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Discrete Particle Simulation of Dense Phase Particle-Gas Flows

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Abstract

First, methods of numerical analysis of gas-particle flows are classified into several approaches based on the length scales; micro, meso and macro scales. Then, the author focuses on particle-micro and gas-meso approach where instanteous motion of individual particles is calculated using the Newtonian equations of motion and motion of gas is calculated using the Navier-Stokes equation with the concept of local averaging. This particle-micro apporach is called discrete particle simulation. The author notes the cases where particle- to-particle interaction has significant effects on the over all phenomena. Concerning the particle-to-particle interaction, two cases are considered: the one is collision-dominated flows and the other is the contact-dominated flows. To treat this interaction mathematically, techniques named DEM (Distinct Element Methjod) and DSMC (Direct Simulation Monte Carlo) have been developed. DEM, which has been developed in the field of soil mechanics, is useful for the contact -dominated flows and DSMC method, developed in molecular gas flows, is for the collision-dominated flows. Combining DEM or DSMC with CFD (computer fluid dynamics), the discrete particle simulation becomes a very practical tool for industrial flows because not only the particle-particle interaction but particle-fluid interaction can be handled. As examples of simulations, various results are shown, such as hopper flows, particle segregation phenomena, particle mixing in a rotating drum, dense phase pneumatic conveying, spouted bed, dense phase fluidized bed, fast circulating fluidized bed and so on.