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Turbulent drag reduction by compliant lubricating layer ALESSIO ROCCON, TU Wien; University of Udine, FRANCESCO ZONTA, TU Wien, ALFREDO SOLDATI, TU Wien; University of Udine — We propose a physically-sound explanation for the drag reduction (DR) mechanism in a lubricated channel, a flow configuration in which an interface separates a thin layer of fluid (viscosity η_1) from a main layer of fluid (viscosity η_2). To single out the effect of surface tension, we focus initially on two fluids having same density and viscosity, and we then consider a wide range of viscosities of the lubricating layer: from $\lambda = \eta_1/\eta_2 = 0.25$ (less viscous) up to $\lambda = \eta_1/\eta_2 = 4.00$ (more viscous). A database comprising DNS of two-phase flow channel turbulence is used to study the physical mechanisms driving DR, which we report between 20% and 30% for $\lambda \leq 1$, 10 % for $\lambda = 2.00$ and absent for $\lambda = 4.00$. The maximum DR occurs when the two fluids have the same viscosity ($\lambda = 1$), and corresponds to the relaminarization of the lubricating layer. Decreasing the viscosity of the lubricating layer ($\lambda < 1$) induces a marginally decreased DR, but also helps sustaining strong turbulence in the lubricating layer. This led us to infer two different mechanisms for the two drag-reduced systems, each of which is ultimately controlled by the outcome of the competition between viscous, inertial and surface tension forces.

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