SIMULATION OF UREA/WATER INJECTION AND EVAPORATION IN AUTOMOTIVE SCR SYSTEMS USING AVL FIRE

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Introduction
The selective catalytic reduction (SCR) of nitrogen oxides is considered to be the most promising technique to fulfill the upcoming legislations regarding NOx emissions in Diesel engine vehicles. The urea/water solution (UWS) is used as ammonia source in the aftertreatment system.

Objectives
The aim of this work is to present new developments in the simulation of the UWS injection for SCR system. Different modules of the CFD code FIRE (i.e. Lagrangian DDM spray, wallfilm, chemistry) have been enhanced to describe the complex physics of the problem.

Modelling
The following models [AVL, 2007] have been developed or improved:

• Fluid properties depending on temperature and urea concentration.
• Hydrolysis of isocyanic acid.
• Thermolysis reaction of dissolved urea [Kim, 2004], [Birkhold, 2007].
• Multicomponent gas diffusion.
• Multi-component species transport and multi-component evaporation in wallfilm.
• Urea spray/wall interaction model [Kuhnke, 2004] with enhancement to 6 regimes [Birkhold, 2007].
• Heat transfer between droplets and wall [Wruck, 1998].
• Lateral heat conduction in the thin walls.

Validation
The modelling approach has been validated with experimental data.

Simulation of urea/water injection
The injected UWS droplets are stopped at the catalyst interface. The system geometry was optimized by means of simulation results.

Smart de-coupling (SDC)
The spray droplets are stopped at the catalyst porosity and the flow field is locally transferred via ACCI (AVL Code Coupling Interface) to the after-treatment simulation.

Conclusions
• A 3D CFD tool for detailed spatially resolved analysis of UWS spray and wallfilm formation, thermolysis as well as transport and distribution of NH3 is available in the FIRE code.
• A work flow based on co-simulation of de-coupled sub-models provides a fast, robust and reliable simulation methodology to support basic understanding and improved design of exhaust systems.