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Framework for a Robust General Purpose Navier-Stokes Solver on Unstructured Meshes[1] CHENG-NIAN XIAO, FABIAN DENNER, BEREND G. M. VAN WACHEM, Imperial College — A numerical framework for a pressure-based all-speeds flow solver operating on unstructured meshes, which is robust for a broad range of flow configurations, is proposed. The distinct features of our framework are the full coupling of the momentum and continuity equations as well as the use of an energy equation in conservation form to relate the thermal quantities with the flow field. In order to overcome the well-documented instability occurring while coupling the thermal energy to the remaining flow variables, a multistage iteration cycle has been devised which exhibits excellent convergence behavior without requiring any numerical relaxation parameters. Different spatial schemes for accurate shock resolution as well as complex thermodynamic gas models are also seamlessly incorporated into the framework. The solver is directly applicable to stationary and transient flows in all Mach number regimes (sub-, trans-, supersonic), exhibits strong robustness and accurately predicts flow and thermal variables at all speeds across shocks of different strengths. We present a wide range of results for both steady and transient compressible flows with vastly different Mach numbers and thermodynamic conditions in complex geometries represented by different types of unstructured meshes.

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