253j Magnetorheological Measurements in Suspensions of Magnetic Nanoparticles

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Suspensions of magnetic nanoparticles, commonly referred to as ferrofluids, are a commercially relevant example of structured fluids where a magnetic body couple, resulting from non-colinear local magnetic field and magnetization vectors, produces a state of asymmetric stress. Such stresses result in forces and torques on surfaces in contact with these suspensions, even in the absence of bulk flow. Alternatively, the internal angular momentum that enters the system due to the action of the magnetic body couple may be transformed into vorticity and result in bulk flow. These phenomena make ferrofluids attractive in applications where magnetic actuation of fluid flow is desirable. Here we report on measurements of the torque required to either rotate or restrain a polycarbonate spindle surrounded by ferrofluid in a cylindrical container and subjected to the rotating field generated by a magnetic induction motor stator, as a function of applied field amplitude and frequency, and for various values of the geometric aspect ratios of the problem. Simultaneously, ultrasonic Doppler velocimetry was used to measure the azimuthal and axial velocity profiles in the ferrofluid contained in the annular gap of our apparatus. These torque and velocity measurements are compared to an asymptotic solution of the ferrohydrodynamic flow problem in zero spin viscosity and linear magnetization limits, and to a numerical solution of the problem*f*|