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Polymer dynamics in turbulent flow

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Presence of dilute amounts of high-molecular weight polymers in liquids undergoing turbulent wall-bounded shear flows leads to significant drag reduction. There are two major proposed mechanisms of drag reduction in the literature. One is based on enhanced viscosity due to chain extension; the other is based on the assumption that elastic energy stored in polymer conformations is comparable to the kinetic energy in some eddies. Using the Navier-Stokes equation for the fluid and the Kirkwood-Riseman-Zimm equation for polymer chains, we have addressed the coupling between the near-wall turbulence dynamics and polymer dynamics. Our theoretical results show that the torque associated with polymer conformations contributes more significantly than the chain stretching and that the characteristic dimensions of polymer coils are much smaller than eddy sizes required for possible exchange of energy. We thus emphasize an additional mechanism to the existing two schools of thought in the search of an understanding of drag reduction.