# MODELING OF AXISYMMETRIC FLOWS BY THE CONTACT SMOOTHED PARTICLE HYDRODYNAMICS (SPH) METHOD WITH KERNEL GRADIENT CORRECTION

*G. D. Rublev, A. N. Parshikov, S. A. Dyachkov*

Federal State Unitary Enterprise "N. L. Dukhov All-Russian Research Institute of Automatics", Moscow, Russia

Joint Institute for High Temperatures of RAS, Moscow, Russia

The contact smoothed particle SPH (CSPH) method [1–2] is widely used for modeling multi-material flows of liquids, gases and solids with large deformations of contact boundaries, free surfaces, as well as with loss of substance continuity. The CSPH method is well established in the above class of problems. To increase accuracy, in classical schemes (with artificial viscosity) of the SPH method, gradient correction of the smoothing kernel is often applied [3]. However, for Godunov-type SPH methods such as CSPH and MUSCL-SPH, a way to introduce such a correction (TKC) has been developed only recently [4–5].

Another possible way to improve the modeling results is to increase the number of SPH-particles. In the three-dimensional case, increasing the number of particles is computationally expensive. Some problems allow a switch to modeling in two-dimensional axisymmetric formulation, which allows us to significantly reduce the total number of particles in the computational domain, as well as the average number of neighboring particles at high accuracy of spatial discretization.

A conservative axisymmetric contact smooth particle method with a smoothing kernel correction is developed. The capabilities of the new method are demonstrated on such problems as Riemann problem in ideal gas (see Fig. 1), Taylor bar test and barrier penetration.

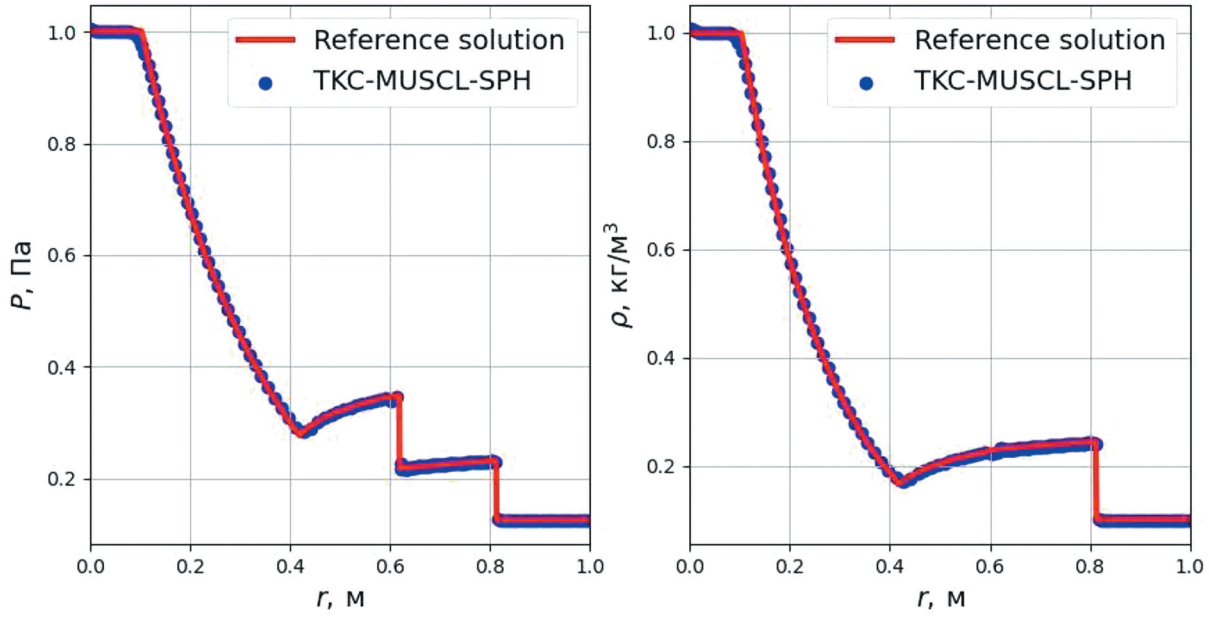


Fig. 1. Axisymmetrical Sod's test: comparison of modeling results by axisymmetric TKC-MUSCL-SPH method with the reference solution obtained by the grid method

## References

1. **Parshikov, A. N.** Application of a solution to the Riemann problem in the SPH method [Text] // Zh. Vychisl. Mat. Mat. Fiz. – 1999. – Vol. 39. – No. 7. – P. 1216–1225.

2. **Parshikov, A. N.** Smoothed Particle Hydrodynamics Using Interparticle Contact Algorithms [Text] / A. N. Parshikov, S. A. Medin // Journal of Computational Physics. – 2002. – Vol. 180. – No. 1. – P. 358–382.

3. **Oger, G.** An improved SPH method: Towards higher order convergence [Text] / G. Oger и др. // Comput. Methods Appl. Mech. Engrg. – 2007. – Vol. 225. – P. 1472–1492.

4. **Rublev, G. D.** Improving approximation accyracy in Godunov-type smoothed particle hydrodynamics methods [Text] / G. D. Rublev, A. N. Parshikov, S. A. Dyachkov // Applied Mathematics and Computation. – 2024. – Vol. 488.
5. **Рублев, Г. Д.** Моделирование прохождения ударной волны через пористую медь с помощью метода подвижного окна для сглаженных частиц с корректировкой градиента сглаживающего ядра [Текст] / Г. Д. Рублев, С. А. Мурзов // ВАНТ, Сер. «Математическое моделирование физических процессов». – 2025.