



Heavy Duty Gas Engines integrated into Vehicles

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Project partners:

7 - IDIADA - Idiada Automotive Technology S.A.- ES

9 - MAN - MAN Truck & Bus AG - DE

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Executive summary

MAN and IDIADA are developing within HDGAS project an advanced dual-fuel LNG prototype truck. This advanced truck will feature a low pressure injection (indirect injection in the intake system) engine with a diesel like performance and drivability. The MAN engine will have as economical advantage a less complex injection system hardware compared to HPDI and spark ignited engines (useful for a still small LNG trucks market with around 30 to 50% extra-costs to the equivalent truck), will have the capability to revert to full diesel operation when required as well, thus allowing LNG dual-fuel MAN trucks run solely on diesel whenever it is a lack of LNG stations (around 60 LNG stations are available in Europe at the moment in 2016) or in case of LNG is not available for any reason.

Deliverable 5.3 condenses preliminary results of the task 5.3, Development of Dual-Fuel engine, where the Master-Slave Dual-Fuel approach introduced in Deliverable 5.1 was replaced by a new fully-integrated engine management system which operates both Diesel and Gas injection at the same time in a unique control unit. This new unit integrates all the functionalities of the engine independently of the fuel used and allows the engine to run on optimized Dual-Fuel mode and operate in Diesel as it was possible before with the baseline Bosch EDC17 unit.

The D26 engine, which was previously used for Tasks 5.1, Development of initial dual-fuel engine assessment, has been upgraded with a new tailored control unit which integrates all the functions to run the engine either on pure Diesel model or Dual-Fuel mode. This functions, algorithms and strategies were performed by IDIADA and integrated on a Pi-Innovo M670 control unit.

The performed tests demonstrate the engine operation in Diesel and dual-fuel mode with the new integrated management system. For such, the baseline BOSCH EDC17 engine Control Unit (ECU) was removed and replaced by an OpenECU control unit which is used to manage all the engine systems. The new control unit interfaces by CAN with other systems such as Aftertreatment and vehicle PTM (MAN's vehicle control module).

The D26 engine was operated first on pure diesel mode to assess the functional operation of air path systems (turbocharger and throttle mainly) and Diesel injection system (Commonrail pump, injectors, etc). Functional tests were performed to assess the capabilities of the new management system (i.e to handle up to 6 injections per cycle on any single cylinder). Engine was firstly calibrated to run on Diesel in specific operating modes (idle, low speed, high speed) at low loads before it was calibrated for higher loads.

Once Diesel operation was achieved, the engine was calibrated in Dual-Fuel mode to perform initial assessment of the operation and capabilities of the system when running with both fuels operated by a single management system, thus allowing from now onwards to focus in the optimization of the Dual-Fuel operation taking advantage of an accurate management of all the engine systems (EGR, Throttle, WG, Commonrail pump, Diesel injectors) in combination with the gas systems (Gas rail, gas injectors, gas pressure regulator, etc) as well as the aftertreatment.

The test bed is configured in such a manner that in case the engineers need, for any reason, to operate the engine in its initial conditions with the BOSCH EDC17 unit, the system allows to connect the original ECU. For such purpose, the wiring harness of the engine was kept the same as for the BOSCH EDC17 unit. A break out box is used, and configured to gather data from the different control units (EDC17 in case of Diesel, and M670 in case of full-management). An extended harness, directly plugged-in between the gas injection system and the new management systems, allows to operate the Natural Gas injectors, actuators and sensors of the gas system in parallel to the Diesel systems.

Considering the results of the Deliverable 5.1, *Development of initial dual-fuel engine assessment*, and Deliverable 5.2, *2013 Dual-Fuels performance evaluation*, it become clear that the most important challenge to achieve Euro VI compliance for an indirect-injection Dual-Fuel engine is Unburned Methane.

Now the engine functional operation has been demonstrated, even including some information of the emissions reduction potential of the new combustion operation. The engine calibration and configuration will be further optimized in the next months to meet the Diesel and Dual-Fuel Euro VI emissions and CO₂ reduction targeted.

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