Example

A bed consists of uniform spherical particles of diameter 3 mm and density 4200 kg/m^3. What will be the minimum fluidizing velocity in a liquid of viscosity 3 mNs/m^2 and density 1100 kg/m^3

Solution

By definition:

Galileo number , Ga = $d^3\rho(\rho_s - \rho)g/\mu^2$

$= ((3 \times 10^{-3})^3 \times 1100 \times (4200 - 1100) \times 9.81)/(3 \times 10^{-3})^2$

$= 1.003 \times 10^5$

Assuming a value of 0.4 for e_{mf} , gives :

$Re'_{mf} = 25.7\{\sqrt{(1 + (5.53 \times 10^{-5})(1.003 \times 10^5))} - 1\} = 40$

And

$u_{mf} = (40 \times 3 \times 10^{-3})/(3 \times 10^{-3} \times 1100) = 0.0364$ m/s or 36.4 mm/s

Example :

A spherical solid particles having a size of 0.12 mm and a density of 1000kg/m^3 are to be fluidized using air at 2 atm and 25 ^{0}C . The porosity at min. fluidizing condition is 0.42

a) If the cross – section of the empty bed is 0.3 m^3 and the bed contains 300 kg of solid , calculate the min. height of the fluidized bed .
b) Calculate the press. drop at min. fluidizing conditions .
c) Calculate the min. velocity for fluidization .
   μ air = 1.845* 10^{-5} kg/m.s

sol.

(a) Vol. of solid = 300kg / 1000 kg/m^3

= 0.3 m^3

The height of the solid would be

L_1=0.3m^3 / 0.3m^2 = 1m

Occupy in the bed if e = zero

$$\frac{L_1}{L_{mf}} = \frac{1 - e_{mf}}{1 - e_1} \gg \frac{1}{L_{mf}} = \frac{1 - 0.42}{1 - 0} \gg L_{mf} = 1.72\ m$$

$\Delta P = (1-e_{mf})(\rho_s-\rho)L_{mf}.g$

$$\rho_{air} = \frac{P.Mwt}{RT} = \frac{2 * 101.325 * 29}{8.314 * 298} = 2.372\ kg/m^3$$

$\Delta P = (1-0.42)(1000-2.372)*1.72 *9.81$

$= 9786\ N/m^2$

(c)

$$U_{mf} = \left[\frac{(\rho_s-\rho)g}{\mu}\right]\left[\frac{e_{mf}^3 d^2}{180(1-e_{mf})}\right]$$

$$U_{mf} = \left[\frac{(1000-2.372)9.81}{1.845*10^{-5}}\right]\left[\frac{(0.00012)^2(.42)^2}{180(1-0.42)}\right]$$

$= 5.42 * 10^{-3}\ m/s$

(d) using an operating velocity of 3 times the min. fluidizing velocity estimate the porosity of the bed

$$U_{mf} = \left[\frac{(\rho_s-\rho)g}{\mu}\right]\left[\frac{e^3 d^2}{180(1-e)}\right]$$

$3* 5.42 * 10^{-3} =$

$e^3 + 0.3832\ e - 0.3832 = 0$

$e = 0.555$