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Validation of the Eulerian Mesoscopic approach in Particle-Charged Homogeneous Isotropic Decaying Turbulence in the scope of Large Eddy Simulation of Fuel Sprays

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Abstract

This work is devoted to the simulation of Diesel like sprays using an Eulerian-Eulerian approach. For this purpose, the AVBP code is used to perform the computations. It solves the compressible Navier Stokes equations for reactive two phase flows with low dissipation schemes adapted to Large Eddy Simulation (LES). To simulate the liquid phase, the Mesoscopic Eulerian Formalism (MEF) developed by Fevrier et al. is used. In this approach, an analogy is made between particles of a dispersed liquid phase, and molecules in a gas. Starting from the Boltzmann equation, it allows to determine eulerian conservation equations. This formalism was first designed for dilute sprays. In order to simulate fuel sprays in engines, these models have been adapted to dense sprays by the addition of collision effects.

The formalism is validated by Direct Numerical Simulation (DNS) of homogeneous isotropic decaying turbulence, loaded with inertial particles. The carrier phase is initiated with a Passot-Pouquet spectrum. The particles are injected uniformly at the same velocity as the carrier phase.

For non-collisional simulations, results are compared to Eulerian/Lagrangian Discrete Particles Simulation (DPS), considered as a reference. Simulations are performed with one-way coupling drag force (no modification of the gas phase by the liquid phase). As the Stokes number is 1.2, strong preferential concentration effects are expected. Results show that the total energy decrease is well reproduced for both phases with the MEF approach, and that preferential concentration effects are in good agreement with DPS computations.

For collisional simulations, the results are analysed qualitatively. To allow a parametric study, the collision and relaxation time scales of the liquid phase are varied: the Stokes number is varied between 0.6 and 2.4 and the mean liquid volume fraction between 0.027% and 2.7%. Results show that all expected asymptotic behaviours are well exhibited.

Key words : Diesel Sprays, Direct Numerical Simulation, Eulerian Mesoscopic, Collisions, Homogeneous Isotropic Turbulence

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