



Wolfson Department of Chemical Engineering Seminar

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Dynamics of flexible fibers in confined shear flows at finite Reynolds numbers

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Ph.D. Mid-Seminar

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We carry out a numerical study on the dynamics of a single non-Brownian flexible fiber in two-dimensional confined simple shear (Couette) flows at finite Reynolds numbers. We employ the bead-spring model of flexible fibers to extend the fluid particle dynamics (FPD) method that was originally developed for rigid particles in viscous fluids. We implement the extended FPD method using a multiple-relaxation-time (MRT) scheme of the lattice Boltzmann method (LBM). The numerical scheme is validated firstly by a series of benchmark simulations that involve fluid-solid coupling. The method is then used to study the dynamics of flexible fibers in Couette flows. We only consider the highly symmetric case where the fibers are placed on the symmetry center of Couette flows and we focus on the effects of the fiber stiffness, the confinement strength, and the finite Reynolds number (from 1 to 10). A diagram of the fiber shape is obtained. For fibers under weak confinement and a small Reynolds number, three distinct tumbling orbits have been identified. (1) Jeffery orbits of rigid fibers. The fibers behave like rigid rods and tumble periodically without any visible deformation. (2) S-turn orbits of slightly flexible fibers. The fiber is bent to an S-shape and is straightened again black when it orients to an angle of around 45 degrees relative to the positive x direction. (3) S-coiled orbits of fairly flexible fibers. The fiber is folded to an S-shape and tumbles periodically and steadily without being straightened anymore during its rotation. Moreover, the fiber tumbling is found to be hindered by increasing either the Reynolds number or the confinement strength, or both.