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GRANULAR AND MULTIPHASE FLOWS

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Mechanics Research Communications and the Granular Science Laboratory

Professor Jeffrey Morris

Department of Chemical Engineering

Levich Institute/City College of CUNY

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Suspension Pressure: Osmotic Concepts Applied to Suspension Flows

Suspensions of particles in liquid are seen in many applications, including ceramic nanocomposites and cement precursors, colloidal inks and ore slurries, and in natural settings we can think of wet beach sand. Our focus in this work is on one unifying feature seen in the behavior of suspensions and granular materials, specifically the tendency of the particle phase to dilate under steady shearing flow. Mechanically, this translates to the presence of a dispersive pressure. The particle pressure in a sheared noncolloidal suspension is measured by a method similar to that based on use of a semipermeable membrane for measuring osmotic pressure using a semipermeable membrane: A viscous suspension of spherical particles is subjected to shearing motion, and by allowing the liquid to pass to or from the sheared zone while the particles are confined in this zone, a means of measuring the particle pressure has been developed. The particle pressure measured is, as expected based on low-Reynolds-number considerations, roughly linear in the shear rate. Note that particle contact does not appear to be critical, as we are able to measure pressures for suspensions as low as 30% solids. We will a) show that the dispersive normal stress measured is the nonequilibrium equivalent of the osmotic pressure exerted by particles in a colloidal dispersion, and b) demonstrate the similarity of the dilational tendency in a viscous suspension with that of granules in contact. What it means to associate this stress with the particle phase and not with the whole material will also be addressed.

After receiving his doctorate at Caltech and a year of post-doctoral study at Shell Research in Amsterdam, Prof. Morris joined the faculty in Chemical Engineering at Georgia Tech in 1996, where he remained until 2002. There he advised six students to the PhD (including a co-advised student in Marseille, France) along with six MS graduates. He served as Senior Scientific Advisor on the staff of Halliburton from 2002-2004. Since January 2005 he has been a member of the Levich Institute Chemical Engineering at the City College of New York, the flagship engineering campus in the City University of New York.

For further information, please contact Dr. A. Rosato, ME Department (rosato@adm.njit.edu; 973-596-5829), or Ms. Barbara Valenti (Valenti@adm.njit.edu; 973-596-3332)