LETTER TO THE EDITOR

Hydrodynamic Particle Volume Factor and Settled Bed Volume

Editor, Can. J. Chem. Eng.:

In their recent communication to this journal, Fouda and Capes[1] have ably shown that the hydrodynamic volume factor, K, which they had previously[2] used in correlating expansion data for liquid-fluidized beds of non-spherical particles with those for similar beds of spherical particles, could be related to the settled bed volume of the non-spherical particles as follows:

$$K = (1 - \epsilon_e) H \quad \ldots\ldots (1)$$

where all symbols are defined in the Nomenclature. Steinour[3] had previously used a similar factor for correlating hindered settling data and Gasparyan and Ikaryan[4] for both liquid fluidization and hindered settling.

Since, by definition,

$$H = \frac{1}{1 - \epsilon_b} \quad \ldots\ldots (2)$$

and since Fouda and Capes[1] found from their experiments that $1-\epsilon_e = 0.603 \pm 0.016$, it follows that

$$K = \frac{0.603 \pm 0.016}{1 - \epsilon_b} \quad \ldots\ldots (3)$$

Thus K can be estimated simply from a knowledge of the settled bed voidage, ϵ_b.

Unfortunately, in concluding their communication, Fouda and Capes[1] attempt to devalue Equation (3) by arguing that

1) The correlations for K derived in their original paper[2], inasmuch as they are based on independent measurements of particle shape, are superior to Equation (3), in which the effect of shape is manifested only indirectly via ϵ_b.
2) Use of Equation (3) requires an accurate measurement of ϵ_b.

If one looks at Table 5 in the original paper[2], however, it is apparent that not only is the exponent in the correlating equation for K different for each particle shape investigated, but there is not even a single definition of characterstic particle diameter which can be applied to all shapes. No such problem presents itself with respect to Equation (3). Furthermore, settled bed voidage ϵ_b is equivalent to random loose porosity, ϵ_L, and to minimum fluidization voidage, ϵ_{mf}[5]. Brown et al[6] present a graphical correlation of ϵ_L with sphericity, which can easily be calculated from geometry for particles with well defined shapes, while Leva[7] shows curves of ϵ_{mf} vs. particle diameter for a variety of particles having irregular shapes. Random loose porosities for many other uniform-size and mixed-size particle species have also been reported[5,8,9]. For all these cases ϵ_b ($=\epsilon_L=\epsilon_{mf}$), and thereby K via Equation (3), can be obtained without any experiment at all. Where it is necessary to depend on an experimental measurement, it is far easier to measure ϵ_b[10] than it is to measure particle shape.

Finally, the necessity for dealing with the hydrodynamic particle volume factor at all is eliminated if, instead, one adopts the approach of correlatng the original bed expansion data by means of an unmodified Richardson-Zaki[11] type equation,

$$\frac{u}{u_i} = \epsilon^n \quad \ldots\ldots (4)$$

and then correlating n with ϵ_b, an approach which has shown some success for constant rate hindered settling of non-spherical particles[10].

Norman Epstein
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Nomenclature

- H = ratio of settled bed volume to contained solids volume
- K = hydrodynamic particle volume factor = volume of fluid envelope plus solid particle divided by volume of solide particle
- n = exponent in Richardson-Zaki type equation
- u = superficial liquid fluidization velocity = constant rate hindered settling velocity
- u_i = value of u extrapolated to ϵ of unity
- ϵ = void fraction = total liquid volume divided by total bed volume
- ϵ_b = void fraction of settled bed
- ϵ_e = volume of liquid outside outside fluid envelopes divided by volume of bed
- ϵ_L = void fraction of random loose packed bed
- ϵ_{mf} = void fraction of bed at minimum fluidization

References

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(5) Eastwood, J., Matzen, E. J. P., Young, M. J. and Epstein, N., Brit. Chem. Eng. 14, 1542 (1969).
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ERRATUM

A Mathematical Model for Concentric Horizontal Capsule Transport

Can. J. Chem. Eng. 56, 538 (1978)

Equation (6) should have D replaced by d, that is:

$$l^* = l/d$$

The entry in the nomenclature should be similarly altered. Equation (7) should then read:

$$\Delta p = 4\,\Gamma_c l^*$$

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On the Use of Residence Time Distributions for the Design of Clarifiers

Can. J. Chem. Eng. 57, 83 (1979)

Editor, Can. J. Chem. Eng.:

Our co-author, Professor Rietema, has drawn to our attention that the development of theory on page 85 of our paper would benefit from addition of the following line immediately following Equation (5):

"and hence, from (3)
u • grad $\alpha = 0$."

In the following line, "ze" should be "be".

R. R. Hudgins,
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