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A Fully Implicit, Conservative, Front Tracking Method for All-Speed Multi-fluid Flows ROBERT NOURGALIEV, VINCENT MOUSSEAU, DANA KNOLL, Idaho National Laboratory — A novel front-tracking method is developed for simulation of compressible all-speed multi-fluid flows. The prominent features of our method are: *a*) it is *fully implicit*, based on Jacobian-Free Newton-Krylov (JFNK) framework, opening the possibility to efficiently simulate multi-physics problems with a wide spread in time scales; *b*) it is *fully conservative*, even near the contacts, without any adverse consequences with pressure/velocity oscillations; *c*) hybridization of the Eulerian treatment in the bulk-fluid with the semi-Lagrangian treatments of cut-cells near multi-material interfaces enables *efficient high-order-accurate spatial discretization*, capturing interfacial jumps sharply, within one cell; *d*) *interfacial geometry is a part of the JFNK solution vector*, avoiding operator-split treatment of the interface and near-interfacial fluid flows, which is a state-of-the-art in all previous (explicit) methods for interface tracking. We discuss and demonstrate the effectiveness of the Implicit Continuous-fluid Eulerian (ICE) physics-based preconditioner (PBP) of the Krylov (GMRES) method used as a linear solver in our Newton-based implicit Runge-Kutta time discretization. It will be shown that the ICE-PBP collapses all generally-complex eigenvalues of the Jacobian matrix to the real axes, effectively clustering eigenvalues and thus enabling a significant speed-up of convergence of the linear solver.

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