Fully implicit time integration in truly incompressible SPH

Manuel Hopp-Hirschler*

* Institute of Chemical Process Engineering, University of Stuttgart
70199 Stuttgart, Germany
e-mail: manuel.hopp@icvt.uni-stuttgart.de, web page: http://www.icvt.uni-stuttgart.de

ABSTRACT

In the last years, the Smoothed Particle Hydrodynamics (SPH) method was introduced in new fields of engineering applications where highly viscous flow like polymer flow or very small geometries, like in micro-flow, are involved [1]. In most of these applications it was not possible to use realistic fluid parameters, larger simulation domains or higher resolution because of the restriction of the time step due to the viscous time step criterion of the explicit time integration scheme. The computational effort was too high even for highly scalable SPH codes. Similar issues exist in shock wave or solid-state mechanics modelling.

In this talk, we present a first order implicit time stepping scheme for multi-phase flow based on truly incompressible SPH (ISPH), where the pressure is estimated using a Pressure Poisson Equation (PPE). The aim is to eliminate the viscous time step criterion. We propose a consistent time stepping approach where both velocity and particle position are solved implicitly and compare the results to traditional semi-implicit ISPH and implicit schemes where only velocity is integrated implicitly [2]. We present a study for simple Poiseuille flow and Rayleigh-Taylor instability. Energy conservation is investigated using a Taylor-Green.

We found that the fully implicit time integration scheme is numerically stable. Since no error estimation of accuracy is used, the larger time step size leads to deviations of the trajectories. In future work, higher-order time integration schemes as well as error estimators will be investigated.

REFERENCES

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