

A DNS database to improve atomization modeling

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Abstract

Recent advances in interface tracking method allows us to use them as a tool to study primary atomization. Some recent works have performed accurate Direct Numerical Simulation of turbulent liquid jets which are very promising [1] [2]. Unfortunately, these simulations have shown that, even with a high resolved DNS of 6 billions points [2], the finest scales of the flow are not resolved. This issue shows that subgrid models are necessary to modelize the physics under this particular scale.

In order to improve modeling, it is useful to study simpler configurations which allows us to solve all relevant scales of the flow. In single-phase flows, DNS of Homogeneous Isotropic Turbulence (HIT) is still used to study scalar mixing and the kolmogorov theory. Extension of this configuration to two-phase flows to characterize important processes (for example turbulence/interface interactions, vaporization) is emerging in recent DNS studies. Concerning vaporization, few studies have emerged using complex numerical methods but are limited to single droplets or laminar jet, because of their high computational cost. Duret et al. [3] have also studied vaporization but in the context of turbulent atomization (high Weber and Reynolds number). A passive scalar is used to represent the evaporation and mixing process in a two-phase turbulent flow, as a first approach.

The aim of this work is to pursue these studies by analyzing the interface behaviour and the vaporization of two-phase flows in a forced HIT. This analysis is performed over a large range of liquid volume fractions. From these results we can extract useful informations in order to improve modeling of primary atomization. The liquid gas interface is represented in Figure 1 to illustrate the numerical configuration for a liquid volume fraction of 5 %.

Both phase are resolved in DNS, the interface tracking method used is a coupled Level Set/VOF method. High density ratio between the two phases is chosen to simulate realistic engine conditions. Quantitative and qualitative aspects are analyzed, with a main focus on interfacial quantities (equilibrium interface density and Weber number), which are key parameters for primary atomization modeling.

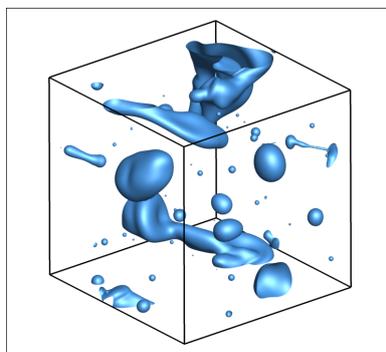


Figure 1. Interface visualization, liquid volume fraction $\phi = 5\%$

References

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