Finite element approximation of density-dependent flows

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Abstract

The density-dependent Navier-Stokes equations describe the motion of incompressible viscous flows with variable density. In its most elementary form, it consists of the classical Navier-Stokes equations, and a convective equation to govern the dynamics of the fluid density. This model becomes more complicate when describing the motion of a viscous fluid with two different densities governed by Fick's law. Then new stress tensors come into play in the momentum system, and the density equation is now a convective-diffusion equation.

The numerical approximations are based on low-order finite elements applied to a modified variational formulation of the problem. We will present the most elementary time-stepping schemes which decouples the computation of the velocity-pressure pair from the density. Convergence is established by compactness arguments and error estimates under appropriate regularity hypotheses. Afterwards, we will show some numerical experiments to validate the proposed numerical approximations.