Title:

CFD modeling of reacting diesel sprays with tabulated detailed chemistry

Authors:

R. Novella, J.M. Pastor and J.F. Winklinger

CMT - Motores Térmicos
Universitat Politècnica de València
Camino de Vera s/n, 46022, Edificio 6D
Valencia, Spain

Abstract

In the last years, combustion modeling by means of CFD has become a widely employed tool in IC engine research and development. Because of new demanding emission regulations, as well as the need of decreasing fuel consumption, it is gaining interest as engine design tool. However, CFD modeling of turbulent combustion in the frame of diesel sprays is very challenging due to the complexity of the physical and chemical processes involved, such as atomization, evaporation, turbulent mixing and fuel oxidation chemistry and therefore, is still under development.

Increasing the accuracy of the CFD model predictions in terms of spray ignition, flame structure and emissions formation requires detailed chemistry mechanisms and accounting for subgrid turbulence-chemistry interaction, which could lead to excessive CPU efforts and very time consuming or even inaccessible calculations. A promising alternative to make the problem computationally affordable consists of combining a pre-tabulation of the complex chemistry out of the CFD framework, such as in the FPI method, together with a presumed conditional moment (PCM) approach for modeling the subgrid turbulence-chemistry interaction.

Present research focuses on the implementation of a FPI-PCM based combustion model in the open-source CFD platform OpenFOAM. Initially, the chemistry pre-tabulation methodology and the generation of the final lookup tables including the turbulence-chemistry interaction is described in detail. Then, this CFD model is applied to simulate the combustion of diesel sprays in a vessel. Finally, the simulation results are validated against a set of experimental data.

Results confirm how the present approach is suitable for predicting the trends of the most relevant spray combustion parameters, such as ignition delay and lift-off length.