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"Towards general purpose LES model of injection and atomization"

Abstract

Injection and atomization of liquid is widely used in many industrial and domestic applications such as, fuel injection in engines or burners, spray painting, medical sprays, spray drying, etc.
Various approaches are used to simulate two-phase flows. Usually, interface tracking methods are used to simulate the primary atomization while a dispersed method such as the Lagrangian particle-tracking approach may be used to model the final spray. Despite progresses in numerical methods and computer performance, complete simulation of atomization and spray remains inaccessible for many applications.
A possibility consists to extend the ELSA approach to the well-established LES framework combined with an interface density equation for subgrid scales. A postulated transport equation of the interface density is used to describe the subgrid spray formation ranging from interface wrinkling, ligaments, and sheets up to the droplets.
The objective of our work is to extend the LES ELSA method developed by Chesnel et al. into a general purpose solver OpenFOAM . The method has been adapted for unstructured mesh to address applications. The interface capturing method is based on the transport of a liquid volume fraction, αl. To sustain the sharp gradient of αl an additional compressive term is added to the equation. LES formulation induced a subgrid term SGSαl that is not compatible with numerical procedure used to capture the interface. The advantage of the compressive method is the possibility to switch it off when SGSαl become important, i.e. when the interface fluctuations become important at subgrid scale.
In order to improve ELSA method a coupling with Lagrangian particle will be initialized. Lagrangian particle are create when liquid structure become droplet. The diameter and the number of particle are determined via the liquid volume fraction and via the interface density. The Eulerian equations have to be linked to the Lagrangian phase, this is achieved through the liquid turbulent diffusion flux closure.
The aim of my work is to study the LES atomization method and make comparison of the liquid dispersion around the axes with a reference DNS.