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Particle dynamics-based hybrid simulation of vibrated gas-fluidized beds of cohesive fine powders SUNG JOON MOON, YANNIS KEVREKIDIS, SANKARAN SUNDARESAN, Princeton University — We use three-dimensional molecular dynamics simulations of macroscopic particles, coupled with volume-averaged gas phase hydrodynamics, to study vertically vibrated gas-fluidized beds of fine, cohesive powders. The interstitial gas flow is restricted to be effectively one-dimensional (1D) in the beds of narrow cross-sectional areas we consider. This model captures the spontaneous development of 1D traveling voidage waves, which corresponds to bubble formation in real fluidized beds. We use this model to probe the manner in which vibration and gas flow combine to influence the dynamics of cohesive particles. We find that as the gas flow rate increases, cyclic pressure pulsation produced by vibration becomes more and more significant than direct impact, and in a fully fluidized bed this pulsation is virtually the only relevant mechanism. We demonstrate that vibration assists fluidization by creating large tensile stresses during transient periods, which helps break up the cohesive assembly into agglomerates. We also study spontaneous demixing in beds of a mixture of particles of different densities, so-called the "phase separation," using an equation-free multiscale approach.

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