Bulletin No. 232

# Minimum Fluidization Velocity for Fluidized Bed Reactors

**Estimating the Minimum Fluidization Velocity for a Fluidized Bed Reactor**

The minimum fluidization velocity is a key parameter describing the fluidization of particles in a fluidized bed reactor. Minimum fluidization is defined as the state at which the weight of the whole bed of particles begins to be completely supported by the fluidizing gas, and the pressure drop of the gas across the bed becomes constant with increasing gas velocity. The minimum fluidization velocity may be determined experimentally by measuring the pressure drop as a function of gas velocity. It can also be predicted with various correlations. One such correlation is given below.

$$V = (G (\rho_p - \rho_g) \varepsilon^3 D^2) / (150 \mu (1 - \varepsilon))$$

V is the minimum fluidization velocity (cm/s)
G is the gravitational acceleration (981 cm/s$^2$)
$\rho_p$ is the particle density (g/cm$^3$)
$\rho_g$ is gas density (g/cm$^3$)
D is the particle diameter (cm)
$\mu$ is the gas viscosity (poise)
$\varepsilon$ is the minimum porosity of the bed. This dimensionless value corresponds to the void fraction at the point of minimum fluidization. Values around 0.5 are typical.

The mass of the bed occupied solely by the solid particles is the same irrespective of the porosity of the bed. When the drag force exceeds the gravitational force, the particles begin to lift, and the bed expands (i.e., the height increases) thus increasing the bed porosity. This increase in bed porosity decreases the overall drag until it is again balanced by the total gravitational force exerted on the solid particles.

**Example**

What is minimum fluidization velocity for a particle size of 250 µm with a density of 2.7 g/cc? The fluidization gas is nitrogen having a density of 0.0011 g/cc and a viscosity of 0.018 cP at 300 K and 1 bar. Assume a minimum bed porosity of 0.55.

**Solution**

$23\ cm/s = (981 \times (2.7 - 0.0011) \times 0.55^3 \times 0.025^2) / (150 \times 0.018/100 \times (1 - 0.55))$

The volumetric flow rate is the product of the cross sectional area of the reactor and the gas velocity. The volumetric flow rate in a one-inch (2.54 cm) ID reactor required for incipient fluidization is $23 \times \pi/4 \times 2.54^2$ or 117 $cm^3$ / s (7.0 L / min).

The volumetric flow rate is directly proportional to the reactor pressure and inversely proportional to the absolute temperature.

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