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Modelling and CNG distribution study of a Natural Gas-Diesel Dual Fuel Engine

The master thesis has analyzed the CNG distribution and its consequences through a model of a CNG-Diesel Dual Fuel engine.

In the last decades, growing environmental concerns have created the need of evolution in combustion engines for trying to give a solution to the growing problem of pollution produced by the combustion of fossil fuels. In combustion engines, this concern is traduced in stricter emission standards. Traditional engines are not enough for fighting this problem, which has produced the research of alternative fuels and new technologies.

In this context, use of natural gas in Dual Fuel engines is a promising solution. CNG (Compressed Natural Gas) present several advantages as alternative fuels, from a significant reduction in greenhouse gas emissions to good combustion properties. However, after-treatment of methane cannot reach 100% in efficiency due to its properties.

CNG-Dual Fuel engines use CNG as main energy source and diesel as ignition source. Primary fuel, CNG, is port-injected and premixed with the air for its later compression in the cylinder. Diesel is direct-injected, spontaneously auto-igniting and starting combustion. These engines can run out of CNG, working as a standard diesel engine, but cannot run only on CNG.

In order to study this technology, a 4-cylinder Volvo CNG-Diesel Dual Fuel engine has been modelled and simulated through GT-POWER software, combining experimental data and theoretical calculations. Modelling presents several advantages in research, but limitations in results have been found in this master thesis.

An experiment is designed with the objective of studying the effect of CNG injection timing, CNG injection duration and engine speed, such as their interaction, in cylinder-to-cylinder variations. The results of the simulation in eight different cases are used for this research.

In order to know how factors affect cylinder-to-cylinder variations, a statistical study of the results is made. The results show that the factor with the strongest effect is the CNG injection timing: a late injection timing increase significantly cylinder-to-cylinder variations.

In relation to CNG distribution study, main conclusions about its behaviour can be summarized in 3 points. At first, both halves of the intake manifold have a symmetric behaviour. At second, there is interaction between both halves. Lastly, fuel mass flows that take place in the intake manifold produce that the external cylinders, 1 and 4, absorb more fuel mass than the internal cylinders, 2 and 3, which is the reason of cylinder-to-cylinder variations.