8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

ADVANCES IN VARIATIONAL MULTISCALE SHOCK HYDRODYNAMICS

*** Guglielmo Scovazzi**[1]

[1] Sandia National Laboratories
P.O. Box 5800, MS 1319, Albuquerque, NM87185-1319
gscovaz@sandia.gov

Key Words: *Stabilized methods, shock hydrodynamics, compressible flow, variational multiscale method.*

ABSTRACT

A new, variational multiscale stabilized formulation for Lagrangian shock hydrodynamics (hydrocode in short) is presented. To the author's knowledge, it is the only hydocode that can accurately and robustly compute the highly unsteady compressible flows of shock hydrodynamics problems on triangular/tetrahedral meshes in two/three dimensions, as well as the more commonly used quadrilateral/hexahedral meshes. The proposed method leverages a quasi-linear formulation of the Lagrangian shock hydrodynamics equations, and global conservation is attained with an approach that differs from most of the stabilized methods for compressible flows. Piecewise linear, equal-order interpolation for velocities, displacements, and thermodynamic variables (specifically pressure or internal energy, depending on the preferred formulation) is adopted. This last aspect makes the current formulation insensitive to the typical pathologies affecting standard hydrocodes (namely hourglass on quadrilateral/hexahedral meshes, and artificial stiffness on triangular/tetrahedral meshes). The stabilization involves additional design requirements with respect to the corresponding operators found in the literature for compressible aerodynamics applications, due to the highly unsteady nature of the problems to be solved, which may include blast/implosions. Numerical tests for the unsteady Euler equations of gas dynamics are presented in two and three dimensions.