6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

NUMERICAL STUDY OF A PRESSURE-SWIRL ATOMIZER USING LES/VOF

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Keywords: *Pressure-Swirl Atomizer, Primary Atomization, Two-Phase Flow, Volume-of-Fluid, Large-Eddy Simulation*

A pressure-swirl atomizer is a widely used atomizer type in which the liquid is forced into a swirling motion before ejecting it from the nozzle. An annular liquid film is formed at the orifice of the injector and a hollow cone spray is generated because the tangential velocity component forces the film to expand radially outward. The liquid first undergoes primary atomization, where the film is deformed by instabilities before the first generation of droplets is formed. Studying primary atomization has been challenging with experimental or analytical approaches, because of its irregular nature and the small time and length scales involved in the process. Computational methods offer a way to study the complex phenomena, but in order to accurately predict atomization characteristics, the motion of the gas-liquid interface has to be solved accurately.

In this work the onset of the primary atomization is studied in a real, industry relevant nozzle geometry used for fuel injection. Large-Eddy Simulation (LES) is used to solve the time-dependent flow field, while a geometric Volume-of-Fluid (VOF) method [1] with adaptive mesh refinement is used to capture the large scales of the liquid breakup in the nozzle near field. Studies have been conducted on annular swirling jets (e.g. [2]), but the full inner nozzle flow is rarely included in the simulation. This study focuses on the flow field inside the nozzle and its influence on the onset of the primary atomization.

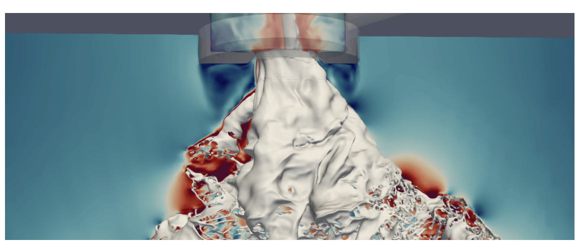

Figure 1: A hollow cone type spray is formed in the nozzle near field.

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