

# A Numerical Study for Atomization and Evaporation Processes of Liquid Fuel Jets in Crossflows Using Eulerian-Lagrangian Method

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## Extended Abstract

Liquid fuels have the advantages of high combustion calorific value, low waste, convenient storage, and transportation. The combustion of liquid fuels exists in many industrial applications such as gas turbines and internal combustion engines, which includes various processes of fuel injection, atomization, evaporation, turbulent mixing and chemical reactions. Transverse fuel injection into a crossflow, as a widely used configuration in such combustors, enhances combustion efficiency, cuts fuel consumption, and lowers emissions [1]. Therefore, improved understanding of the atomization and combustion processes of liquid fuel jets in crossflows is necessary for developing new industrial combustors.

The integrated modelling of liquid fuel combustion is challenging due to the multiscale and multiphysics phenomena involved. In the present work, a numerical framework using OpenFOAM is proposed to model the complex physical and chemical processes during liquid fuel combustion. Particularly, the primary atomization process of the liquid jet is modelled with the volume of fluid (VOF) method combined with adaptive mesh refinement. After the primary atomization, the small liquid structures which satisfy the transformation criteria are converted into Lagrangian particles (LP), and are further tracked using the point-particle method. The secondary atomization is modelled with the Pilch-Erdman breakup model. As for the evaporation process, the effect of droplet evaporation in both the Eulerian and Lagrangian frameworks is considered.

The atomization process of liquid fuel in crossflow is simulated using the Eulerian-Lagrangian method for validation, and the modelling results are in a good agreement with the experimental measurements [2]. The proposed framework is then applied to the simulation of liquid-fuel jet in hot crossflow. The general characteristics of the liquid, turbulence and evaporation are investigated using the direct numerical simulation data. The effects of various parameters including momentum ratio, Weber number and ambient temperature on the liquid jet penetration, atomization/evaporation regions, droplet distribution and combustion process are explored. The module for combustion processes of the solver is not robust so far, which will be improved.

## References

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