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Effects of Polydispersity on Stresses in Granular Shear Flow

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Event-driven molecular dynamics simulations are performed for the simple shear flow of smooth inelastic disks, with a focus on the effect of polydispersity on stresses. Simulations are conducted for both binary mixtures and polydisperse media with a Gaussian size distribution. For the binary mixture, the total solids volume fraction ($\phi = \phi_1 + \phi_2$), the solids fraction ratio (ϕ_1 / ϕ_2) the particle diameter ratio (d_1 / d_2) and the coefficient of restitution (e_p) are varied, and the simulation results are compared with an existing kinetic-theory model. The calculated stresses compare reasonably well with the model predictions for $d_1 / d_2 < 2$ in the nearly elastic limit, but the agreement deteriorates significantly at larger size ratios. Furthermore, the assumption of equipartition of granular energy between the two particle sizes appears to have a very limited range of validity in terms of both particle-size ratio and inelasticity. For a granular mixture characterized by a Gaussian size distribution, simulations are carried out in which the standard deviation in particle diameter, the coefficient of restitution and the total solids fraction are varied. The calculated stresses are in good agreement with predictions obtained from an existing kinetic-theory model for an “equivalent” monodisperse mixture.