Numerical issues in the simulation of variable-density flows
dd LEE SHUNN, FRANK HAM, PARVIZ MOIN, Stanford University — The interaction
of variable-density flow-solvers and tabulated state-relationships is explored in the
context of combustion and mixing problems. Numerical issues arising from the in-
consistent evaluation of density in hydrodynamic simulations are highlighted and
discussed. Particular attention is given to the strong coupling that occurs between
density, velocity, and pressure in low-Mach number, incompressible flow-solvers. The
implications for turbulence and combustion models resulting from numerical com-
plications surrounding this coupling are briefly outlined. An adaptive method that
utilizes optimized quadrature-rules over tetrahedral volumes to reliably enforce the
equation-of-state in variable-density simulations is developed. The new method is
shown to mitigate many of the undesirable artifacts previously observed. A sum-
mary of the costs and benefits associated with the adaptive method is given. The
method is applied to the large-eddy simulation of a three-dimensional buoyant he-
lium plume, and the simulation results are compared with experimental data and
previous computations.

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