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Efficiency potential of gas engines for utility vehicles

Only 1% of the 1.5 million Light Commercial Vehicles (N1 class According to EC No 595/2009) sold in 2015 in Europe, were equipped with CNG engines. However, CNG drivetrain has a good potential in this segment because of:

- very low pollutant emissions, also in real-world driving conditions, due to three-way catalytic converter,
- low level of noise compared to diesel engines,
- full compatibility with renewable or synthetic biogenic methane,
- nearly unchanged payload (in contrast to hybrids and full electric vehicles),

CNG engines do not have such a large development budget as diesel engines. They are normally converted from classical engines with only small modifications and do not exploit their efficiency potential.

Jakub Rojewski
Empa, Automotive Powertrain Technologies
Powertrain Systems Group
jakub.rojewski@empa.ch

Patrik Soltic
Empa, Automotive Powertrain Technologies
Powertrain Systems Group
patrik.soltic@empa.ch

Giacomo Manca di Villahermosa
Politecnico di Milano
Internal Combustion Engine Group
giacomo.manca@mail.polimi.it

Introduction

The aim of the project is to improve the efficiency of the drivetrain of a light commercial vehicle (LCV) equipped with an engine fueled by natural gas. The first phase of the project it is the development of a accurate thermo and fluid dynamical simulation. The second phase will focus on further improvements which will require more advanced changes in the engine.

First phase

Results of experiments will be used to calibrate the engine model (Figure 1) and drivetrain model (Figure 2). This will allow an accurate analysis of the current state.

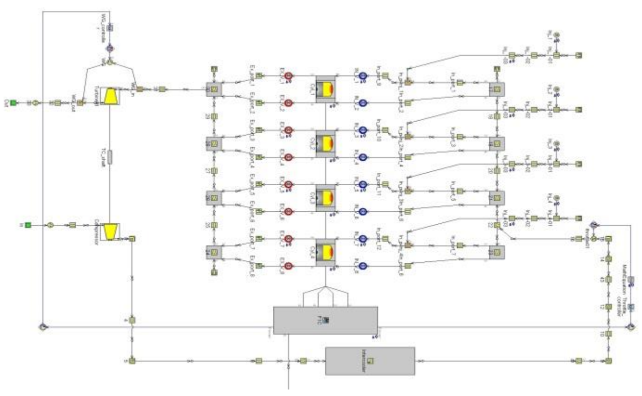

Figure 1 One-dimensional model of the engine.

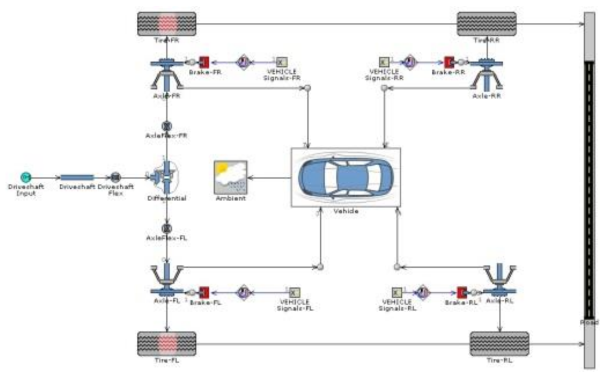

Figure 2 Model of drivetrain.

Focus of this phase is the implementation of exhaust gas recirculation (EGR). This is to limit the nitrogen oxides emmisions, but also to reduce throttling loses during partial load operation.
In stochiometric spark-ignited engines proper mixing of fresh charge is very important. This can by optimized by the use of computational fluid dynamics (Figure (3).

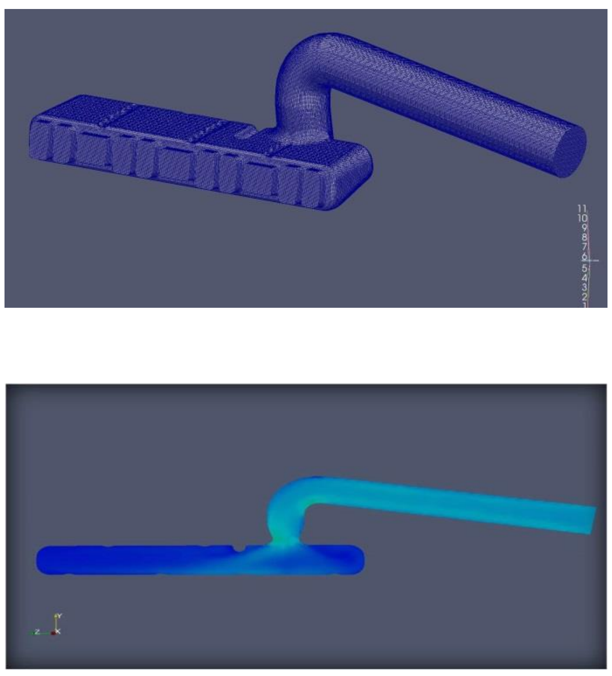

Figure 3 Intake manifold geometry and 3d air flow.

Thanks to cooperation with Politecnico di Milano it will be possible to simulate a one-dimensional model of the engine with a three-dimensional model of the intake manifold. An optimal version will be implemented on a real engine and tested on an engine dyno at Empa.

Second phase

This phase will focus on more advanced solutions such as:

- water injection - a potential reduction of the NOx level and higher volumetric efficiency,
- alternative methods of ignition – due to the fact it is hard to ignite natural gas, especially mixed with exhaust gases,
- cooled exhaust system.

Modifications necessary at this stage are for a large part of the engine (Figure 4) – exhaust and intake, manifolds, ignition system, injection, turbocharger.

Figure 4 Engine elements.

Expected impact

The aim of the project is to reduce fuel consumption and CO_2 emissions by 20% compared to the current state of EURO VI CNG engines for utility vehicles.
This is a relevant goal for industry and customers as CO_2 limits for N1 class vehicles will come into the force soon.

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