Abstract:

The seminar re-examines the problem of computationally modelling the flow over moderately close-packed, in-line tube banks that are a frequently adopted configuration for large heat exchangers. While an actual heat exchanger may comprise thousands of tubes, applied computational research aimed at modelling the heat-exchanger performance will typically adopt, at most, a few tens of tubes. The present contribution explores the sensitivity of the computed results to the pitch:diameter ratio of the tube, to the number of tubes in the domain and to the particular modelling practices adopted. Regarding the last aspect, both large-eddy-simulation (LES) and URANS (unsteady Reynolds-averaged Navier-Stokes modelling) approaches have been tested using periodic boundary conditions. The results show that URANS results adopting a second-moment closure are in closer accord with the LES data than those based on linear eddy-viscosity models. Moreover, the treatment of the near-wall region is shown to exert a critical influence not just on wall parameters like the Nusselt number but also on such fundamental issues as the flow path adopted through the tube bank. Comparison is also made with experiments in two small, confined, tube-bank clusters such as are typically used to provide data for performance-estimation of a complete industrial tube-bank. It is shown that such small clusters generate very substantial secondary flows that may not be typical of those found in a full-sized heat exchanger. Moreover, a new previously unreported secondary flow pattern is created that greatly amplifies mixing rates.