Two-level Schemes for Solving Transient Problems of Barotropic Fluid

Petr Vabishchevich
Nuclear Safety Institute of RAS, Moscow, Russia
vabishchevich@gmail.com

Abstract

Transient flows of a compressible inviscid fluid are simulated [1]. The Euler equations system includes the scalar advection equation for the fluid density and the vector advection equation for velocity. It is assumed that the pressure depends on the density in a power-law manner. A new possibility in using the advection-reaction equation for the pressure instead of the standard equation of state is highlighted. To construct approximation in space, standard Lagrangian methods [2] are used for the density and cartesian velocity components. The focus is on constructing discretization in time [3]. For implicit approximations, the property of mass conservation is exactly inherited whereas the property of the total mechanical energy conservation is fulfilled only approximately. A nonlinear discrete problem at a new time level is solved numerically using Newton's iteration method. An iterative linearized scheme is constructed. At each iteration, the linearization is carried out over the convective transport field. Such schemes belong to the class of decoupling schemes, where splitting with respect to physical processes is implemented. Namely, individual problems for the density and velocity are solved separately. The theoretical analysis is supplemented by the results of numerical experiments. Time-evolution of a 2D layer of a compressible fluid being initially at rest is predicted after a density perturbation in a square computational domain.

References

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