WP8: Engine Integrated SCR and combined SCR and Filters

Hercules II PTB meeting

10th May, Zurich

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WP8: Engine Integrated SCR and combined SCR and DPF

Objectives

Engine Integrated SCR

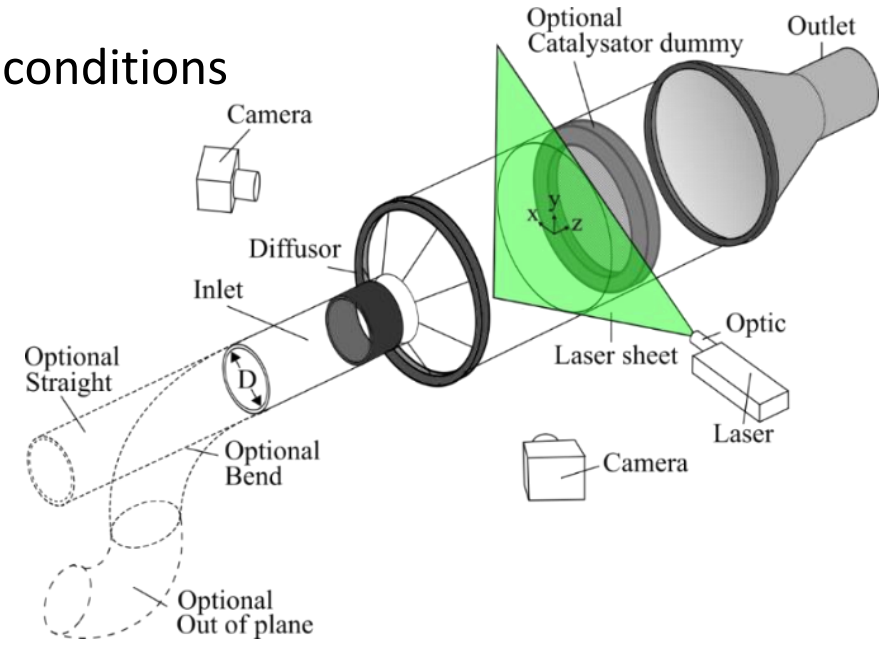
- Investigation of High Pressure SCR process; injection, mixing, decomposition and flow distribution with the aim of making the SCR components compact while still maintaining the same high performance as best available technology today
- Designing of engine integrated High Pressure SCR with system with unaffected engine footprint and only slightly affected gallery arrangement around the engine
- Testing of compact High Pressure SCR component performance on 4T50ME-X test engine

Combined DPF and SCR

- 80% PM reduction with after-treatment system (based on IMO Tier II engine out emissions)
- 80 % NOx reduction with after-treatment system to reach IMO Tier III limits
- Reduce the necessary installation space for after-treatment system SCR on DPF within IMO Tier III (SCR only) system
- Adaption and integration of the after-treatment system (SCR on DPF) on a marine Diesel engine

Main results achieved during 2nd year – Flow in SCR systems

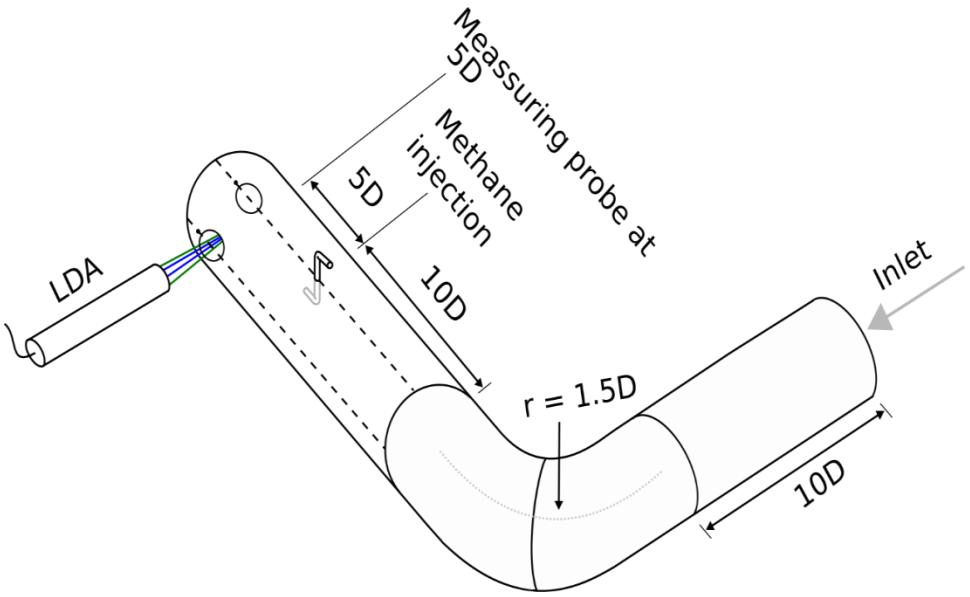
- Flow through the model of the reactor determined, with increased complexity
  - An empty reactor
  - The reactor with a catalyst dummy (pressure resistance)
  - The reactor with the flow distributer
  - Combined
- Ongoing experiments, with different inlet conditions
  - A straight pipe
  - A in-plane bend
  - A out-of-plane bend



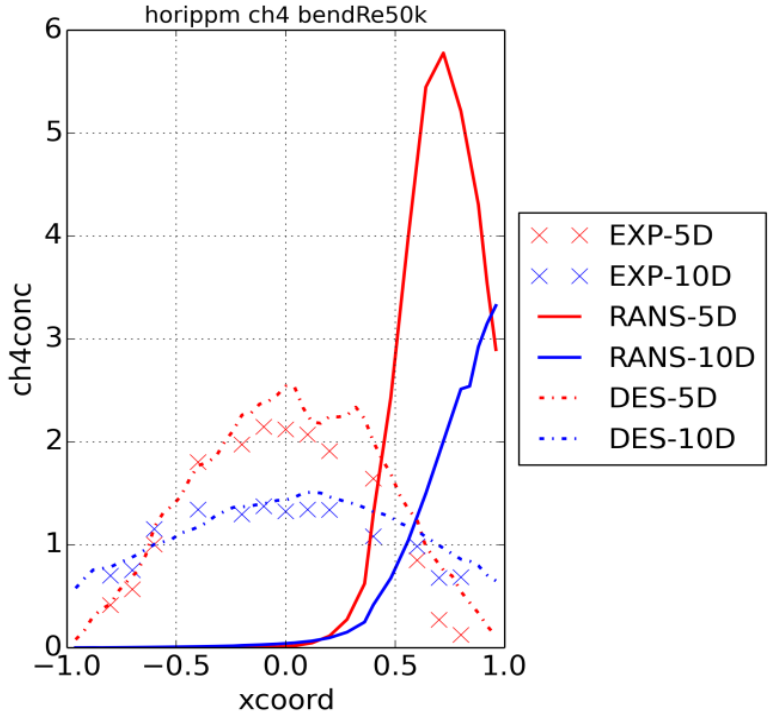
Test set-up

Main results achieved during 2nd year - CFD Model validation

- Three different mixing configurations



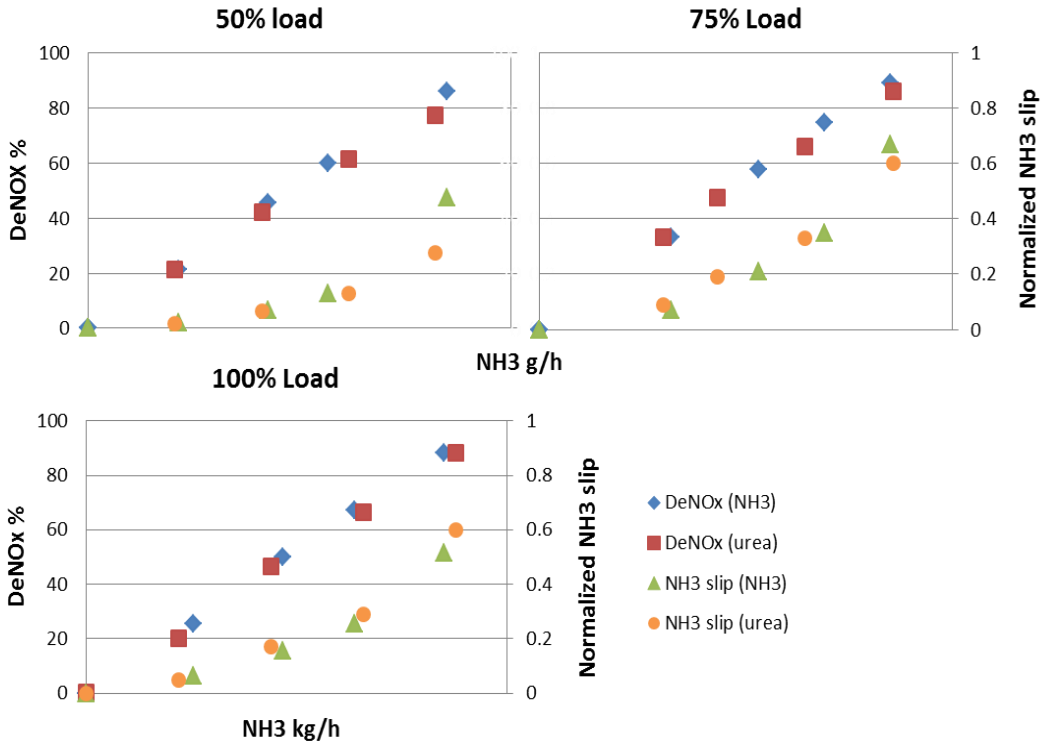
The bend setup, with dimensions. The LDA equipment and windows are shown to indicate where the measurements are made, compared to the bend of the pipe.



A simple turbulence model (RANS) and the results from a high fidelity turbulence model (DES).

Main results achieved during 2nd year – Studying HP SCR processes

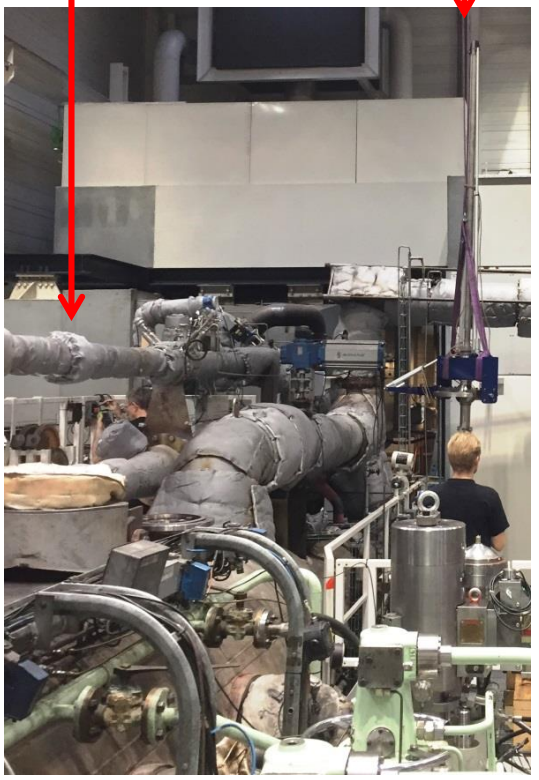
- Traverse mechanism 4T50ME-X
- Experiments on High pressure SCR test bed



HP SCR testbed results. Ammonia respectively urea used as reducing agent.

Mechanism for high pressure traverse gas measurements

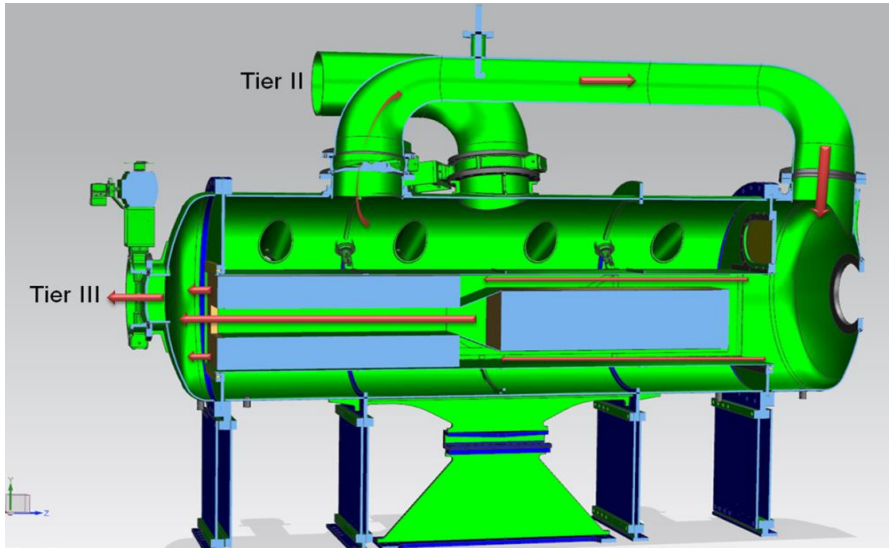
HP SCR testbed



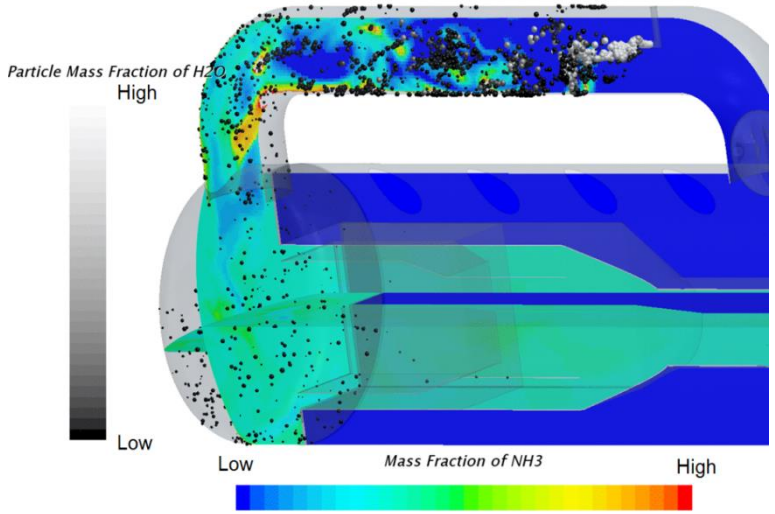
HP SCR testbed on 4T50ME-X

Main results achieved during 2nd year – Engine integrated HP SCR - Design

- Engine performance
- Choice of catalyst, amount and configuration
- Optimal flow distribution
- Appropriate design related to thermal stress and pressure
- Maintenance/service access
- Scaling possibilities
- Flexibility for testing different concepts



Engine integrated HP SCR

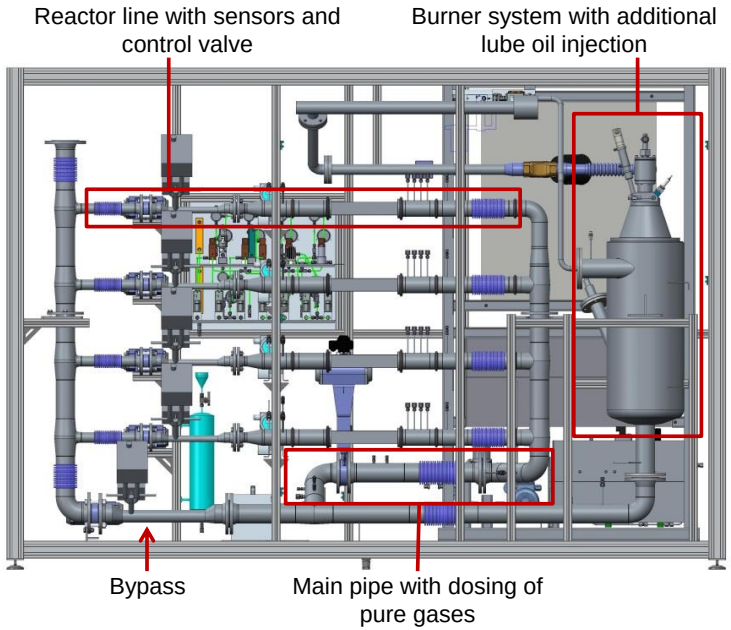


Flow distribution, validated with CFD

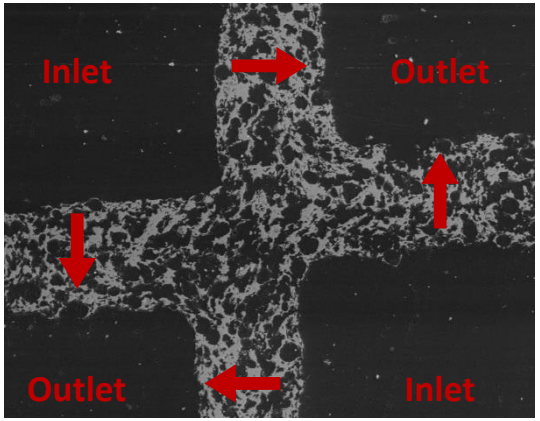
WP8.2: Combined SCR and DPF

Main results achieved during 2nd year

- Build-up of synthetic gas test bed including particulate matter generation and characterisation (D.8.3)
- Investigation and characterisation of SCR coated Diesel particulate filters in laboratory scale (D8.3)
  - SCR performance test
  - Back pressure investigation
  - Optical investigation with SEM
- Pre-tests of Diesel oxidation catalysts on engine test bed with different marine fuels



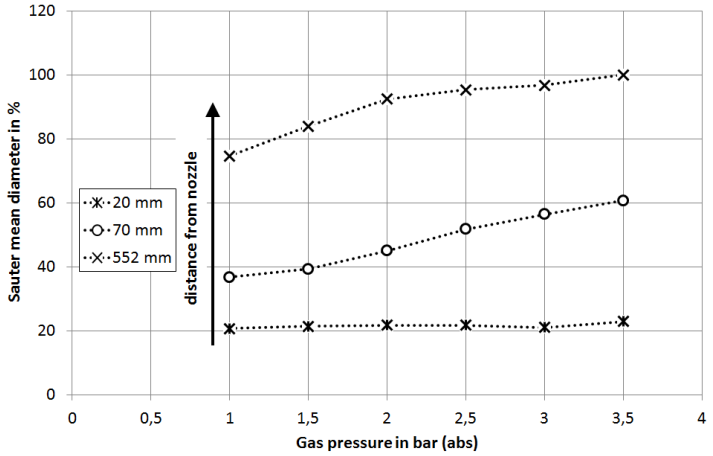
Synthetic gas test bed



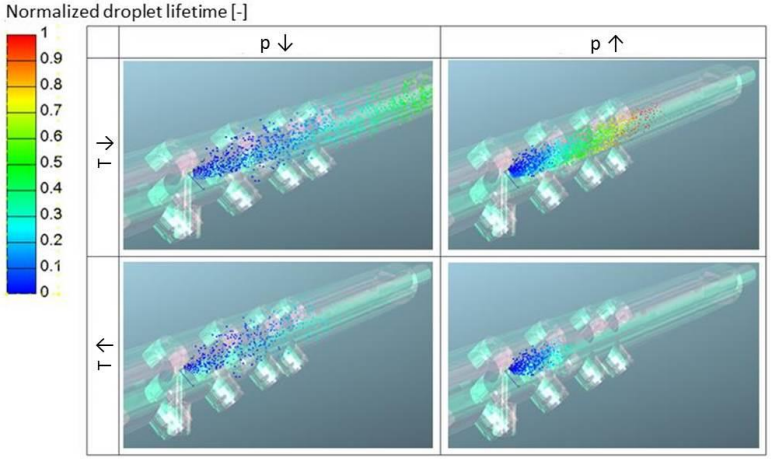
SEM image of uncoated DPF

Main results achieved during 2nd year

- Study of influence of hot gas pressure and temperature on urea decomposition
  - ➢ Spray configuration and droplet spectra
  - ➢ Chemical components
- Investigation of mixing elements to enhance urea decomposition
- Both tasks carried out experimentally (LUH) and numerically (MDT-AUG)
- All work and results of first two years covered in D8.4



Influence of pressure on droplet diameters



Simulated spray behaviour at different operating conditions

Future Work

- Manufacturing and installing of a new exhaust gas receiver with integrated SCR on 4T50ME-X
- Test Engine integrated HP SCR on 4T50ME-X
- SCR Testbed, DTU: inlet pipe flow, more realistic catalyst model, pulsating flow
- Ongoing characterization and investigation of SCR on DPF samples
- Procurement of the benchmark system of SCR coated DPFs for validation on an engine test bed in full scale
- Endurance test of the DOC system on engine test bed with marine distillate fuel up to the installation of the EAT including SCR on DPF
- Improve design for urea decomposition unit and further investigation on mixing elements and different process parameters
- Modelling of urea decomposition for real engine upscale