The LES modelling of diesel injectors: the spray first instants

S. Hoyas, X. Margot, J.M. Mompó-Laborda
CMT - Motores Térmicos. Universidad Politécnica de Valencia.
Camino de Vera, s/n 46022 Valencia, Spain
E-mail addresses: serhocal@mot.upv.es, xmargot@mot.upv.es, juamomla@mot.upv.es

In the automotive industry, computational fluid dynamics (CFD) tools are very useful in order to reduce experimental measurements and help understand many thermodynamic processes that take place inside internal combustion engines. These CFD codes solve the Navier-Stokes equations together with the energy equation and one state equation using three different approaches to model the turbulence: Reynolds-Averaged Navier-Stokes (RANS), Large Eddy Simulation (LES), and Direct Numerical Simulation (DNS). Regarding Diesel spray injection, the most commonly used codes in the automotive industry, until very recently, are based on the RANS approach. These computational methods are very useful to study the averaged flow, but they do not provide any information neither about the turbulent fluctuations nor about the flow on the jet boundary. Nevertheless, they provide reasonably accurate results and have relatively lower computational cost.

On the contrary, direct numerical simulation (DNS) methods solve all the significative scales of the flow, and no modelling is required. Therefore, the DNS provides the highest level of description of the flow, but the computational resources required for most practical cases are above current computer hardware limitations (and will be in the next 20 years).

LES is a compromise between DNS and RANS. LES methods model only the smallest-scale fluid motions and directly represent the large-scale ones. While the use of LES increases the computational cost, LES has been a predictive tool able to consistently simulate the complex structures related with turbulent mixing, which is decisive in the injection and combustion processes and invisible for RANS solvers.

It is the aim of this paper the evaluation of numerical (LES) approach to simulate Diesel sprays by means of the open source CFD code OpenFoam. Previous works performed by these authors showed the potential of LES methodology for Diesel spray simulations, also with Euler-Euler approximations. In this work we will focus in the first instant of the spray, both in time and space. A parametric and sensibility study of the most significant parameters of the LES approximation will also be presented.