Optimization of Mixture Formation in Medium Speed Dual-Fuel and Gas Engines with Support of Advanced Optimization Techniques and Optical Measurements

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Abstract: For future gas and dual-fuel engines mixture formation is one of the most important development areas to fulfill upcoming emission legislations and to improve combustion efficiency. Therefore MAN Diesel & Turbo SE is optimizing the mixture formation of gas and dual-fuel engines with support of advanced CFD-optimization techniques and single cylinder engine measurements. Today’s CFD-optimization of an intake port with gas admission pipe is an iterative process starting with an educated first guess design which has to be evaluated with simulation results and engine measurements. This evaluation is base of the first optimization loop. The experience of the CFD-engineer is the optimization tool in that process. In general 4 to 5 iterations are necessary to improve the mixture formation and flow behavior in the intake port. With this state of the art method it takes about two weeks to reach the design target for mixture formation. With advanced CFD-simulation and optimization tools it is possible to get the best possible design under consideration of the available design parameters within days. Nevertheless, the quality of the CFD-optimization is directly linked to the quality of CFD-simulation methods. The easiest way to validate mixture formation simulation results is an indirect validation with engine measurements. The validation is a comparison of the simulated mixture formation quality at start of ignition with engine measurements considering emissions, knocking behavior and gas consumption. For bigger variations this validation shows surprisingly good agreement. Still investigating flow details and a direct validation of the mixture formation is not possible. Up to now no optical investigations considering mixture formation in the intake port for large engines are known. To close this gap MAN Diesel & Turbo SE in cooperation with the Institut fuer Kolbenmaschinen of the Karlsruhe Institute of Technology have done PIV and Mie-scattering measurements on a modified flow bench for gas and dual-fuel engines. The measurements aimed on flow behavior and mixture formation for different gas admission pipes and intake valve seat rings for varying the flow behavior in the combustion chamber. The optical measurements helped to rise the quality of CFD-simulation methods and to improve the mixture formation of gas and dual-fuel engines to fulfill future emission legislation limits.