Li, C. F.; **Gupta, V. K.**; **Sureshkumar, R.**; **Khomami, B.**

Turbulent channel flow of dilute polymeric solutions: drag reduction scaling and an eddy viscosity model. (English) Zbl 1195.76034

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Summary: Direct numerical simulation of viscoelastic turbulent channel flows up to the maximum drag reduction (MDR) limit has been performed. The simulation results in turn have been used to develop relationships between the flow and fluid rheological parameters, i.e. maximum chain extensibility, Reynolds number, Re_τ, and Weissenberg number, We_τ and percent drag reduction (%DR) as well as the slope increment of the mean velocity profile. Moreover, based on the trends observed in the mean velocity profile and the overall momentum balance three different regimes of drag reduction (DR), namely, low drag reduction (LDR; $0 \leq \%DR \leq 20$), high drag reduction (HDR; $20 \leq \%DR \leq 52$) and MDR ($52 \leq \%DR \leq 74$) have been identified and mathematical expressions for the eddy viscosity in these regimes are presented. It is found that both in LDR and HDR regimes the eddy viscosity varies with the distance from the channel wall. However, in the MDR regime the ratio of the eddy viscosity to the Newtonian one tends to a very small value around 0.1 within the channel. Based on these expressions a procedure that relies on the DNS predictions of the budgets of momentum and viscoelastic shear stress is developed for evaluating the mean velocity profile.

MSC:

76A05 Non-Newtonian fluids
76M22 Spectral methods applied to problems in fluid mechanics

Keywords:

turbulent drag reduction; slope increment; Reynolds stress; viscoelastic; FENE-P; direct numerical simulation (DNS); eddy viscosity model

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