Summary of the deliverable D4.6: Coupled simulation of Diesel injector flow/cavitation and fuel atomisation

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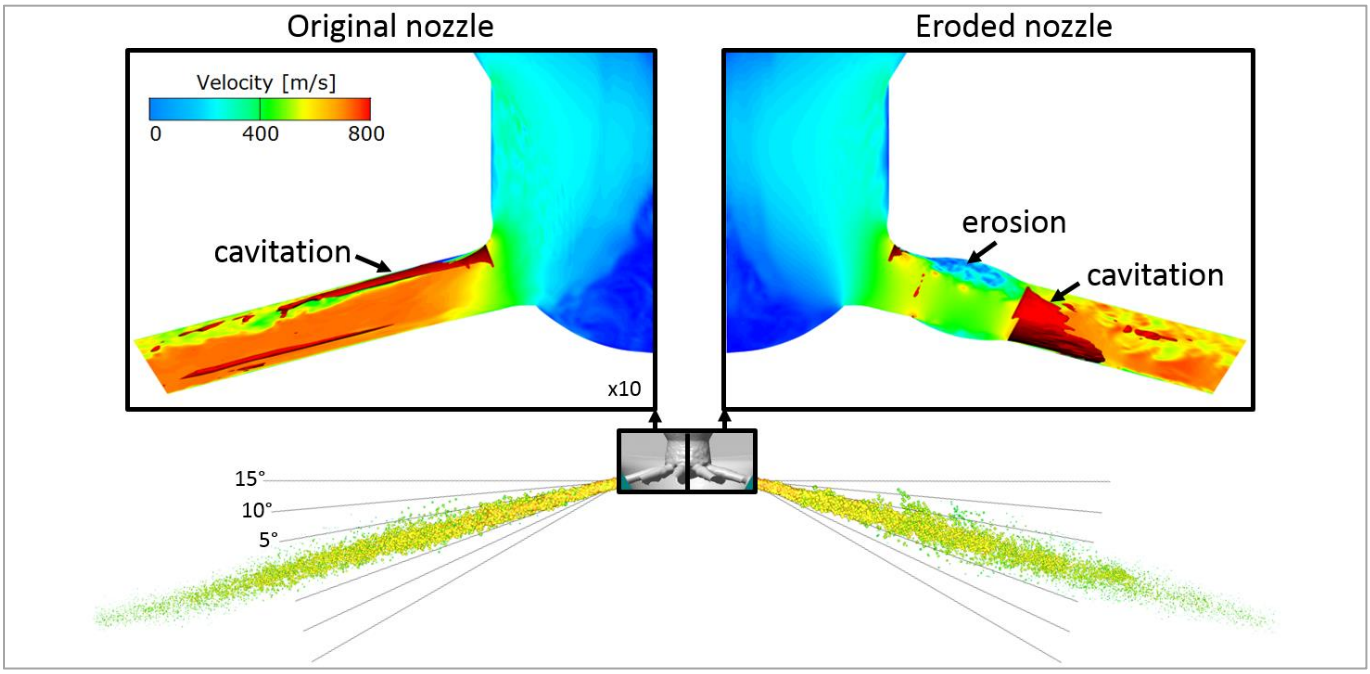

Comparison between simulation results between the original and the eroded nozzle. Internal nozzle flow presented with velocity cut and vapor iso-surfaces and spray visualizations.

Diesel injectors can be affected by cavitation. Numerical models able to predict the appearance of cavitation and the possible effects related to it, are of great interest for the injectors' designers. The presented work exploits the capability of a compressible 3-phase pressure-based CFD solver accounting together with Large Eddies Simulation approach. Cavitation has been included as mass transfer term between liquid and vapor phases. The numerical methodology has been applied on a 9-hole Diesel injector operating at 2000 bar injection pressure. Two 40° injector sectors were considered: one with the nominal nozzle geometry and one introducing the deformation caused by cavitation erosion that were detected by experiments. A main injection event was simulated, including the needle movement with a mesh deformation technique. Variations in the injection characteristics as well as in the internal nozzle flow have been detected between the two geometries simulated. Pressure peaks were also recorded on the nozzle surface and correlated with cavitation erosion risk. Moreover, simulation of the injected sprays were then performed using a Lagrangian method which used as initial conditions the simulated nozzle flow. These simulations revealed the effect of cavitation erosion on the spray pattern.

Future work aims to increase the model accuracy by considering some of the physical aspects that were neglected in the current approach. Geometrical data obtained from x-rays would be of great importance to correctly describe the internal surface imperfections generated during the manufacturing process that may be relevant to this study. The simulation of the entire injector, together with the inclusion of eccentric needle movement, may lead to visible nozzle to nozzle flow and spray differences. The introduction of the energy equation in the set of solved equations should permit to model temperature variation in the domain due to viscous heating and mass transfer. Finally, a new methodology to model transcritical sprays within a pure Eulerian single phase framework may be adopted. All these aspects would then lead to higher fidelity models for both the internal nozzle flow and the spray simulations.