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Prediction of Minimum Semi-Fluidization Velocity (From Minimum Fluidization Velocity) of Irregular Particles in Liquid-Solid Systems by Nomograph

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In an earlier communication(3), the author has given two nomographs for the direct prediction of the minimum and the maximum semi-fluidization velocity for liquid-solid systems. The nomographs have been prepared on the basis of the co-relations developed by the author(2). In a recent communication Roy and Sharma(4) have given a correlation which relates the ratio of the minimum semi-fluidization to the minimum fluidization velocity with the system parameters. The correlation is-:

$$\frac{G_{osf}}{G_{mf}} = 1{\cdot}625 \left(\frac{D_c}{d_p}\right)^{0{\cdot}266} \left(\frac{\rho_s}{\rho_f}\right)^{-0{\cdot}228} \left(R\right)^{0{\cdot}585} \quad \ldots \quad (1)$$

The minimum fluidization velocity can be calculated from Leva's simplified equation(1)

With the help of equation (1), a nomograph has been prepared (fig. 1) for the rapid estimation of the minimum semifluidization velocity ratio with the help of minimum fluidization velocity obtained from equation (2), the actual value of the minimum semi-fluidization velocity can be calculated.

Accuracy of the nomograph

The value obtained from nomograph, has been compared with the respective values obtained by the other two methods, viz., from the equation and the actual experiment. The percentage deviations have also been calculated.

Example :

System : Dolomite-water

Diameter of column (D_c)	......	1·58 inch.
Particle size (d_p)	......	0·0036 ft.
Particle density (ρ_s)	......	172·2 lb/ft³.
Fluid density (ρ_f)	......	62·4 lb/ft³.
Fluid viscosity (μ)	......	0·8 c. p.
Bed Expansion ratio (R)	......	2·5

Calculate and compare the values of minimum semi-fluidization velocity for the above case.

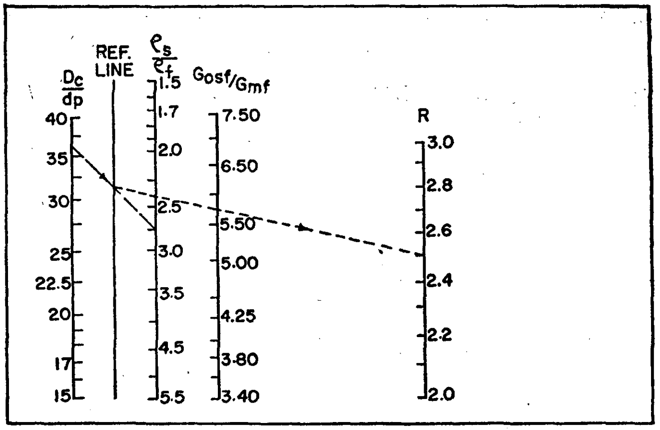

Fig. 1

Prediction of minimum semi-fluidization velocity ratio.

(i) From equation—

$$\frac{G_{osf}}{G_{mf}} = 1{\cdot}625 \frac{(D_c)^{0.266}}{d_p} \frac{(\rho_s)}{\rho_f}^{-0.228} \left(R\right)^{0.585}$$

$$\frac{D_c}{d_p} = 36{\cdot}4$$

$$\frac{\rho_s}{\rho_f} = 2{\cdot}76$$

$$R = 2{\cdot}5$$

$$\frac{G_{sf}}{G_{mf}} = 1{\cdot}625\ (36{\cdot}4)^{0\cdot266}\ (2{\cdot}76)^{-0\cdot228}(2{\cdot}5)^{0\cdot585}$$

$$= 1{\cdot}625\ (2{\cdot}6)\ (0{\cdot}794)\ (1{\cdot}71) = 5{\cdot}74$$

$$G_{mf} = 688\ \frac{d_p^{1\cdot82}\left[\rho_f\left(\rho_s - \rho_f\right)\right]^{0\cdot94}}{\mu^{0\cdot88}}$$

$$= 688\ \frac{(0{\cdot}0036\times12)^{1\cdot82}\ [62{\cdot}4(174{\cdot}2-62{\cdot}4)]^{0\cdot94}}{(0{\cdot}8)^{0\cdot88}}$$

$= 9440$ lbs/hr.ft^2

$G_{osf} = 5{\cdot}74 \times 9440 = 54100$ lbs/hr.ft^2

(ii) From experiment—

$G_{osf} = 53600$ lbs/hr.ft^2

(iii) From nomograph—

$$\frac{G_{osf}}{G_{mf}} = 5{\cdot}70$$

$G_{osf} = 5{\cdot}70 \times 9440 = 53900$ lbs/hr.ft^2

Table I

Comparison of G_{osf} values

G_{osf}	lbs/hr.ft^2		Percentage deviation of nomograph values	
Nomograph	Experiment	Calculation	From experimental value	From calculated value
53900	53600	54100	+0·56	—0·37

Nomenclature

D_c = Inside diameter of column (or semi-fluidizer), L

d_p = Particle diameter, L

G_{mf} = Minimum fluidization velocity, $ML^{-2}\ \theta^{-1}$

G_{osf} = Minimum semi-fluidization velocity, $ML^{-2}\ \theta^{-1}$

h = Height of semi-fluidized bed, L

h_s = Height of initial static bed, L

R = Bed expansion ratio in semi-fluidization, dimensionless, h/h_s.

ρ_s = Density of solid, ML^{-3}

ρ_f = Density of fluid, ML^{-3}

μ = Viscosity of fluid, $M\theta^{-1}\ L^{-1}$

Conclusion

It has been observed that the value of minimum semi-fluidization velocity compare favourably well with those calculated by the equation and also with the experimental values. The deviations have been found to be almost negligible.

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