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Numerical Prediction of Mixed Convection Flow Regime in Low-Prandtl Number Fluids

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Turbulent heat transfer is an extremely complex phenomenon and is critical in scientific and industrial applications. It becomes much more challenging in a buoyancy-influenced flow regime, particularly for non-unity Prandtl number (Pr) fluids. In this article, an effort has been put forward to assess the prediction capabilities of different Reynolds-Averaged Navier-Stokes (RANS) based turbulence models for a mixed convection flow regime. In this regard, a fixed Richardson number (Ri = 0.5) case is considered at three different Prandtl number fluids (Pr= 1, 0.1, and 0.01). The considered flow configuration is a parallel plate arrangement with differentially heated top and bottom walls. Two different classes of turbulent heat flux models, i.e., based on Simple Gradient Diffusion Hypothesis and Algebraic formulations, are compared with the available reference DNS (Direct Numerical Simulation) database. The prediction capabilities for these modeling approaches are assessed and will be extensively discussed in this full-length paper.

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