Handling the numerical viscosity of contact SPH method at modelling compressible flows

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The smoothed particle hydrodynamics (SPH) with the Riemann problem solution on interparticle contacts [1] is widely used to model compressible flows with discontinuities. This approach does not require artificial viscosity to stabilize a solution in the vicinity of the discontinuity: stable and monotonous solutions are provided due to the significant viscosity of the numerical Godunov-like scheme itself. The latter can exceed the physical viscosity of real fluids by several orders of magnitude, which distorts simulations too much. For this reason, it is necessary to reduce the numerical viscosity of SPH to obtain more realistic flows [2].

In this study, a new explicit approach to handle the numerical viscosity of SPH is proposed. It is found that the numerical viscosity is a unique function of the acoustic impedance of a material and the particle size. In addition, the smoothing length and the kernel function can also affect the numerical viscosity of SPH. We consider several test problems with and without viscosity correction and compare simulation results with the corresponding analytical solutions. It is shown that the applied viscosity correction allows to model viscous flows that correspond to those of real fluids at arbitrary particle sizes.

[1] Parshikov A and Medin S 2002 *J. Comp. Phys.* **180** 358

[2] Yanilkin Y V, Toporova O O, Stadnik A and Korzakova L E *About the approximate viscosity of numerical schemes and simulations of viscous flows* (Sarov, RFNC–VNIIEF: High performance computing and mathematical modelling (in russian))