fluids

Editorial

Editorial for Special Issue "Drop, Bubble and Particle Dynamics in Complex Fluids"

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The presence of drops, bubbles, and particles affects the behavior and response of complex multiphase fluids. In many applications, these complex fluids have more than one non-Newtonian component, e.g., polymer melts, liquid crystals, and blood plasma. In fact, most fluids exhibit non-Newtonian behaviors, such as yield stress, viscoelastity, viscoplasticity, shear thinning, or shear thickening, under certain flow conditions. Even in the complex fluids composed of Newtonian components, the coupling between different components and the evolution of internal boundaries often lead to complex rheology. Thus, the dynamics of drops, bubbles, and particles in both Newtonian fluids and non-Newtonian fluids are crucial to the understanding of the macroscopic behavior of complex fluids. The goal of this Special Issue was to gather recent experimental, numerical, and theoretical research on drop, bubble, and particle dynamics in complex fluids.

Leiva and Geffory [1] experimentally investigated the variation of droplet size distribution of emulsions under slow shearing flow. In contrast to the good stability of emulsions at rest, the size distribution changes significantly due to breakup and coalescence of droplets under flow. A bimodal size distribution and a banded structure were observed at lower and higher shear rates, respectively.

Amah et al. [2] performed direct numerical simulations on the motion of dielectric particles in electric fields of microfluidic devices, where the rigid-body motion of particles was enforced by a distributed Lagrange multiplier method and the electric force acting on the particles was computed using the point-dipole and Maxwell stress tensor approaches. Their numerical results revealed that the tendency of particles to form chains diminishes when the particle size is comparable to the spacing between electrodes, due to the modification of the electric field by the presence of particles.

Poryles and Zenit [3] experimentally studied the rising of Newtonian oil drops in a shear-thinning viscoelastic liquid. A so-called rising velocity discontinuity was observed for drops larger than a certain size. Beyond the critical velocity, the drop forms a long tail, which emits small droplets. The size and emission frequency of the droplets were found to be dependent on the volume of the mother drop. Potentially, this setup can be used to generate small droplets with desirable sizes by adjusting the volume of the rising drop.

Spanjaards et al. [4] numerically investigated the migration of sedimenting particles in a viscoelastic Couette flow between two rotating cylinders. An arbitrary-Lagrangian–Eulerian moving-mesh method was used to track the moving particles, and the DEVSS-G and log-conformation representation were used for the viscoelastic stress. The migration velocity of a sedimenting particle in a Couette flow was found to be higher than the sum of migration velocities due to sedimentation and Couette flow individually.

Hamidouche et al. [5] investigated the performance of a discrete element method (DEM)/large-eddy simulation (LES) solver for the prediction of gas-particle flows in a fluidized bed. Mesh sensitivity, wall conditions for the gas phase, and particle-wall and particle-particle friction coefficients were systematically studied. Good agreements with experimental data were achieved if the numerical parameters were properly chosen.

Helmers et al. [6] developed a mathematical model to predict the excess velocity of Taylor drops in square microchannels. The proposed model was adapted with a stochastic and metaheuristic optimization approach based on genetic algorithms and compared well with high-speed camera measurements and published empirical data.

Zaleski and Afkhami [7] analyzed the dynamics of ellipse-shaped droplets, either conducting or dielectric, in an electric field using conformal maps. Different from previous analytical work in the literature, the complexity of boundary conditions at the electrode was also considered. In the conducting case, the maximum droplet height is attained when the distance between the electrode and the drop becomes sufficiently large; in the dielectric case, hysteresis can occur for certain values of electrode separation and relative permittivity.

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