OpenFOAM developments around fuel injection in internal combustion engines

Norberto Nigro

CIMEC-CONICET-UNL, Colectora Ruta Nacional 168, Santa Fe, Argentina, +54 342 4511594, norberto.nigro@gmail.com

The target of this work is the development of different numerical approximations to simulate the fuel injection and its ultimately combustion inside a real opposed piston engine
inside the OpenFOAM suite. The key ingredients of this developments are first, the usage of an efficient dynamic mesh strategy with deformation and topological changes using a combination of layering with AMI/ACMI for non-conformal coupling between different submeshes, exploiting the parallelism. In particular the AMI/ACMI implementation rests on a definition of a pseudo supermesh that allows to reduce significantly the cpu-time. Next the implementation of a particle tracking procedure with different submodels for the atomization, spray formation, break-up and evaporation through an Eulerian (for the gas) and a Lagrangian (for fuel droplet parcels) all embedded in a parallel computation and finally the usage of a flamelet combustion model library to assess different proposals available in the literature. The phenomenological injection models are parameterized in terms of matching variables obtained from more detailed approaches. These last simulations are also included in this project using two different approaches, that may be available for general usage very soon, inspired on pseudo DNS simulations of the primary and secondary atomization processes employing either VOF-PLIC or a new methodology, called Particle Finite Volume Method. The former, very well known in the CFD community, includes a geometric advection for the interface positioning coupled with a height functions based curvature computation for the surface tension forces. The other methodology, an own development inspired on the Particle Finite Element Method (PFEM) that takes advantage of a combination of mesh and particle based methods with good properties in terms of boundedness, accuracy and efficiency, in particular for multifluid flows. Advances in these two proposals are included also in this presentation.

This project has the following members: Horacion Aguerre, Santiago Marquez Damian, Cesar Pairetti, Juan Gimenez and Norberto Nigro