Sorting grains by successive depositions computed using an unresolved FEM-DEM multiscale model

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ABSTRACT

Fluid-grains mixtures or *immersed granular flows* are increasingly used in many industrial processes requiring simulations to be calibrated. There exists a lot of numerical models able to compute immersed granular flows depending on the scale at which the continuous and discrete phases are computed [1]. This submission is devoted to the use of an unresolved stabilized finite element-discrete element methods to compute the hydraulic sorting of grains. The grains are considered at their scale as rigid bodies and contacts are solved on a fixed time step using the non-smooth contact dynamics method giving forces, positions and contact network of the solid phase over time. The fluid is computed at a greater scale than the grains scale by solving Navier-Stokes equations in which the point variables are averaged by the fluid volume fraction over a representative volume. The fluid-grains interaction containing the drag force component constitutes the closure relation of the multiscale model and is based on an empirical formula. The neighbours influence on the drag force applied on a grain is taken into account by the use of an independent function of the fluid volume fraction.

A stabilized finite element method using equal-order interpolations for the fluid pressure and velocity fields is used to maintain the efficiency and the speed of this multiscale model. Pressure-stabilizing/Petrov-Galerkin (PSPG) and streamline-upwind/Petrov-Galerkin (SUPG) terms are introduced in the average Navier-Stokes equations in order to smooth spurious modes appearing in the pressure and the velocity fields.

This multiscale model has been implemented in an open-source software[1] and successfully validated by comparing the experimental results of settling Stokes clouds with simulations [2]. It will now be used to compute and study the sorting of grains by successive depositions. Grains are encased in a box containing water. Then more fluid is pushed periodically inside the box from the base. The grains are suspended before settling. Suspending and settling velocities depend on the density and geometrical properties of the grains so that is is possible to sort the grains according to their composition. A sensitivity analysis will be performed to find the set of parameters providing the optimal sorting.

REFERENCES

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