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The scaling of polymer drag reduction with polymer and flow parameters in turbulent channel flow DONG-HYUN LEE, RAYHANEH AKHAVAN, Dept. of Mechanical Engineering, University of Michigan, Ann Arbor, MI 48109-2125, USA — The scaling of polymer drag reduction with polymer and flow parameters is investigated using results from direct numerical simulations (DNS) of dilute, homogeneous polymer solutions in a turbulent channel flow performed at a base Reynolds number of $Re_{\tau_b} \approx 230$. The full range of drag reduction from onset to maximum drag reduction (MDR) is reproduced in DNS with realistic polymer parameters, with results in good agreement with available experimental data. Onset of drag reduction is found to be a function of both the polymer concentration and the Weissenberg number (We_τ), in agreement with the predictions of DeGennes (1986). Saturation of drag reduction is achieved at a viscosity ratio of $\beta \approx 0.98$ at all We_τ, with the magnitude of drag reduction at saturation being a strong function of We_τ. A $We_{\tau_b} \sim O(Re_{\tau_b}/2)$ is needed to reach MDR. The presence of the polymer results in attenuation of turbulence at certain turbulent scales, determined by the Weissenberg number and the concentration. At saturation concentrations, the size of the largest attenuated eddy conforms to the predictions of Lumley (1969), while at concentrations below saturation, it conforms to a modified form of DeGennes (1986) theory. A mechanism of polymer drag reduction consistent with these observations will be presented.

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