

A coarse-grained discrete particle method for particle-fluid flows

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Abstract

Particle-fluid flows are often found in natural and engineering processes. As the number of particles involved is typically enormous, tracking the motion of these particles individually is infeasible in general, and continuum assumption is usually applied to the particle (solid) phase also. This is, however, not sufficient or accurate enough in many cases. Coarse-grained discrete particle methods (CG-DPM) which follow the motion of a collection of particles can retain many advantages of a discrete description while reducing the computational cost greatly. A critical issue for these methods is to determine the properties of the coarse-grained particles involved. To addressing this issue, we have been developing such a method based on the kinetic theory of granular flow with consideration to the heterogeneous meso-scale structures formed in the particle phase. In particular, the energy-minimization multi-scale (EMMS) model is employed to determine or constrain some of the parameters of the coarse-grained particles, such as size and porosity. We will report our newest results on this study, including a systematic validation of the method with rigorous DPM simulation and experiments, and the application of the method to a pilot-scale circulating fluidized bed, demonstrating the engineering significance of this method.