New statistical approach of the gas-liquid interface and high order moment for modeling polydisperse and evaporating spray

Mohamed ESSADKI, CentraleSupélec and IFPEN

Marc MASSOT, CMAP - École Polytechnique

Stephane de CHAIMARTIN, IFPEN

Adam LARAT, Florence DRUI, EM2C LAB, CentraleSupelec

Thibaut MENARD, CORIA LAB

In an industrial context, reduced-order two-phase models for fuel injection are needed to perform predictive simulation of complex industrial configurations with reasonable numerical cost. The aim of these simulations is indeed to help the design of new injectors, that can save the fuel consumption by enhancing the fuel atomization, and also improve the combustion and reduce the pollutant emissions. However, building up a global multi-scale model and accurate and robust numerical methods with the capacity to resolve the whole injection process, starting from the region of separated phases down to the region of disperse phase, requires a major breakthrough in terms of modeling, numerical methods and high performance computing. On the way to a unified model, we propose a new statistical description of the gas-liquid interface [3]. In this new approach, we define a Surface Density Function (SDF) whose phase-space variables are given by some geometrical properties of the interface. Furthermore, we show that, in the case of a collection of non-spherical droplets or even ligaments, the surface density function can be related to a Number Density Function (NDF) satisfying a William-Boltzmann-like equation, and classically used in the description of sprays of droplets. After presenting the theoretical foundations of this new statistical approach, the proposed approach will firstly be assessed on a series of deformed drops configurations, obtained thanks to the ARCHER code of CORIA [4]. In a second contribution, we derive from the new approach formulation the high order moment model for spherical droplet [2]. In this model, the NDF is approximated by a Maximum Entropy (ME) reconstruction that closes the model. New ingredients in both modelling and numerical methods in order to handle such a high order moment method and preserve realizability will be presented, as well as the framework in order to conduct high performance computing using such models using AMR on massively parallel architectures.

Références

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Mohamed ESSADKI, IFPEN, 1-4 Avenue du Bois Préau, 92852 Rueil-Malmaison (France)
mohamed.essadki@centralesupelec.fr
Marc MASSOT, CMAP - École Polytechnique Route de Saclay 91128 PALAISEAU CEDEX
marc.massot@polytechnique.edu
Stephane de CHAIMARTIN, IFPEN, 1-4 Avenue du Bois Préau, 92852 Rueil-Malmaison (France)
stephane.de-chaisemartin@ifpen.fr
Adam LARAT, Florence DRUI, Laboratoire EM2C, Grande Voie des Vignes 92295 Chtenay-Malabry France
adam.larat@centralesupelec.fr, florence.drui@centralesupelec.fr
Thibaut MENARD, CORIA, Avenue de l'Université, 76801 Saint-Étienne-du-Rouvray INSA ROUEN (France)
tmenard@coria.fr