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Direct numerical simulation of turbulent supercritical flow and heat transfer of water in a vertical pipe[1] JUNG YUL YOO, SANG HOON LEE, Seoul National University, JOONG HUN BAE, Koreanair R&D Center —
Turbulent heat transfer to supercritical-pressure water flowing in a heated vertical tube is investigated using direct numerical simulation. A conservative space-time discretization scheme for variable-density flows at low Mach numbers is adopted to treat steep variations of fluid properties at supercritical pressure just above the thermodynamic critical point, where the fluid properties at such conditions are obtained using PROPATH and used in the form of tables. The buoyancy influence induced by strong variation of density across the pseudo-critical temperature proves to play an important role in turbulent flow and heat transfer at supercritical state. The predicted wall temperature shows localized peaks in the axial distribution. Localized heat transfer impairment of the supercritical-pressure water is found to occur where turbulent energy diffusion is locally suppressed due to the influence of buoyancy. Although the present DNS has been performed at a much lower Reynolds number than that of typical experimental conditions, the peculiar characteristics of supercritical heat transfer including both enhancement and local deterioration are well predicted, in particular, the occurrence of double hot spots.

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