

EXTENSION OF THE LS-STAG METHOD FOR SIMULATING TWO-PHASE NON-NEWTONIAN FLUID-AIR FLOWS

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Keywords: *Cut-Cell method, Granular Flows, Two-phase Flows, non-Newtonian Fluids*

The “PowderReg” project is a collaborative project between various universities (Université de Lorraine, Saarland University, Université de Liège, Université du Luxembourg, University of Kaiserslautern) whose focus is the optimization of industrial processes for the treatment of granular materials. The primary objective of the “PowderReg” project is the development of a versatile and efficient CFD solver based on a non-Newtonian continuum modeling of the granular materials [1] for simulating industrial processes that most often involve free-surfaces in complex 3D geometries. One of the distinctive features of the project is to propose a sharp and unified numerical treatment of the fluid-air and fluid-solid interfaces based on the LS-STAG cut-cell method [2] that has been developed initially for single-phase flows of non-Newtonian fluids in 3D extruded complex geometries.

As an intermediate step towards this objective, this talk presents an extension of the LS-STAG solver for simulating two-phase non-Newtonian fluid-air flows. Our numerical method is based on the "one-fluid" approach and the level-set method [3] is used for capturing the fluid-air interface. In the vicinity of the interface, the computation of the local viscosity relies on the use of special averaging formulas that will be discussed in details.

Our numerical method is validated for the well-documented flow past a circular cylinder below a free-surface and applied to the granular flow down an inclined and vibrated plane for which our group has recently provided accurate PIV measurements [4].

References

- [1] S Kiesgen de Richter, Caroline Hanotin, Philippe Marchal, Sébastien Leclerc, Franck Demeurie, and N Louvet. Vibration-induced compaction of granular suspensions. *The European Physical Journal E*, 38(7):74, 2015.
- [2] Farhad Nikfarjam, Yoann Cheny, and Olivier Botella (in press). The LS-STAG immersed boundary/cut-cell method for non-newtonian flows in 3D extruded geometries. *Computer Physics Communications*, 2018.
- [3] S. Osher and R. P. Fedkiw. *Level Set Methods and Dynamic Implicit Surfaces*. Springer, New-York, 2003.
- [4] Naïma Gaudel, Sébastien Kiesgen de Richter, Nicolas Louvet, Mathieu Jenny, and Salaheddine Skali-Lami. Bulk and local rheology in a dense and vibrated granular suspension. *Physical Review E*, 96(6):062905, 2017.