FINITE-SIZED PARTICLES IN TURBULENT TAYLOR-COUETTE FLOW

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We study the modification of drag by neutrally buoyant spherical particles in highly turbulent Taylor-Couette flow, as shown in Fig. 1 These particles can be used to disentangle the effects of size, deformability, and volume fraction on the drag, when contrasted with the drag for bubbly flows. We find that rigid spheres hardly change the drag of the system beyond the trivial viscosity effects caused by replacing the working fluid with particles. The size of the particle has a marginal effect on the drag, with smaller diameter particles showing only slightly lower drag. Increasing the particle volume fraction shows a net drag increase as the effective viscosity of the fluid is also increased. The increase in drag for increasing particle volume fraction is corroborated by performing laser Doppler anemometry where we find that the turbulent velocity fluctuations also increase with increasing volume fraction. In contrast with rigid spheres, for bubbles the effective drag reduction also increases with increasing Reynolds number. Bubbles are also much more effective in reducing the overall drag.
In addition, we also investigate finite-sized fibers in highly turbulent Taylor-Couette flow.

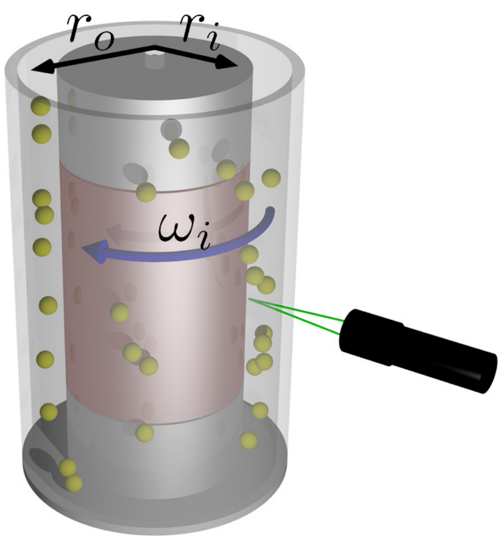

Figure 1: Schematic of the Taylor-Couette setup. Two concentric cylinders of radii $r_{i,o}$ with a working fluid in between. Particles are not to scale. The inner cylinder rotates with angular velocity ω_i, while the outer cylinder is kept at rest. We measure the torque on the middle section (highlighted). The laser Doppler anemometry (LDA) probe is positioned at mid height to measure the azimuthal velocity at mid gap.

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