

Non-Dimensionalization and Three-Dimensional Flow Regime Map for Fluidization Analyses

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ABSTRACT

This article is on the dimensional analysis and the classification of fluidization from the viewpoint of numerical analysis. At first, the governing equations used in the DEM (Discrete Element Method) and CFD (Computational Fluid Dynamics) coupling model were non-dimensionalized with the method of Hellums and Churchill (1964). From the resulting dimensionless equations, it was concluded that the five dimensionless numbers, i.e. Re : Reynolds number, Ar : Archimedes number, Ga : Galilei number, Fr : Froude number and ρ^{\oplus} : ratio of particle density divided by fluid one, can be derived and hydrodynamically dominant on the fluid behaviors. Further, these can illustrate the dimensionless numbers proposed in the previous studies. Secondary, a three-dimensional flow regime map of homogeneous, bubbling and turbulent fluidizations was proposed with these dimensionless numbers using the DEM–CFD simulations. Finally, the plane of Reynolds number, $Remb$ at the minimum bubbling fluidization velocity, umb in the map can be proposed and expressed as, $Remb = 0.263 \rho^{\oplus} - 0.553 Ar^{0.612}$. umb can be estimated using this equation for various conditions.

KEYWORDS: Fluidization; Flow regime; Dimensionless number; Non-dimensionalization; Similarity rule; DEM (discrete element method)

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