

Multiphase CFD Simulation of Fluidized Beds with Lagrangian Particle Tracking

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Fluidized bed reactors are widely used in chemical and process industries due to their excellent heat and mass transfer characteristics. Accurate numerical modeling of particle-fluid interactions inside fluidized beds remains a significant challenge because of the complex multiphase flow behavior involved. This work aims to investigate the hydrodynamics of gas-solid fluidized beds using Computational Fluid Dynamics (CFD) coupled with Lagrangian particle tracking techniques.

The study focuses on resolving particle motion, particle-fluid interactions, and flow structures within a fluidized bed system under varying operating conditions. A coupled Eulerian-Lagrangian framework is considered, where the gas phase is treated as a continuous medium while solid particles are tracked individually using a Lagrangian approach. The simulations are intended to provide insight into bubble formation, particle circulation, mixing behavior, and local velocity distributions. The numerical framework is expected to contribute toward improved understanding of multiphase transport phenomena and optimization of industrial fluidized bed operations.

The work is currently in progress, and preliminary simulation setup and model development are being carried out using high-performance computing resources. Future results are expected to support the development of more efficient and reliable fluidized bed reactor designs for applications in chemical engineering, energy systems, and sustainable process technologies. In particular, the developed framework will be extended toward the reduction of metallic particles in reactive gas-solid environments, enabling the study of process intensification in metallurgical and sustainable energy conversion systems.