Objectives / Expected Results

WP Leader: Dr. M. Moser, T. Moeller

Cut operating, maintenance and deployment costs

- Develop systems, methods an processes for improved engine lifetime performance

Reduction of emission & increased efficiency at part load

- Cylinder cut-out
- NOx: expanding operation range emission reduction technologies
- Particle: novel lubrication injection system

Enhance dynamic performance

- Model-based control

Partners:

University of Bremen

Vienna University of Technology

Karlsruher Institute of Technology

Linköping University

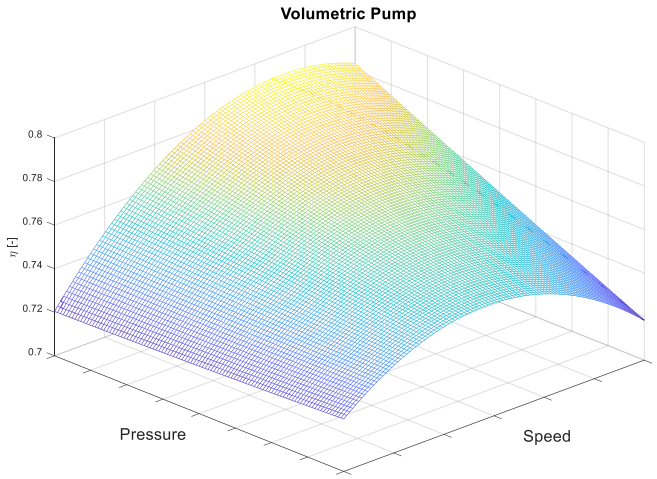
Aventics GmbH

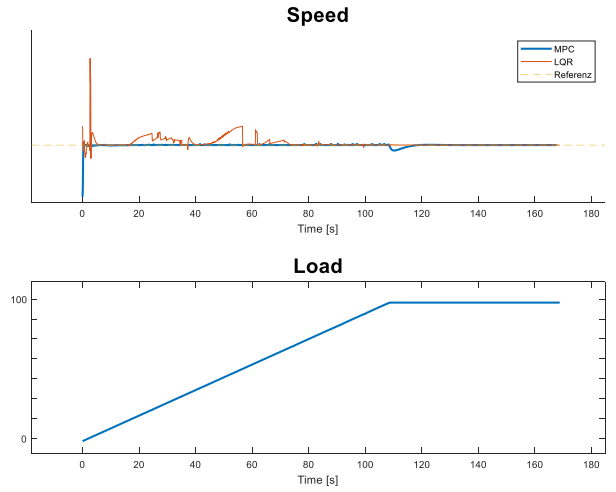
Technical University of Denmark

National Technical University of Athens

Engine control and optimization

- Development of physical-based models for Model-based engine control
- Combustion model developed and implemented
- Volumetric efficiency of the engine (volumetric pump) modeled
- The model was identified with simulation results in order to enable an comprehensive validation against an standard PID controller
- The model was build up in Matlab/Simulink and C++
- Model predictive controllers (MPC and LQR) were designed
- Next step is the comparing of the different control concepts by simulation

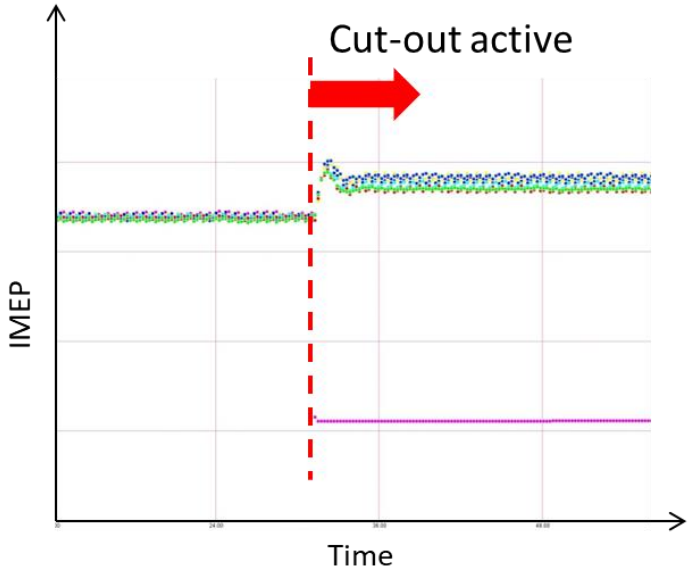


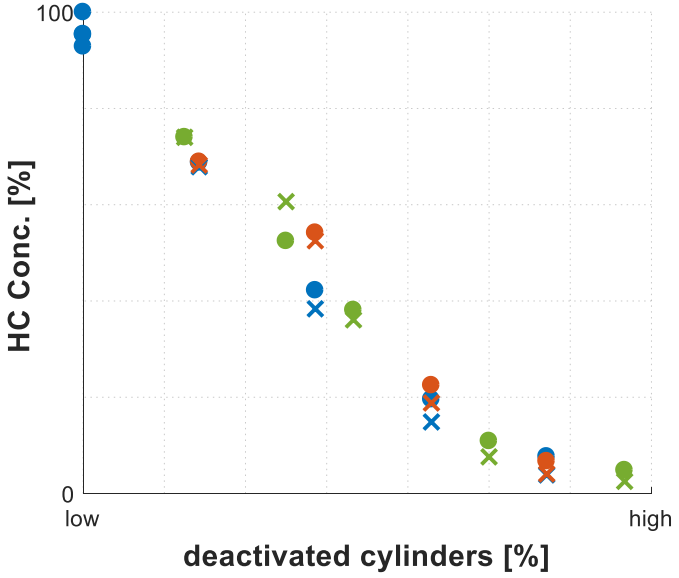


Engine control and optimization

- SW-function for low load operation with cylinder cut out (static, dynamic, different amount of cylinders) was developed
- Prototype-SW was model-based developed and tested on the HiL test bench
- Test on the engine has been conducted without any problems or delays
- Promising results were achieved – evaluation in progress

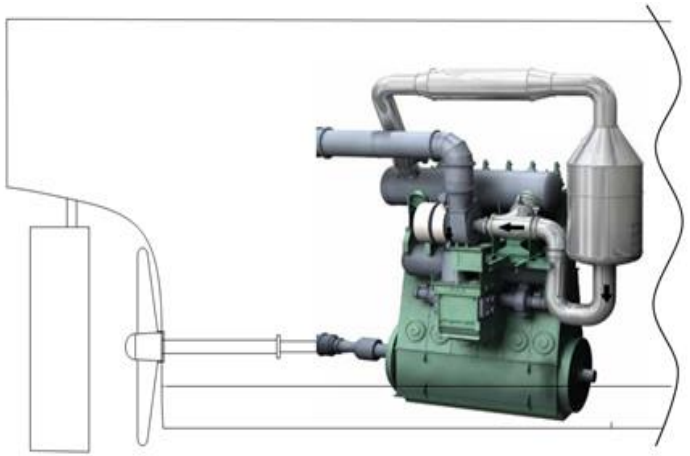
- Publication of paper “Engine Efficiency Optimization under Consideration of NOX- and Knock-Limits for Medium Speed Dual Fuel Engines in Cylinder Cut-Out Operation” on SAE World Congress 2018

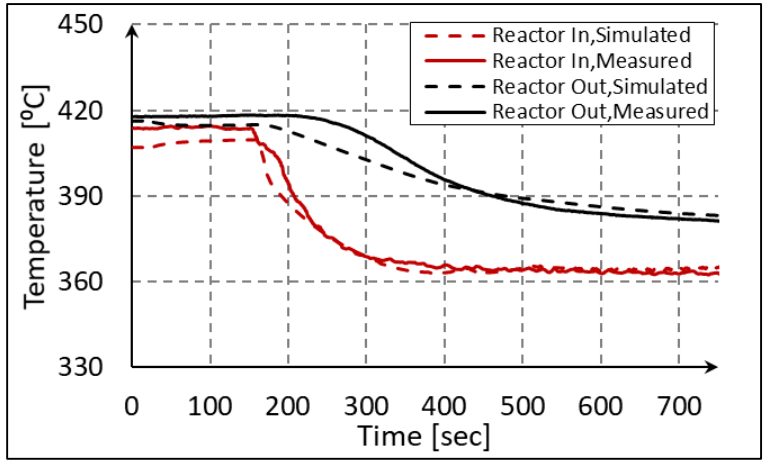




Engine control and optimization

- An engine, SCR, propeller and ship model was developed and validated using measurement data
- A blower model was also developed in order to increase model accuracy in low loads
- Transient simulations of the entire system (engine with SCR-propeller-ship) were performed
- The focus will now turned on low load SCR simulations
- Next steps are an investigation the effect of heavy weather on the performance of an SCR engine
- And engine performance during Tier 2 to Tier 3 switching

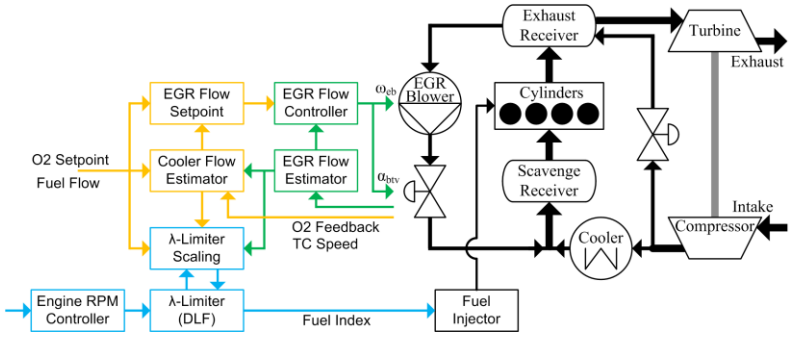




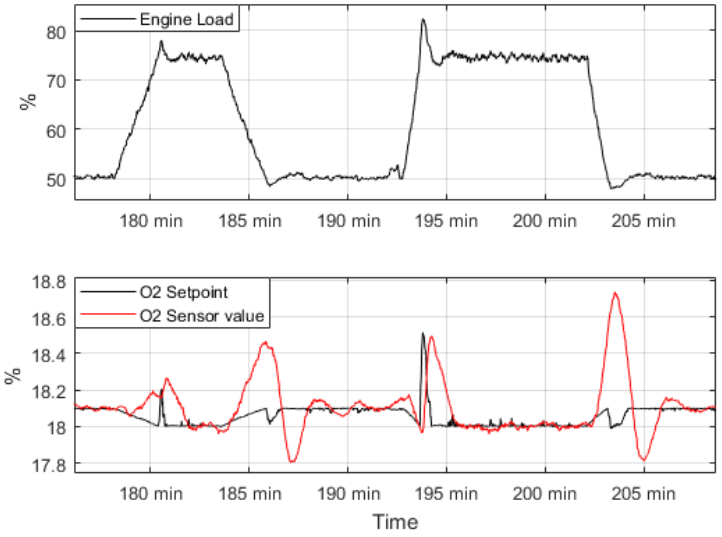
SCR Reactor Inlet and Outlet temperatures during a deceleration from 100% to 75% load (Tier 3)

Engine control and optimization

- A new EGR controller has been implemented as part of MDT's emission reduction control system software package and is available on new build vessels
- The new EGR controller was tested in acceleration tests on the 4T50ME-X engine and on several shop tests
- The shop test showed improved transient performance compared to the previous controller
- Scavenge O_2 control was significantly improved
- Small software bugs where found
- Next step will be to test new EGR controller on vessel during maneuvering



New EGR control design.



Results from acceleration tests.

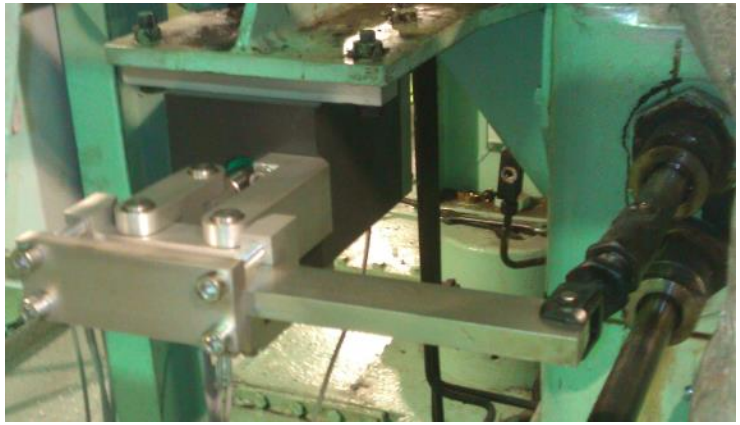
Engine control and optimization

- Development of a retrofit solution for continuous engine performance optimization for mechanical controlled engines
- Electronically controlled actuator for fuel injection (double-acting pneumatic cylinder with a non-contact displacement sensor)
- Mechanical prototype sample designed, produced and tested
- Failsafe behavior was tested (failure in the control signals, the supply of electric power or air)

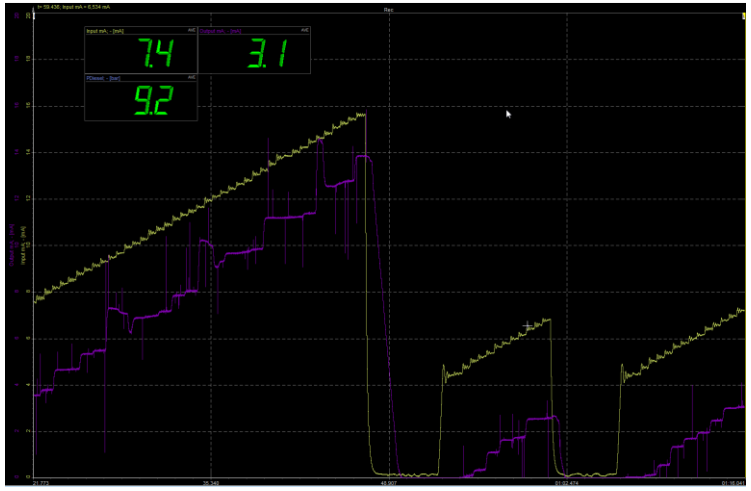
➢ Due to drop in fuel oil price no field test carrier could be found

➢ No further prototype samples will be produced

WP 6.5 further development stopped



Prototype actuator

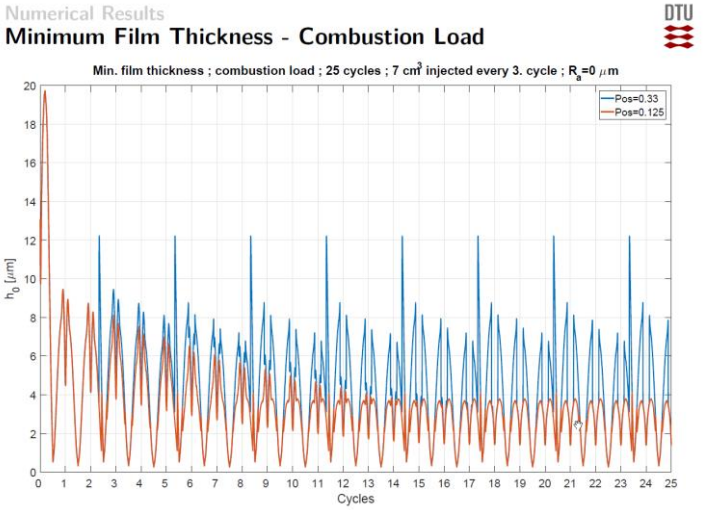


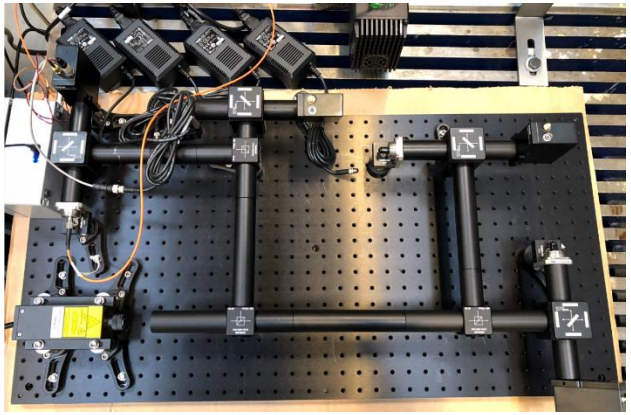
Test results

Engine control and optimization

- New numerical techniques have been developed
- The numerical code was validated, bugs were fixed and the code was optimized
- Multi channels laser induced fluorescence (LIF) system was installed
- The instrumentation of the piston rings and cylinder liner to be tested is in progress
- The configuration of the measurement setup for the system is ongoing

- The paper “Finite Element Method for Starved Hydrodynamic Lubrication with Film Separation and Free Surface Effects” was published (Computer Methods in Applied Mechanics and Engineering)





Remote monitoring & software distribution

- Development of a stream based sub space search method witch allows to analyze data streams
- Alarm detectors continuously adapt their concept of usual
- Investigations concerning compression rate and sub space search quality was carried out
- High compression rates prevent from finding high-contrast subspaces
- Above 60% compression the data quality gets to worse for sub space search
- To overcome this: utilize dependency of sensor measurements in compression