An Immersed Boundary Method for Flow Simulations Around Stationary and Moving Rigid Particles

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An immersed boundary method for flow simulations around stationary and moving rigid particles

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Solid-fluid systems occur in many technological applications where intense contact between both phases is expected. The overall performance of these equipments strongly depends on the hydrodynamics of multiphase mixtures. Hydro-dynamical interactions of particles in these disperse solid-fluid systems are one of the key point for prediction of flow behavior in process apparatuses or for correct design of industrial technologies. Although chemical engineering is in its base experimental branch, in present time mathematical modeling becomes very useful tool for solving many problems. Numerical simulations can test theoretical predictions in cases where real experiments are not feasible or are very expensive.

In this contribution we propose hydrodynamics simulations of incompressible viscous flow around rigid particles. The hydro-dynamical interactions between moving bodies and fluid were calculated by using multi-direct forcing scheme and the immersed boundary method. In this way, fixed uniform Cartesian mesh can be used and the no-slip boundary conditions are well satisfied [1, 2]. According to Peskin [3] spatial discretization of the immersed boundary formulation is based on a fixed Cartesian mesh for the Eulerian variables, and a moving curvilinear mesh for Lagrangian variables. The two types of variables are linked by interaction equations that involve a smoothed approximation to the Dirac delta function.

For verifications and validations of presented method two-dimensional simulations of fluid flow over stationary cylindrical particle were used for different Reynolds numbers. The drag and lift coefficients were evaluated and compared with results of benchmark experiments.

The main aim of this work was study of the particles motions and interactions by the evaluation of particles positions, velocities and accelerations. It was shown that immersed boundary method is able to successfully describe interactions between particle and fluid, the interactions between particle and particle and interactions between particle and wall. The results were quantitative compared with other studies.

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Literature:

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