Influence of temperature-dependent fluid properties on heat transfer in turbulent channel flow

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— Forced-convection heat transfer in turbulent liquid flows is parametrized by a correlation between the Nusselt number, $Nu$, the flow Reynolds number, $Re$, and the Prandtl number, $Pr$. Most of existing expressions for such $Nu = f(Re, Pr)$ correlation were developed under the assumption of negligible dependence of the thermo-physical properties of the liquid on temperature. This may be a bottleneck when system optimization is required. In this work we use pseudo-spectral direct numerical simulation to investigate the influence of temperature-dependent fluid properties on the overall turbulent heat transfer. In particular, we focus on turbulent channel flow of water, and we let viscosity vary with temperature at fixed $Pr$. Compared to the case of constant thermo-physical properties, it is observed that, already at low $Re$, temperature-dependent variations alter velocity profiles, and modify both the Nusselt number and the friction factor significantly (up to about 10 %).

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