

231i Rheology of a Dilute Suspension of Non-Spherical Particles in Parallel-Wall Geometry

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We study the effects of confinement on the rheology of a dilute suspension of non-spherical particles in a parallel-wall geometry. The suspension is subject to shear flow that results from the relative motion of the walls. The suspension consists of linear chains of spherical particles with the length comparable to the channel width. The hydrodynamic mobility of the particles and their contribution to the effective stress are accurately evaluated using our recently developed Cartesian-representation algorithm.

In our simulations particles are initially randomly distributed. The subsequent evolution of their distribution is determined for different wall separations and chain lengths. In an unbounded, infinitely diluted suspension the particles undergo periodic motion, with the period that is independent of the initial orientation. Therefore, the initially random particle distribution, as well as the instantaneous ensemble-averaged quantities (such as the mean particle orientation and particle contributions to the effective shear and normal stress) also undergo periodic evolution.

In a confined geometry the periods of individual particle trajectories depend on the initial position and orientation of the particle. Thus at long times particle distribution is stationary. For a smooth distribution of the periods the stationary state is approached as the inverse of time. We find that even for the wall separation comparable to the chain length, the distribution of the periods is sharply peaked; thus the approach to the stationary state is slow.

Finite-concentration effects have been included by forming a population balance of periodic particle trajectories. The particles are displaced from their original trajectories due to pair collisions, as in the Boltzmann Monte-Carlo method. The evolution of the angular and spatial particle distribution has also been examined. Implications of our results for separation of particle mixtures are discussed.