Review of Cluster Characteristics in Gas-Solid Fluidized Bed Systems

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The phenomenon of particle clustering in gas-solid fluidization system has been recognized in 1948 [1], but only received more attention from researchers in the last two decades [2]. Clusters, which are thermodynamically unstable groups of loosely agglomerated particles, result from hydrodynamic effects [2, 3]. The presence of clusters in a fluidized bed system can alter the flow patterns in the fluidization column and affect system performance (namely, reaction rate, heat transfer, elutriation rate, etc), which hence warrants the need for better understanding of the clustering phenomenon [4]. Unfortunately, efforts targeted at enhanced understanding of clusters are hampered by apparent contradictions among experimental results. Therefore, this work aims at a comprehensive review of the available experimental data on clusters to provide a more complete landscape of the clustering phenomenon, thereby shedding light on the dominant underlying physics.

Accordingly, analysis of the cluster frequency trends available of Geldart Group B particles was carried out. Several interesting results are worth highlighting here: (1) Monodisperse and polydisperse (i.e., continuous particle size distributions) systems exhibit higher cluster frequency compared to binary (i.e., two particle species of different size and/or density) systems. (2) Cluster frequency increases with particle size and particle density, with the latter having a more prominent impact. (3) Higher superficial gas velocity and/or lower particle loading increases cluster frequency only for denser systems but not for dilute ones.

Keywords: Cluster; Cluster Frequency; Dense CFB Riser; Dilute CFB riser; Geldart Group B

References

1. Wilhelm, R.H. and M. Kwauk, *Fluidization of Solid Particles.* Chemical Engineering Progress, 1948. **44**(3): p. 201-218.
2. Horio, M. and R. Clift, *A Note on Terminology - Clusters and Agglomerates.* Powder Technology, 1992. **70**(3): p. 196-196.
3. Fan, L.S. and C. Zhu, *Principles of Gas Solid Flows*. 1998, New York: Cambridge University Press.
4. Chew, J.W., et al., *Cluster characteristics of continuous size distributions and binary mixtures of Group B particles in dilute riser flow.* Chemical Engineering Journal, 2011. **178**: p. 348-358.