Multi Component Spray – Turbulence Interaction

Background

Blended fuels are gaining high importance in the automotive industry owing to the benefits of improved fuel efficiency and reduced emissions. A lot of research is done to study blends of fuels with very different chemical behavior, typically a mix of high and low octane fuels – dual fuel combustion.

When it comes to modeling, the spray model has an additional requirement concerning volatility of fuel components. This is because the volatility of fuel blends can vary substantially and care has to be taken while implementing the differential evaporation process to maintain thermodynamic equilibrium and keep the solution robust.

Method

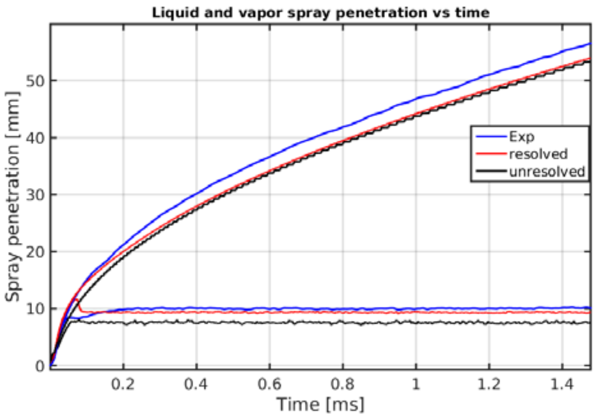
The spray model used in this project is VSB2 (Stochastic Blob and Bubble). The main focus areas of the project are:

- To extend the VSB2 model to handle multicomponent fuels. The VSB2 will also be extended to include non-ideal vapor liquid equilibrium, taking inter-molecular interactions into account.
- To study the influence of resolving injector orifice into multiple cells on fuel spray prediction.
- To perform combusting multicomponent fuel spray simulations and compare predictions with experimental data.

Results

Up until now, the VSB2 model is extended for multicomponent fuels including non-ideal vapor liquid equilibrium. All the simulations are performed using OpenFOAM 2.2.x. The VSB2 model uses a non-linear algebraic solver (KINSOL, provided by SUNDIALS), to calculate multicomponent evaporation. The kinsol solver can be used in principle for any number of fuel components and allows easy handling of multicomponent fuels. It has been tested and validated with experimental data for 2 component fuels.

A study on influence of resolving injector orifice was done. Two simulations were performed for ECN spray A case. First one is using a mesh, where the injector orifice is unresolved (represented by 1 grid cell), and the second one, where the injector orifice is divided into 9 cells (3 cells across). The resolved orifice mesh predicted liquid penetration curve closer to experiment. Also, the transient part of liquid penetration (early stage of injection) was accurately



predicted when compared to the mesh with unresolved orifice. The resolved mesh case also predicted a wider spray.

Conclusion and outlook

The VSB2 spray model is extended to handle multicomponent fuels. Differential evaporation is solved using a non-linear algebraic solver (SUNDIALS' Kinsol). Resolving the injector orifice has proved to improve liquid penetration results. However, final conclusions can be drawn only after observing the influence on combusting fuels sprays, which will be the next step.