World Academy of Science, Engineering and Technology
International Journal of Mechanical and Industrial Engineering
Vol:9, No:01, 2015

Investigations on the Influence of Optimized Charge Air Cooling for a Diesel Passenger Car

Authors : Christian Doppler, Gernot Hirschl, Gerhard Zsiga

Abstract : Starting from 2020, an EU-wide CO2-limitation of 95g/km is scheduled for the average of an OEMs passenger car fleet. Considering that, further measures of optimization on the diesel cycle will be necessary in order to reduce fuel consumption and emissions while keeping performance values adequate at the least. The present article deals with charge air cooling (CAC) on the basis of a diesel passenger car model in a 0D/1D-working process calculation environment. The considered engine is a 2.4 litre EURO VI diesel engine with variable geometry turbocharger (VGT) and low-pressure exhaust gas recirculation (LP EGR). The object of study was the impact of charge air cooling on the engine working process at constant boundary conditions which could have been conducted with an available and validated engine model in AVL BOOST. Part load was realized with constant power and NOx-emissions, whereas full load was accomplished with a lambda control in order to obtain maximum engine performance. The informative results were used to implement a simulation model in Matlab/Simulink which is further integrated into a full vehicle simulation environment via coupling with ICOS (Independent Co-Simulation Platform). Next, the dynamic engine behavior was validated and modified with load steps taken from the engine test bed. Due to the modular setup in the Co-Simulation, different CAC-models have been simulated quickly with their different influences on the working process. In doing so, a new cooler variation isn’t needed to be reproduced and implemented into the primary simulation model environment, but is implemented quickly and easily as an independent component into the simulation entity. By means of the association of the engine model, longitudinal dynamics vehicle model and different CAC models (air/air & water/air variants) in both steady state and transient operational modes, statements are gained regarding fuel consumption, NOx-emissions and power behavior. The fact that there is no more need of a complex engine model is very advantageous for the overall simulation volume. Beside of the simulation with the mentioned demonstrator engine, there have also been conducted several experimental investigations on the engine test bench. Here the comparison of a standard CAC with an intake-manifold-integrated CAC was executed in particular. Simulative as well as experimental tests showed benefits for the water/air CAC variant (on test bed especially the intake manifold integrated variant). The benefits are illustrated by a reduced pressure loss and a gain in air efficiency and CAC efficiency, those who all lead to minimized emission and fuel consumption for stationary and transient operation.

Keywords : air/water-charge air cooler, co-simulation, diesel working process, EURO VI fuel consumption
Conference Title : ICAME 2015 : International Conference on Automotive and Mechanical Engineering
Conference Location : Zurich, Switzerland
Conference Dates : January 13-14, 2015