Impact of Particle Shape and Continuous Particle Size Distribution on Minimum Pickup Velocity in Pneumatic Conveying Processes

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Pneumatic conveying is an important particle transport operation in many industries spanning pharmaceutical, oil and gas, agro-processing, etc. The knowledge of minimum pickup velocity (U_{pu}), defined as the gas velocity at which particle starts to entrain from a static bed, is essential in pneumatic transport to ensure operation of at optimal capacities and minimal energy costs.

Due to a lack of understanding of particle shape effects and polydisperse flows, processes employing particulate flows often operate below design capacity and exhibit undesired flow behavior. Previous work has largely focused on spherical particles, and monodisperse or binary mixtures (two particle species which vary in size and/or density) to characterize U_{pu}[1,2]. Relatively little work has been performed, however, for angular particles and continuous particle size distributions (PSDs), despite their practical importance.

In this study, the effect of (i) particle sphericity and (ii) the widths of continuous PSDs on U_{pu} have been investigated via the modified weight loss method. Regarding (i), the U_{pu} values of glass beads (spherical) and plastic and aluminum oxide (non-spherical) of the same Sauter mean diameter (d_{sm}) were compared. Results indicate that the effect of particle sphercity is non-negligible, especially for wider PSDs. As for (ii), U_{pu} values were measured for varying widths of lognormal PSDs with a fixed (d_{sm}). Results reveal a surprising non-monotonic trend in the variation of U_{pu} with respect to the width of the lognormal distribution.

Keywords: Pneumatic conveying, minimum pickup velocity, lognormal particle size distribution, shape factor

References

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