144q Particle Migration Patterns Observed in Oscillatory Flow by Nmri

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Particle migration to the center of a tube is a well-known phenomenon observed in steady, pressure-driven flows of a concentrated suspension of noncolloidal spheres in a viscous Newtonian liquid. In comparison, oscillatory, pressure-driven flow of the same material in a tube exhibits a wide range of particle distribution patterns. Observed patterns include rings and concentrated columns of particles, and appear depending on operating conditions such as bulk particle volume fraction and oscillation amplitude and frequency. Particle concentration profiles obtained by nuclear magnetic resonance imaging (NMRI) will be presented. Additional discussion will focus on determining a suitable method (NMRI or other) for quantifying the oscillation amplitude and time-dependent velocity profile in small amplitude oscillatory flow, where many of the most interesting patterns have been observed.

The phenomenon of “reverse” migration, where particles migrate toward the tube wall, is investigated in this study. “Reverse” migration has been observed in small strain amplitude oscillatory flows of concentrated suspensions in rare simulation and experimental studies. The phenomenon is intriguing because many continuum models of flowing suspensions at low Reynolds number fail to predict or explain it, and additionally biomedical and industrial applications can be envisioned.

In this work, nuclear magnetic resonance imaging (NMRI), supplemented by video imaging and rheology, is used to obtain particle concentration profiles. Experiments characterize the particle properties and flow conditions (e.g. particle volume fraction, Reynolds number, particle-tube radius ratio, oscillation amplitude), which lead to “reverse” migration and other interesting migration patterns. The observed dependence on these parameters may suggest what driving forces can be identified as the main mechanism for the various migration patterns.