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Decreasing Computational Load by Using Similarity for Lagrangian Approach to Gas-solid Two-phase Flow

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Abstract

Gas-solid two-phase flow constitutes a continuous-discrete phase system. It is natural to employ the Lagrangian approach to numerically analyze the discrete phase (solid particles); However the computational load becomes very heavy, when the number of particles increases. In this paper, we employ similarity rules to decrease the computational load. An imaginary system with imaginary gas and particles is used to describe the real gas-particle system. Each imaginary particle with a diameter K times of that of the real particle, replaces a group of real particles. By dimensionless analysis of the conservation equations of gas-solid two- phase flow, it is show that the solution of the imaginary system is similar to that of the real system, if the physical properties of the imaginary system are adjusted such that Reynolds number Re and Archimedes number Ar euqal those of the real system. Enlarging the imaginary particles by a factor K can decrease the number of particles and hence the computational load by a factor of $K^{-4.5}$.
In order to validate the similarity rules, the behavior of a bubble in a fluidized bed is simulated with various factors K. It is shown that the similarities show reasonable accuracy.

Nomenclature

$$Re = \frac{|V-U|\rho_f \varepsilon D_p}{\mu_f}$$

$$Ar = \frac{D_p^3 \rho_f (\rho_p - \rho_f) g}{\mu_f^2}$$

D_p	particle diameter	ε	void fraction
g	gravity acceleration	ρ_f	gas density
U	particle velocity	ρ_p	particle density
V	gas velocity	μ_f	gas viscosity

Key words: Similarity, Lagrangian approach, computation load, two-phase flow simulation