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The effect of large property fluctuations on turbulent heat transfer to supercritical pressure fluids in pipes RENE PECNIK, HASSAN NEMATI, ASHISH PATEL, BENDIKS JAN BOERSMA, Delft University of Technology — When a fluid slightly above the thermodynamic critical pressure is heated, such that the fluid's state crosses the pseudo-critical line, no distinct liquid to gas phase transition occur. However, the fluid properties change abruptly. If these property variations occur in a turbulent flow the conventional behavior of turbulence is strongly altered. We study the influence of these large property fluctuations in forced convection heat transfer to supercritical carbon dioxide in a pipe, with DNS at a Karman number of Re=180 (based on the pipe inlet conditions). At the inlet the temperature is slightly below the pseudo-critical point, such that during the heating process the developing thermal boundary layer crosses the pseudo-critical line. We show that the occurring property fluctuations have a strong effect on the averaged wall enthalpy if a constant wall heat flux boundary condition (infinite thermal effusivity ratio of fluid to solid) is used. By changing the boundary conditions to constant wall temperature (vanishing thermal effusivity ratio) these fluctuations are eliminated at the wall and the heat transfer coefficient is decreased.

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