Mass decaying algorithm in multiphase SPH for the modelling of the sedimentation in a turbulently convecting flow

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ABSTRACT

The settling of particles (we refer to them collectively as dust) in the presence of turbulence is of great interest and importance in many turbulent flow problems. The particles are stirred by the turbulence but they can sediment close to the bottom boundary where the no-slip boundary condition drives the particle velocity to zero. The layer of sediment is normally very thin, and to simulate it correctly requires a very large number of particles. To escape this problem we introduce a new SPH algorithm based on the idea that the boundary forms a sink. The continuum version of the continuity equation therefore has an extra sink term that can be interpreted in an SPH formulation by allowing the SPH dust particles to lose mass in the neighbourhood of the sedimenting boundary. The complete algorithm involves representing the liquid (there may be several liquids) by SPH particles and the dust by a fluid that is itself represented by SPH dust particles. This algorithm enables us to simulate the sedimentation in the presence of turbulence without resolving the thin boundary layer.

The turbulence in this work was produced by using (1) a mechanical stirrer, and (2) a stochastic stirrer so called Ornstein-Uhlenbeck (OU) process. From the result, we verified that the mass decaying algorithm simulates turbulent settling very well regardless of the way the turbulence is driven. The results agreed well with the theoretical model by Martin and Nokes (1989). Given the similarity between the mass decaying model and a general chemical reaction kinetics, the basic concept of this particle mass changing approach can be extended to a generalized reactive transport modelling using SPH.

REFERENCES

[1] D. Martin, R. Nokes, “A Fluid-Dynamical Study of Crystal Settling in Convecting Magmas” Journal of Petrology, 30, 1471-1500 (1989)