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Numerical investigation of supercritical water turbulent flow and heat transfer characteristics in vertical helical tubes

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Abstract:

Heat transfer of supercritical water turbulent flow in helical and straight tubes is simulated using the SST $k-\omega$ model to investigate the effects of property variations, buoyancy forces and centrifugal forces. Compared with constant property water flow, centrifugal forces near the wall are decreased due to lower densities while centrifugal forces in the center are increased due to higher densities, which result in stronger secondary flow intensity for supercritical water flow. Due to large buoyancy forces, the secondary flow is stretched. The maximum secondary flow velocity near the bottom wall region is 17.6% higher than that near the top wall region. For heating conditions, the axial velocities are accelerated in the flow direction and result in increased secondary flow intensities. However, when the bulk temperature reaching the pseudo-critical temperature, the temperature distributions are flattened and the non-uniformities of wall temperature distributions are decreased due to the higher effective thermal conductivities.

Key words: turbulent flow; heat transfer; helical tube; supercritical water