Atomization Modeling of Liquid Jets using Two Surface Density Equations

B. Mandumpala Devassy*[1], C. Habchi[2], E. Daniel[3]
1 & 2: IFP Énergies nouvelles, 1-4 av. Bois-Préau - 92852 Rueil Malmaison, France,
md.bejoy@ifpenergiesnouvelles.fr & chawki.habchi@ifpenergiesnouvelles.fr
3: Aix-Marseille Université, IUSTI, 5 rue E. Fermi 13453 Marseille cedex 13, France,
eric.daniel@polytech.univ-mrs.fr

Abstract

Atomization is a phenomenon of high importance for many practical devices involving turbulent mixing of compressible flows having significant density and velocity gradients. This study focuses on the modeling of liquid jets in the aim of improving the Diesel spray simulations. Here a compressible two-phase flow model is used which relies on an Eulerian-Eulerian (E-E) diffused interface approach [1] implemented in the three dimensional CFD code IFP-C3D [2]. The current trend to track the liquid-gas interface is done by defining surface density ($\overline{\Sigma}$) equations. This quantity represents the area of gas-liquid interface and will allow the calculation of the interfacial exchange terms like heat transfer and phase changes. The first model of this kind in two-phase flows has been done by Vallet $et\ al.$ [3]. Compared to previous $\overline{\Sigma}$ models [3, 4], the significance of the present model lies in the fact that, near to the nozzle, during the time of primary breakup there happens a transfer of liquid from the liquid core (separate phase) to the dispersed phase. The initial developments of this model is summarized in the work of Mandumpala Devassy $et\ al.$ [5]. While modeling the atomization of liquid jet using $\overline{\Sigma}$ equation the need of separating the liquid phase into the separate and dispersed phase thus focuses attention. This idea is then formulated and thereby a new atomization model is developed by defining separate equations of $\overline{\Sigma}$ for liquid core and droplets (dispersed phase) coupled with their corresponding volume fraction equations. This new atomization model based on two surface density equations thus proposed made it possible to distinguish between the liquid core and droplets (Figure (1)) more precisely.

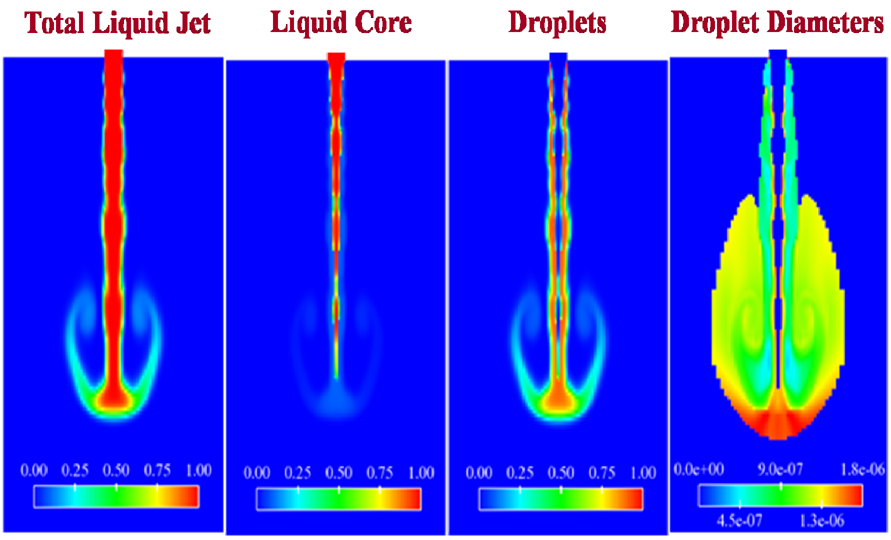

Figure 1. Liquid jet atomization by the proposed atomization and breakup model at 20μs after start of injection

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*Corresponding author: md.bejoy@ifpenergiesnouvelles.fr