

Polymer Elasticity and Turbulent Drag Reduction

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It is well-known that polymer drag reduction is positively correlated to extensional viscosity, which is coupled to polymer extension. Rod-like polymers always assume this favorable conformation, while randomly-coiling chains need to be unraveled by fluid strain rate in order to become effective. The coiling and stretching of flexible polymers in turbulent flow produces an additional elastic component in the polymer stress. The effect of the elastic stresses on drag reduction is unclear. To study this issue we compare Direct Numerical Simulations of turbulent drag reduction in channel flow using rod-like polymers and randomly coiling chains.

When compared at constant cr^2 both simulations predict the same amount of drag reduction. Here c is the polymer volume fraction and r is the polymer aspect ratio, which for flexible polymers is based on average polymer extension at the channel wall. This demonstrates that polymer elasticity plays a marginal role in the mechanism for drag reduction.