Abstract.

The main objective of this work is the modeling of diesel sprays under engine conditions, including the atomization, transport and evaporation processes pivotal in the diesel spray formation and its development. For this purpose, an Eulerian single fluid model, embedded in a RANS environment, is implemented in the CFD platform OpenFOAM.

The modeling approach implemented here is based on the Σ-Y model. The model is founded on the assumption of flow scales separation. In actual injection systems, it can be assumed that the flow exiting the nozzle is operating at large Reynolds and Weber numbers and thus, it is possible to assume a separation of features such as mass transport (large scales) from the atomization process occurring at smaller scales. The liquid/gas mixture is treated as a pseudo-fluid with variable density and which flows with a single velocity field. Moreover, the mean geometry of the liquid structures can be characterized by modeling the mean surface area of the liquid-gas interphase per unit of volume. Additionally, an evaporation model has been developed around the particular characteristics of the current engine technologies. This means that vaporization process is limited by fuel-air mixing rate and fuel droplets evaporate as long as there is enough air for them to heat up and vaporize. Consequently, the evaporation model is based on the Locally Homogeneous Flow (LHF) approach. Under the assumption of an adiabatic mixing, in the liquid/vapor region, the spray is supposed to have a trend towards adiabatic saturation conditions and to determine this equilibrium between phases Raoult's ideal law is considered. Finally, the spray model is coupled with an advanced combustion model based on approximated diffusion flames (ADF), which reduces the computational effort especially for complex fuels and is a natural step for modeling diesel sprays.

First, the model is applied to a basic external flow case under non-vaporizing conditions, extremely convenient due to both the experimental database available and the symmetric layout which allows important simplification of the modeling effort. Good agreement between computational results and experimental data is observed, which encourages its application to a more complex configuration. Secondly, the model is applied to the "Spray A" from the Engine Combustion Network (ECN), under non-vaporizing conditions, in order to reproduce the internal structure of diesel sprays as well as to produce accurate predictions of SMD droplets sizes. Finally, vaporizing "Spray A" studies are conducted together with the baseline reacting condition of this database. The calculated spray penetration, liquid length, spray velocities, ignition delay and lift-off length are compared with experimental data and analysed in detail.