121a Pressure Pulsation in Vibrofluidization of Fine Powders

Sung Joon Moon, Yannis G. Kevrekidis, and Sankaran Sundaresan

Fine powders are difficult to fluidize because of the strong cohesive interparticle forces. It is well known that by supplementing gas flow with mechanical vibration, a bed of cohesive particles can be fluidized [1-4], but the understanding of the basic physics of a vibrated gas fluidized bed is far from being complete. Matawari et al. [1] and Nam et al. [2] found that pressure drop in fully fluidized state has no appreciable dependence on the vibration intensity, and it approximately balances the bed weight per unit cross sectional area; however, Tasirin and Anuar [3] found that the pressure drop increases as the vibration intensity increases. On the other hand, Erdesz and Mujumdar [4] found the opposite trend. Thus far, there has been no consensus on the effect of vibration on the pressure drop. We have probed through particle dynamics-based hybrid simulations involving three-dimensional particles with periodic boundary conditions in lateral directions and one-dimensional volume-averaged gas effects [5], the manner in which vibration and fluidization combine to influence the dynamics of the cohesive particles. Vibration of the base plate affects the particle motion through direct impact and through cyclically varying pressure pulsations in each cycle. As the gas flow rate increases, the latter mode is found to become more and more significant. In a fully fluidized state, the pressure pulsation is virtually the only relevant mechanism, and the average pressure drop in a fully fluidized state does not have any appreciable dependence on the vibration intensity, which is consistent with the observation of Matawari et al. [1] and Nam et al. [2]. A simple explanation of our results through force balance arguments will be presented. The pressure pulsation resulting from the plate vibration facilitates fluidization by creating transient periods of large tensile stresses, which helps break up the cohesive assembly into agglomerates.

[1] Matawari et al., Powder Technol. 123, 69 (2002). [2] Nam et al., AIChE J., 50, 1776 (2004). [3] Tasirin and Anuar, J. Chem. Eng. Jpn., 34, 1251 (2001). [4] Erdesz and Mujumdar, Powder Technol., 46, 167 (1986). [5] Moon et al., AIChE Annual Meeting, (2004).