Nomograph for
the Prediction of Minimum Semi-Fluidization Velocity of Irregular Particles in Gas-Solid Systems

-G. K. Roy*

THE author has earlier (3) given two nomographs tor the direct prediction of minimum and maximum semi-fluidization velocity for gas-solid systems. The nomographs have been prepared on the basis of the correlations developed by the author (C[2]). In a recent communication Roy and Sen Gupta ([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—

$$\frac{G_{osf}}{G_{mf}} = 2.66 \times 10^{2} \left(\frac{D_c}{d_p}\right)^{0.62} \left(\frac{\rho_s}{\rho_f}\right)^{-1} (R)^{0.5}$$

The onset of fluidization velocity can be calculated from Leva's generalized equation (1).

$$G_{mf} = \frac{0.005\, g_c \cdot \rho_f (\rho_s - \rho_f) d_p^{2} \phi_s^{2}}{\mu} \cdot \frac{\epsilon_{pa}^{3}}{(1-\epsilon_{pa})}$$

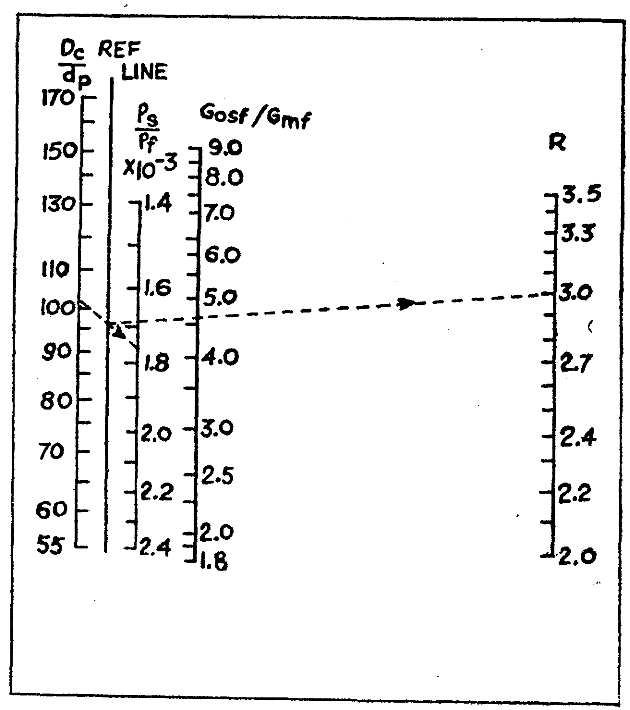
With the help of equation (1), a nomograph has been prepared (fig. 1) for the rapid estimation of the minimum semi-fludization velocity ratio and with the help of minimum fluidization velocity, obtained from equation (2), the actual value of the minimum semi-fluidization velocity can be calculated.

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:	Table salt-air.	
Diameter of column	(D_c) ...	0.045 m.
Particle size	(d_p) ...	0.000442 m.
Particle density	(ρ_s) ...	2100 kg./m³
Fluid density	(ρ_f) ...	1.2 kg/m³
Fluid Viscosity	(μ) ...	0.00018 poise.
Bed expansion ratio	(R) ...	3.0
Fixed bed porosity	(ϵ_{da}) ...	0.588
Sphericity	(ϕs) ...	0.452



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

Solution:

(i) From equation—

$$\frac{G_{osf}}{G_{mf}} = 2.66 \times 10^{2} \left(\frac{D_c}{d_p}\right)^{0.62} \left(\frac{\rho_s}{\rho_f}\right)^{-1} (R)^{0.5}$$

$$D_c/d_p = 101.8$$

$$\frac{\rho_s}{\rho_f} = 1750$$

$$R = 3.0$$

$$\frac{G_{osf}}{G_{mf}} = 2.66\,(10)^{2}(101.8)^{0.62}(1750)^{-1}(3)^{0.5}$$
$$= 4.63$$

*The author is teaching at the Dept. of Chemical Engineering, Regional Engg. College, Rourkela-8 (Orissa.)

Table 1

—Comparison of G_{osf} values—

G_{osf} Kg./hr. m^2			Percentage deviation of nomograph values.	
Nomograph	Experiment	Calculation	From experimental value	From caluculated value.
2260	2275	2275	-0.66	-0.66

$$G_{mf} = 0.005(9.81)(3100)^2(0.000442)^2(1.2) \times (2100-1.2)(0.452)^2(0.588)^3 \div (0.00018)\,10(3600)(1-0.588)$$

$$= 491 \text{ Kg.|hr. m}^2$$

$$G_{osf} = 4.63 \times 491$$

$$= 2275 \text{ Kg|hr. m}^2$$

(ii) From experiment—

$$G_{osf} = 2275 \text{ Kg.|hr. m}^2$$

(iii) From nomograph—

$$\frac{G_{osf}}{G_{mf}} = 4.60$$

$$G_{osf} = 4.60 \times 491$$

$$= 2260 \text{ Kg.|hr. m}^2$$

Conclusion

It is 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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D_c = **Inside diameter of column (or semi-fluidizer), Nomenclature L,**
d_p = **Particle diameter, L**
g_c = **Gravitational constant,** $L\,\theta^{-2}$.
G_{mf} = **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.

Greek letters

ρ_s = **Density of solid,** ML^{-3}
ρ_f = **Density of fluid,** ML^{-3}
μ = **Viscosity of fluid,** $ML^{-1}\theta^{-1}$
ϕ_s = **Sphericity of solid.**
ϵ_{pa} = **Porosity of packed bed.**

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