Numerical simulation of shock-tube piston problems with adaptive, anisotropic meshes

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ABSTRACT

Numerical simulations of the flow generated inside a shock-tube by the motion of a magnetically-driven piston are carried out using a novel finite volume adaptive scheme for dynamic meshes. Local modifications of the grid topology, including the addition or deletion of grid nodes are interpreted as a series of fictitious, continuous deformations of the mesh, thus allowing mesh adaptation to be described within the Arbitrary Lagrangian Elurerian (ALE) framework. The local deformations of the mesh elements are taken into account in a conservative fashion by adding additional fictitious fluxes to the ALE formulation of the governing equations for inviscid compressible flows. The solution on the new grid is recovered without any explicit interpolation. Therefore, the method that automatically guarantees the solution to be conservative by construction. The scheme, presented in [1] for two-dimensional flow, has been recently extended to deal with three-dimensional meshes of tetrahedral elements [2]. Three-dimensional computations of the flow field resulting from the oscillation of a magnetically-driven piston are carried out to test the scheme capabilities for computing the fluid-structure interaction (FSI) of compressible shocked flows with rigid, moving bodies. Anisotropic mesh adaptation is used to improve the computational efficiency. The solution compares fairly well with the analytical one-dimensional model.

REFERENCES

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