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3D CFD Simulation of Urea-SCR systems

Background: Selective Catalytic Reduction (SCR) of nitrogen oxides (NOx) is based on the selective conversion of NOx to nitrogen (N2) by addition of ammonia (NH3). The injection of AdBlue (32.5 % urea/water solution) in the hot exhaust gas has been developed as feasible alternative. Urea is gradually converted to ammonia by dehydration and subsequent thermolysis and hydrolysis. Due to incomplete evaporation, wall film and solid by-products can be formed as a result of spray-wall interaction, which significantly influence the conversion and the spatial distribution of ammonia over the catalyst cross-section. AdBlue deposits can lead to a failure of the dosing strategy, reduction of the NOx conversion and, in serious cases, to a blockage of the whole SCR-system. To predict these processes, their correct implementation into CFD models and simulations are of high priority.

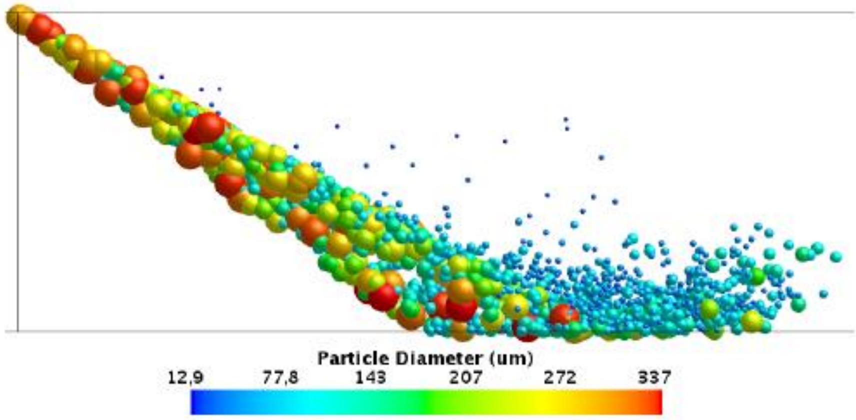

Figure 1 CFD results for droplet-wall-interaction of injected urea-water-solution

Project: The project covers different aspects and models for the CFD simulation of AdBlue injection, droplet/wall interaction and deposit formation. The first research goal is the understanding of droplet/wall interaction on smooth, rough and porous surfaces, development of impingement regime maps and their implementation into the simulation.

Furthermore, the formation of liquid films and pools shall be simulated with an optimized model for the transition between thin films and thicker pools, which have to be modeled with a Volume-of-Fluid method. Droplet stripping from deposits or liquid pools shall be taken into account.

Additionally, new mechanism for urea decomposition and improved physical property data are implemented into the CFD simulations. These resulting multiphase films are simulated with a slurry model (gas-liquid-solid) for the fluid film. The resulting CFD model will then include relevant phenomena and enable advanced prediction of urea by-product formation.

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AiF Forschungsnetzwerk Mittelstand

iGF Industrielle Gemeinschaftsforschung

FVV Research Association for Combustion Engines