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Titel des Beitrags: Large-Eddy Simulation of turbulent, cavitating fuel flow inside a 9-hole Diesel injector including needle movement

Abstract: We investigate the turbulent multiphase flow inside a nine-hole common rail Diesel injector during a full injection cycle of ISO 4113 diesel fuel into air by implicit large-eddy simulation (LES). The simulation includes a prescribed needle movement obtained from a one-dimensional multi-domain simulation. The injector geometry is represented by a conservative cut-element-based immersed boundary method with subcell resolution, which has been developed for the application in the context of cavitating liquid flows. We employ a barotropic two-phase two-fluid model, where all components (i.e. air, liquid diesel, gaseous diesel) are represented by a homogenous mixture approach. The cavitation model is based on a thermodynamic equilibrium assumption. Compressibility of all phases enables full resolution of collapse-induced pressure wave dynamics. The analysis of the turbulent flow field reveals that the opening and closing phase are dominated by small-scale turbulence, while in the main injection phase large vortical structures are formed in the needle volume and reach into the nozzle holes. Violent collapse events of cavitation structures are detected during the closing phase in the nozzle holes and
after closing in the sac hole region. A comparison with LES results with a fixed injector needle at different lift positions shows a good agreement for large needle lifts, while the needle movement has significant effects on important flow features at low needle lifts.

Stichworte: Large-Eddy Simulation; turbulent, cavitating fuel flow; diesel injector

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