Numerical investigation of turbulent viscoelastic planar jets

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Direct Numerical Simulations (DNS) are used first to investigate Reynolds-averaged flow characteristics of the far-field of turbulent viscoelastic planar jets of FENE-P fluids under zero pressure gradient. Elasticity is shown to delay the beginning of the fully-turbulent region, and suppress small scale turbulence, but the streamwise mean velocity remains self-similar everywhere in the far-field. The identification of regions of polymer deformation/stretching together with leading order analysis of turbulent kinetic energy and of the evolution of the conformation tensor, allow the definition of asymptotes of solvent dissipation reduction, the observation of self-similar behaviour of several components of the conformation tensor, polymer stress tensor and turbulent polymer stretching tensor within each region and the determination of the corresponding scaling laws for the streamwise variation of the characteristic quantities used in the normalisations.

In the final part of the talk, DNS are used to help develop subgrid-scale (SGS) closures for the Large Eddy Simulation (LES) of planar jets. The SGS polymer stress and turbulent advection of the conformation tensor are both negligible, but a dynamic closure is required for the SGS turbulent polymer stretching, the Distortion self-SIMilarity model (DSIM). The LES model, incorporating also the dynamic Smagorinsky closure for the inertial SGS tensor, is shown to be capable of capturing well the main features of turbulent viscoelastic planar jets, including the scaling laws.