62c Fluidization of Cohesive Particles

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Fluidization has been widely used in many powder processes because of its continuous powder handling ability and good gas-solid contacting. This results in high heat and mass transfer coefficients and high rates of reaction. However, particles with different physical properties have very distinct fluidization behaviors. Geldart (1973), based on empirical observations, classified powders into four groups: A, B, C, and D, depending on their size and the density difference between the solid particles and the fluidizing gas. The distinction between these groups of powder is related to the different fluidization behavior observed for each type of powder. In a conventional gravity-driven fluidized bed, particles having an average diameter smaller than 20 microns and a density difference greater than 1000 kg/m3 are classified as Geldart group C powders. These powders are extremely difficult to fluidize and generally will form cracks, channels or “rat holes” or even lift as a solid plug when exposed to the fluidizing gas. However, there are many applications that can benefit from being able to fluidize such cohesive particles, and therefore, fluidization of cohesive particles has been an active area of research for number of years. Several investigations have been reported on this topic, indicating that the fluidization quality of cohesive powders can be improved by using external aids such as vibration, magnetic field, and acoustic field. However, there are some disadvantages with each method.

In this paper, we explore a different approach where we first examine the fundamental reasons for the difficulty in fluidizing Class C particles by considering various terms that influence the boundary between Geldart class A and C. It can be easily shown that the transition between A and C is governed by relative magnitudes of forces such as the apparent weight of the particle, cohesion force, etc. In previous work, it was shown that one term that can be manipulated is the “particle body force” through application of centrifugal field, which will increase the “body force” and thus shift the A-C transition curve on Gerdart's map to the left, indicating that now much smaller particles may be fluidized. Based on that, fluidization of otherwise cohesive (class “C”) particle have been shown to occur in a rotating fluidized bed. However, in this work, we examine another approach that can be employed to increase the relative magnitude of the body force as compared to the cohesive force. This is accomplished through a novel proprietary process. In this paper, details of how Geldart's classification between A and C can be manipulated are shown, and comprehensive experimental data on various cohesive powders fluidized in conventional fluidized bed is presented.