COMBINED EXPERIMENTAL AND NUMERICAL SIMULATION OF CONVECTIVE TRANSPORT

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ABSTRACT

Experimental results play a crucial role in the validation of mathematical and numerical models for a variety of basic and applied thermal transport problems. They are also used to establish the accuracy and predictability of numerical simulation, particularly for complex transport processes that arise in practical thermal systems. Material properties that are crucial to any accurate simulation are also obtained experimentally. In addition, there are many important convective heat transfer processes where the boundary conditions are not well defined, or limited information is available on the imposed conditions. This makes an accurate numerical simulation of the problem difficult and, in several cases, virtually impossible. However, properly selected experimental data can be used, along with the numerical solution of an inverse problem, in such cases to provide the appropriate boundary conditions to allow the simulation of the system to be carried out and to obtain realistic and accurate results. The experimental results not only provide inputs for solving the problem but also the physical insight needed for an accurate model, which can subsequently be used for prediction, design and optimization of the process or system. Examples of experimentation data based simulation, along with the solution of the inverse problem, are presented.

In addition, there are many problems in which numerical simulation is particularly suitable over given parametric ranges, while experimentation is more appropriate over other regions, as defined by the governing parameters and operating conditions. In such cases, a concurrent numerical and experimental approach may be used to solve the problem more accurately and efficiently. Such combined experimental and numerical simulation of

convective transport arising in a variety of fundamental and practical problems is discussed in this paper. Basic considerations in these approaches are outlined and a few practical circumstances where this approach is appropriate are discussed. A few relatively simple problems are considered for the presentation of the concurrent simulation and experimentation approach, and the results obtained are discussed. The application of the approach to system optimization is also discussed.

A few circumstances where experimentation is used to define the boundary conditions and thus allow the simulation to proceed are also discussed. The basic considerations that arise in this approach are outlined and a few circumstances, where experimental inputs are effectively employed in the overall simulation are discussed. It is shown that experimental data are valuable in solving complex practical problems that involve thermal transport processes and are often critical for obtaining accurate, valid, physically realistic and dependable numerical results.