Summary of deliverable D4.4 : Cavitation Characteristics in a Diesel Nozzle Tip

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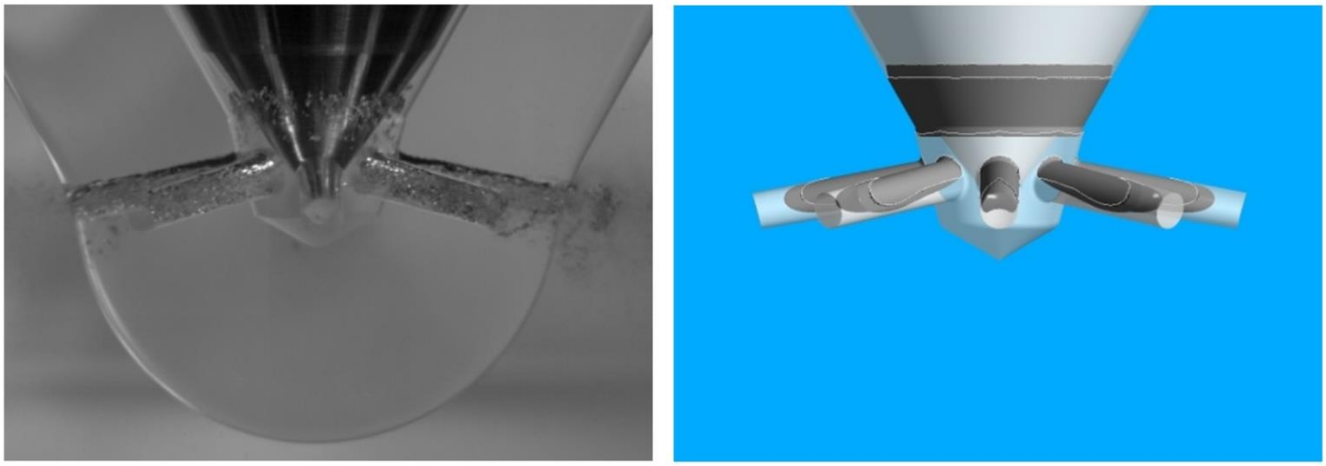

Experimental large scale model and CFD results of the real-size nozzle showing cavitation

Cavitation cannot be avoided in parts of high-pressure fuel systems. Cavitation is a benefit in certain regions and can inhibit deposit formation, but it does have potential to cause problems in the form of hydraulic instability and erosion of component surfaces. Hence, understanding cavitation characteristics is important so as to eradicate any such problems in the prototype phase before the design reaches series production. In order to gain experience and insight into cavitation, high-speed images were taken of a large-scale model (LSM) of a nozzle from a series production diesel injector. These results enabled useful visualization of the cavitating regions in the nozzle tip and provided the observer with an appreciation of the nature of the phenomenon. Understanding these characteristics and establishing where the cavitation originates, and is likely to flow, is an important part in understanding the cavitation erosion potential.

Corresponding CFD analyses were carried out at similar running conditions to the LSM and used a two-phase mixture model for the cavitation and a RANS k-epsilon turbulence model. The simulation results were similar to those from the LSM experiments, with cavitation occurring in the same locations, namely around the needle upstream of the sac entry at low valve lift, and inside the nozzle holes. The differences in the degree of cavitation and cavitation initiation location were examined and tested by changing the geometry details, some of which were associated with manufacturing imperfections. The effects of the fluid properties were also studied. Overall, this research provides baseline data to compare a non-eroding nozzle, such as the nozzle used here, with past and future experimental designs and prototypes which may experience erosion.

The work done here was RANS based. Future work will look to run higher detailed simulations so an LES/RANS hybrid model will be used in the next steps. Various aspects of the multiphase model and the mass transfer model will be investigated also. To reduce computation time the cell count will be reduced by using less complicated geometries. The methods mentioned above will be explored, among others, with one of the control orifices located in a prototype fuel injector. The initial geometry of the control orifice in the prototype injector results in cavitation erosion whereas the subsequent geometry does not, which makes them excellent examples for further work.