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 for 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). 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).

With the help of equation (1), a nomograph has been prepared (fig. 1) for the rapid estimation of the minimum semi-fluidization 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 \((\rho_p)\) ... 2100 kg/m³

Fluid density \((\rho_f)\) ... 1.2 kg/m³

Fluid Viscosity \((\mu)\) ... 0.00018 poise.

Bed expansion ratio \((R)\) ... 3.0

Fixed bed porosity \((\varepsilon_{fb})\) ... 0.588

Sphericity \((\phi_s)\) ... 0.452

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

Solution:

(i) From equation—

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

\[
\frac{D_c}{d_p} = 101.8
\]

\[
\frac{\varepsilon_s}{\varepsilon_f} = 1750
\]

\[
R = 3.0
\]

\[
\frac{G_{osf}}{G_{mf}} = 2.66 \times 10^2 (101.8)^{0.62} (1750)^{-1} (3)^{0.5}
\]

\[
= 4.63
\]

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<table>
<thead>
<tr>
<th>$G_{osf}$</th>
<th>Kg./hr. $m^2$</th>
<th>Percentage deviation of nomograph values.</th>
<th></th>
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<tr>
<td>Nomograph</td>
<td>Experiment</td>
<td>Calculation</td>
<td>From experimental value</td>
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<tr>
<td>2260</td>
<td>2275</td>
<td>2275</td>
<td>-0.66</td>
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</table>

$$G_{osf} = 0.005 (9.81)(3100)^2(0.000442)^2(1.2) \times (2100 - 1.2)(0.452)^2(0.588)^3 \div (0.0001610(3600)(1-0.588)$$

\[= 491 \text{ Kg./hr. } m^2\]

$G_{osf} = 4.63 \times 491$

\[= 2275 \text{ Kg./hr. } m^2\]

(i) From experiment—

\[G_{osf} = 2275 \text{ Kg./hr. } m^2\]

(ii) From nomograph—

\[G_{osf} = 4.60\]

(iii) From calculation—

\[G_{osf} = 4.60 \times 491\]

\[= 2260 \text{ Kg./hr. } m^2\]

**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.

**Acknowledgement**

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**REFERENCES**


**Greek letters**

$\varepsilon_s$ = Density of solid, $\text{Ml.}^{-3}$

$\varepsilon_f$ = Density of fluid, $\text{Ml.}^{-3}$

$\mu$ = Viscosity of fluid, $\text{Ml.}^{-1}\text{g}^{-1}$

$\phi_s$ = Sphericity of solid.

$\varepsilon_{pa}$ = Porosity of packed bed.

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