Fluidization Regime Mapping Analysis for 200 µm Glass Beads in a Circulating Fluidized Bed Riser

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One of the most difficult challenges faced when trying to apply process information obtained from fluidization and hydrodynamic testing in small scale circulating fluidized beds to larger pilot or commercial scale units is identifying the correct scaleup methodology. Historically, there have been several approaches that have met with varying levels of success, including similarity methods that rely on defining and matching the values of dimensionless numbers involving different length scales.

Recent efforts by Breault et al. [1, 2] have focused on developing a method utilizing a dimensionless regime map incorporating use of two dimensionless ratios: U_g/U_{tr2} – the ratio of the superficial gas velocity to the upper transport velocity, and Gs /Gs* - the ratio of the solids circulation rate to the saturation carrying capacity of the fluidizing gas. These recent efforts have led to the development of more accurate correlations for the Gs* as a function of riser diameter for both Geldart A- and Geldart B-type particles.

Utilizing these newly developed correlations for Gs*, experimental data for 200 micron glass beads obtained from fluidization experiments previously conducted in the 12-inch (0.3m) diameter cold flow circulating fluidized bed (CFCFB) unit at the National Energy Technology Laboratory's (NETL) Morgantown, WV site have been revisited via addition to the recently developed dimensionless regime map. The resulting regime map illustrates that the tests conducted covered a range of fluidization regimes, including the dilute upflow, core annular flow, and fast fluidization regimes.

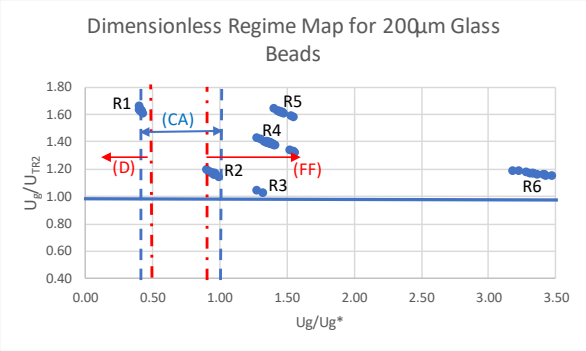

Figure 1: Dimensionless regime map for 200 micron glass beads showing test point regions (R1-R6), and approximate boundaries for dilute flow (D), core-annular flow (CA), and fast fluidization (FF) regime boundaries.

This paper presents a review of the resulting dimensionless regime map (figure 1) as well as analysis of radial solids fraction profiles obtained from fiber optic probes within these different fluidization regimes. As evidenced in figure 2, the resulting solids fraction profiles exhibit a strong dependence upon the Gs/Gs* value.

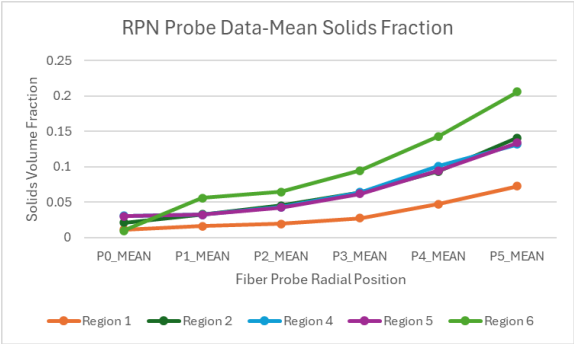

Figure 2: Solids volume fraction radial profiles for the "RPN" fiber optic probe.

References

[1] R. W. Breault, J. Weber and J. Yang, "Saturation carrying capacity Group B particles in a circulating," *Powder Technology,* pp. 442-451, 2021.

[2] R. W. Breault, "Scaling CFB risers: Maintaining microstructure dynamics," vol. 415, 2023.