SHORT COMMUNICATIONS

PREDICTION OF SEMIFLUIDIZATION VELOCITY AND PACKED BED FORMATION FOR HETEROGENEOUS MIXTURES IN LIQUID-SOLID SYSTEMS

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Introduction

Semifluidization is a new type of solid-fluid contacting technique, which has been reported in the last decade only. It is claimed to be a compromise between the packed and the fluidized bed operations and can be achieved in a conventional fluidizer by incorporating certain modifications to the column construction. The special features of such a bed have been reported in literature".

A glance into semi-fluidization literature reveals that various aspects of liquid-solid semi-fluidization viz.. the prediction of minimum and maximum semi-fluidization velocities[6-7], packed bed formation[2,3,8] 'and pressure drop" have been exhaustively investigated for closed-cut particles. But information as regards the semi-fluidization behaviour of mixed particles system is very limited[10]. Of late, two correlations have been suggested by one of the authors (Roy) for the prediction of minimum and maximum semi-fluidization velocities[11,12] for heterogeneous mixtures in liquid-solid systems. In this communication a correlation has been proposed for the prediction of semi-fluidization velocity in terms of a few dimensionless groups which influence the system. This will be of practical applicability in determining the relative distribution of particles in the fixed and fluidized sections of a semi-fluidized bed.

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Experimental Procedure

The experimental set-up used and the procedure followed in the present study has been described in

Table 1 Characteristics of mixtures and ranges of variables studied

Particle size: 36/44 BSS Mixture ratio: 50: 50 binary

Sl. No.	Mixture components	Mixture nomenclature	$(\rho_s)_{av}$ [kg/m³]	h_s [cm]	R
1.	Dolomite-chromite	D-C	3.21×10^3	6.0, 8.0 10.0, 12.0	2.0, 2.5 3.0, 3.5
2.	Dolomite-baryte	D-B	3.45×10^3	6.0	"
3.	Dolomite-iron ore	D-I	3.67×10^3	6.0	"
4.	Iron ore-chromite	I-C	4.34×10^3	6.0	"
5.	Iron-ore-baryte	I-B	4.80×10^3	6.0	"

detail elsewhere[10].

Results and Discussions

Altogether 32 sets of runs have been taken using five different 50:50 binary mixtures of dolomite, chromite, iron ore and baryte particles of 36/44 BSS size. Characterstics of mixtures and ranges of variables studied are given in Table 1.

Prediction of semi-fluidization velocity and packed bed formation: Based on experimental investigations, Roy has given the following correlation for the prediction of semifluidization velocity for pure components in c."se of liquid-solid systems[1]".

$$\frac{G_{sf}}{G_{msf}} = 0.925\left(\frac{D_c}{d_p}\right)^{-0.35}\left(\frac{\rho_s}{\rho_f}\right)^{-0.12}(R)^{0.43}\left(\frac{h_{pa}}{h_s}\right)^{0.32} \quad (1)$$

G_{msf} in the above equation has been calculated by[13)]

$$G_{msf} = 1.85 \times 10^4 \frac{d_p^{0.65}[\rho_f(\rho_s - \rho_f)]^{0.55}}{\mu_f^{0.10}} \quad (2)$$

The particle density in the above equations has been replaced by $(\rho_s)_{av}$ for the mixtures and this has been calculated as—

$$(\rho_s)_{av} = \frac{\sum W}{\sum(W/\rho_s)} \quad (3)$$

With the help of Eqs. (l)-(3), values of semi-fluidization velocity can be calculated for desired packed bed formations. On the other hand, the same equations can also predict the relative distribution of particles in the two regimes of operation viz. the packed and the fluidized zones for a definite semi-fluidization velocity.

The values of semi-fluidization velocity calculated from above have been compared with the experimental values. It is observed that excepting a few cases all, the deviations lie within +10.0 to -25.0%. The mean and standard deviations for a set of 165 values have been found to be 8.40 and 9.71 % respectively. Further it is found that in most, of the cases experimental values are higher than the calculated ones. (Fig. 1) This is due to the fact that in case of calculation, average values of density have been used for the mixtures, whereas in actual semi-fluidization experiment with heterogeneous mixtures the lighter components will reach the top restraint earlier, thereby indicating lower calculated values, as the semi-fluidization velocity ratio $(G_{sf}/G_{msf}$ is inversely proportional to the particle density (fluid density remaining constant). In the second phase of the phenomenon, while dealing with the heavier components at higher fluid mass velocities, the effect of compaction of the top packed bed becomes more prominent as compared to the density effect. Hence, for a required lop formation actual (experimental) values of semifluidization velocity will be higher than those calculated by the equations: However, the correlation for pure components with density modification is useful for the prediction of either the semi-fluidization velocity or the packed bed formation for solid binaries.

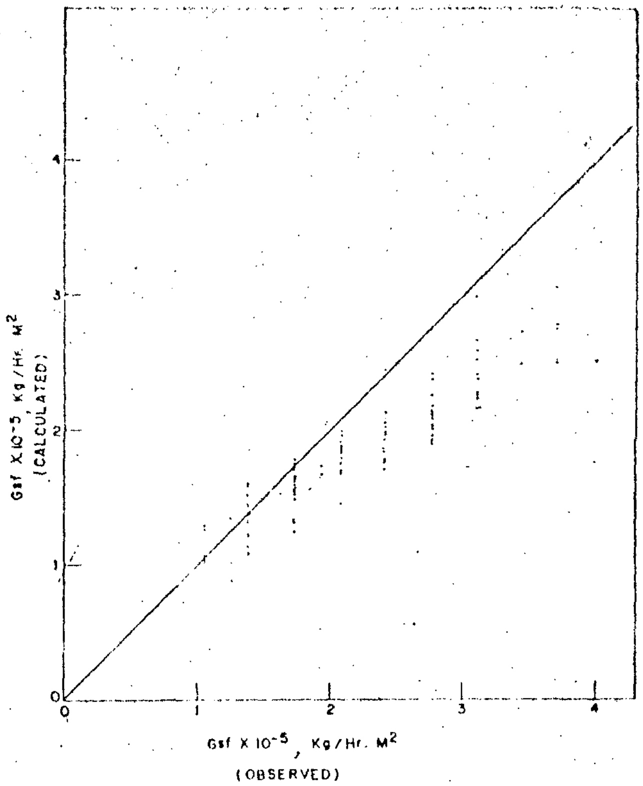

Fig. 1 Comparison of semifluidization velocity for heterogeneous mixtures

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Nomenclature

B. S. S. = British Standard Sieve
D_c = diameter of the semifluidized particle [L]
d_p = particle diameter [L]
G_{msf} = maximum semi-fluidization mass velocity $[ML^{-2}\cdot\theta^{-1}]$

G_{sf}	=	semi-fluidization mass velocity	[[illegible] $\cdot\theta^{-1}$]
h	=	height of semi-fluidized bed	[L]
h_{pa}	=	height of packed section in semi-fluidization	[L]
h_s	=	height of initial static bed	[L]
R	=	bed expansion ratio in semi-fluidization, h/h_s	
$W_1, W_2 ..$	=	weights of components of the mixture	[M]
ρ_s	=	density of particles	$[ML^{-3}]$
$(\rho_s)_{av}$	=	average (weighted) density of the mixture	$[ML^{-3}]$
ρ_f	=	density of fluid	$[ML^{-3}]$
μ_f	=	viscosity of fluid	$[ML^{-1}\cdot\theta^{-1}]$

Literature Cited

1) Fan, L. T., Y. C. Yang and C. Y. Wen: *AIChE J.*, 5, 407 (1959).
2) Fan, L. T. and C. V. Wen: *ibid.*, **7,** 606 **(1961).**
3) Fan, L. T., S.C. Wang **and C.Y. Wen:** ***ibid., 9,*** **316(1963).**
4) Kurian, J. and M. Raja Rao: ***Indian J. Technol.,*** **8, 275** "(1969).
5) Poddar, S. K. and D. **K. Dutt:** ***Trans. Indian.Inst. Chem.*** *Engrs.,* **11,** 80(1969).
6) Roy, G. **K.** and **K. J. R. Sarma:** ***Chem. Eng. J.,*** **4, 294** (1972).
7) idem: *J. Inst. Engrs.* ***(India),*** **54, 34 (1974).**
8) idem: *Chem. Process and Eng.,* **5, No. 6, 23 (1971).**
9) idem: *Indian Chem.* ***Engr.,*** **14, 4,90(1974).-**
10) **Roy, G. K.** and **J. Dash:** ***Indian Chem. J.,*** **No. 1, 23 (1976).**
11) Roy, **G. K.** and **Sharat Chandra:** ***Chem. Eng. J.,*** **12, 77** (1976).
12) idem: *Trans. Indian Inst.* ***Chem. Engrs.,*** **communicated.**
13) Roy, G. **K.: Ph. D. Thesis, Sambalpur Univ., India (1975).**