BC for the forward problem. These models are benchmarked and compared with one-dimensional heat conduction experimental data involving both, known and unknown time-varying BCs. It is found that the estimation of heat flux via the one-thermocouple model is highly dependent on the exactness of the explicitly known BC. **Furthermore, the extended applicability of semi-infinite model well beyond the thermal penetration time makes them suitable for problems with unknown BCs such as nuclear reactor containments, furnaces, etc. However, as compared to both these models, the two-thermocouple model is much more versatile and robust with a wider range of applicability**. This latter model overcomes the limitations of commercially available packaged thermopile flux sensors - this is demonstrated through the estimation of time varying unknown heat flux during steam condensation on a vertical flat surface.

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