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A generalized Oldroyd model for a suspension of rod-like or disk-like particles ROBERT DAVIS, RICHARD MARTIN, ALEXANDER ZINCHENKO, University of Colorado Boulder — Early work on emulsion rheology was performed by Frankel and Acrivos [J. Fluid Mech., 44, 65 (1970)] for dilute emulsions of drops with small deformations. Martin, Zinchenko and Davis [J. Rheol. 58, 759, (2014)] developed a more general approach, valid for larger deformations and based on a 5-parameter Oldroyd model with variable coefficients found from fitting the equation to three viscometric and two extensiometric functions in simple shear and hyperbolic flow, respectively, at arbitrary flow intensities. The method was validated with the Frankel-Acrivos small-deformation theory. We have extended the method to ellipsoidal particles subject to Brownian rotations. The viscometric and extensiometric functions were obtained by numerically solving the Fokker-Planck equation for the particle orientation distribution function through expansions into spherical harmonics. The results compare well with the interpolation models of Hinch and Leal [J. Fluid Mech., 76, 187 (1976)] between the limits of weak and strong flows. A benefit of our general approach to constitutive modeling is that it can be applied to concentrated systems (suspensions, emulsions, etc.), while the prior models are limited to dilute systems of non-interacting particles or drops.

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