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Flow of concentrated suspensions in asymmetric bifurcations

Concentrated suspensions flowing in complex geometries are often encountered in materials processing applications such as injection molding and extrusion. One example of a practical complex geometry is a branching, or bifurcation flow. Previous work on the behavior of dispersed particles in branching flows has generally emphasized dilute suspensions where the particle diameter is similar to the channel width. Meanwhile, a high loading of small particles, where the suspension can be compared to a continuum material, and the resulting impact on the concentration and flow fields have not received as much attention.

In our study, suspensions of neutrally buoyant, noncolloidal spheres in Newtonian liquids undergo steady, pressure-driven flow in a rectangular channel (4:1 aspect ratio) that divides into two branches at an asymmetric T-junction. We examine two cases, where the downstream branches either have equal width or unequal widths in a ratio of 1.5. Particle concentration and velocity profiles are obtained by nuclear magnetic resonance imaging (NMRI). We aim to determine the effect of the branching ratio and geometry on the observed concentration and flow fields, for particle volume fractions of 0.4-0.5 and low flow and particle Reynolds numbers. We find that the particles follow flow streamlines fairly closely for the unequal branch flow cell, while in the case of equal branches, the particles are more evenly distributed between the downstream branches than expected. Recent results from bifurcation flow experiments will be presented, comparing the two bifurcation geometries in terms of dividing streamlines, concentration inhomogeneities, particle fluxes in the branches and cross-stream particle motion.