6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 15 June 2018, Glasgow, UK

MATHEMATICAL MODELLING OF MULTI-PHASE FLOW USING ENTROPY SYMMETRIZATION

P. Cordesse[1], M. Massot[2], A. Murrone[3]

[1] DMPE, ONERA, Chemin de la Hunière 91123 Palaiseau, FRANCE, pierre.cordesse@polytechnique.edu
[2] CMAP, Route de Saclay 91128 Palaiseau Cedex, FRANCE, marc.massot@polytechnique.edu
[3] DMPE, ONERA, Chemin de la Hunière 91123 Palaiseau, FRANCE, angelo.murrone@onera.fr

Key words: *Multiphase flow, thermodynamic, entropy symmetrization, numerical simulation*

Jet atomizations play a crucial role in many applications such as in cryogenic combustion chambers. Since direct numerical simulations of these two-phase flows in engine real configurations are still out of reach, predictive numerical tools must be developed using reduced-order models with sound mathematics properties. The contribution of this paper is three-fold. First, we introduce a new formalism to symmetrize non-conservative systems using entropic variables by extending Mock-Godunov theory and apply it to the Baer-Nunziato model [3]. This new theory broaches new leads to obtain an original Eulerian diffuse interface model describing various mixture disequilibrium level based on an a consolidated mixture thermodynamic [1, 2]. Second, to cope with the strong discontinuities encountered in jet atomization, a robust and accurate numerical method using multi-slope MUSCL technique is applied to the various levels of the diffuse interface models [4]. Third, relying on the previous two points, simulations of a jet atomization in a cryogenic combustion chamber in subcritical conditions are presented using diffuse interface models with thermal and velocity disequilibria coupled to an Eulerian kinetic-based moment method.

References

[1] Baer, M. R. and Nunziato, J. W. A two-phase mixture theory for the Deflagration-to-Detonation Transition (DDT) in reactive granular materials. *Int. J. Multiphase Flow*, 12.6, 861–889, 1986.

[2] Gallouët, T., Hérard, J.-M., and Seguin, N. Numerical modeling of two-phase flows using the two-fluid two-pressure approach. *Math. Models Methods Appl. Sci.* 14.05, 663–700, 2004.

[3] Harten, A., Lax, P., and van Leer, B. On upstream differencing and Godunov type schemes for hyperbolic conservation laws. *SIAM Rev.* 25.1, 33–61, 1983.

[4] Le Touze, C., Murrone, A., and Guillard, H. Multislope MUSCL method for general unstructured meshes. *J. Comput. Phys.* 284, 389–418, 2014.