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Incorporation of Interstitial Gas Effects on Granular Flows

CHRISTINE HRENYA, University of Colorado, VICENTE GARZO, Universidad de Extremadura, SUDHEER TENNETI, SHANKAR SUBRAMANIAM, Iowa State University — Numerous examples of granular flows exist in which the role of the interstitial gas cannot be ignored. A range of approaches have been taken to incorporate these effects into continuum descriptions. Early efforts simply added a mean drag law to the momentum balance. This ad hoc approach was followed by more rigorous treatments in which an instantaneous drag was incorporated directly into the kinetic equation. Analytical expressions for the resulting continuum description were obtained in the Stokes limit, but not possible higher Reynolds numbers. In the current effort, DNS-based simulations are used to develop a model for the instantaneous drag force that is applicable to a wide range of Reynolds number. This model, based on the Langevin equation, is incorporated into the Enskog equation in order to derive a continuum description for the gas-solid flow. In the limit of Stokes flow, the additional terms arising in the conservation equation are found to match those of previous analytical treatments. Furthermore, the impact of gas on the solid-phase constitutive relations, which was ignored in analytical treatments, is determined. The parameter space examined is consistent with that found in circulating fluidized beds. For such systems, the results indicate a non-negligible impact of the gas phase on the shear viscosity and the Dufour coefficient.

Christine Hrenya
University of Colorado

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