FEV Spray-guided Turbocharged Vehicle – Reducing CO_2 Emissions

Spark ignition engine downsizing, when used in conjunction with the turbocharging, is currently considered to be a promising method for reducing CO_2 emissions. Using this concept, FEV has developed a new, highly efficient drivetrain to demonstrate fuel consumption reductions and driveability in a vehicle based on the Ford Focus ST. The newly designed 1.8L turbocharged gasoline engine incorporates infinitely variable intake and outlet control timing and direct fuel injection in a central location with piezo injectors. In addition, this engine uses a prototype FEV engine control system, with software that was developed and adapted entirely by FEV. The vehicle features a 160 kW engine with a maximum mean effective pressure of 22.4 bar. The CMD port plays a major part in depicting the required volumetric efficiency and the desired charging movement. The cooling of the cylinder head, in particular the injectors and spark plugs, was optimized using CAE design. Tests of the stratified combustion process on the engine testbed revealed potential fuel consumption reduction to about 310 g/kWh at an operating point of 2,000 rpm, 2 bar.

During the first stage, a new electrohydraulically actuated hybrid transmission with seven forward gears and one reverse gear and a single dry starting clutch will be integrated. The electric motor of the hybrid is directly connected to the gear set of the transmission. Utilizing the special gear set layout, the electric motor can provide boost during a change of gears, so that there is no interruption in traction. Therefore, the transmission system combines the advantages of a double clutch controlled gear change (gear change without an interruption in traction) with the efficient, cost-effective design of an automated manual transmission system. Additionally, the transmission provides a purely electric drive system and the operation of an air-conditioning compressor during the start/stop phases. Compared to the vehicle on which it is based with a 2.5L turbocharged engine and a manual six-speed transmission, computer simulations show a savings in fuel consumption for the downsizing concept with a 1.8L turbocharged engine and shift operation of 26 % and for a hybrid drivetrain a 34 % savings, which also offers improved performance.

One other alternative is through the use of CAI (Controlled Auto Ignition), which incorporates a process developed by FEV for controlled compression ignition. Due to the very low untreated emissions, CAI also makes it possible to avoid the complex aftertreatment of NO_x emissions, while at the same time achieving a similar potential reduction in fuel consumption to that obtained with a stratified lean-burn operation.

Furthermore, the vehicle serves to demonstrate a variety of future transmission technologies for reducing CO_2, such as stratified engine operation ($\lambda > 1$), power EGR, various turbocharging techniques and ethanol operation. It also allows for the demonstration of the optimization of exhaust emission treatment concepts, such as NO_x adsorber catalytic converters and SCR. The projected tests for NO_x reduction using SCR provides a low-consumption alternative to NO_x adsorber catalytic converter technology. The central injector position also provides the potential to fulfil the strict SULEV emission standards in $\lambda = 1$ operation, without additional exhaust emission treatment procedures.

Fig. 1: Prototype Vehicle for Demonstrating Different CO_2 Reduction Technologies

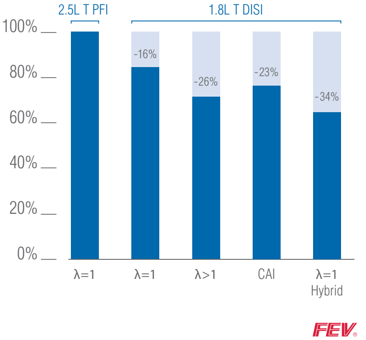

Fig. 2: Potential CO_2 Reduction Values of the SGT Demonstrator Vehicle

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