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HCCI-COMBUSTION IN THE Z ENGINE
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ABSTRACT

The most common car engine is a 4-cylinder 4-stroke engine. The car manufacturers have a great pressure to lower the cost of the cars and this deals also with the engines. The challenges are the coming new emission norms (for example EURO-6) and also the custom acceptance, because of the fact, that the car drives are used to the 4-cylinder engine and they want to have the same driving fun also from the new engines.

A 2-cylinder 2-stroke engine has the same power output and toque as a 4-cylinder 4-stroke engine and thus it offers the same driving fun. Equal balancing is easy to make without some big additional costs, if the gas exchange of the engine is made by using poppet valves and camshafts. As there are only about 50% of the moving parts in the engine, its acceleration is even better than by a 4-cylinder engine.

One of the latest development in 2-stoke engines is the Z engine, having the compression partially transferred outside of the working cylinders. This offers new thermo dynamical possibilities to adjust the working cycle and the combustion. As there are methods to control the temperature at TDC, a HCCI-combustion is possible in the Z engine at all loads. This lowers significant the cost of the engine, as no urea injection, or NOx catalyst is needed to pass the coming EURO-6 emission norm. The cost of the Z engine is lower also because of the fact that it has only 2 working cylinders instead of 4. These unique features lower the production costs of the Z engine about 30% compared to an equal 4-cylinder 4-stroke engine.

In 1999, Aumet Oy began to research this 2-stroke car diesel engine, called the Z engine, in co-operation with the Internal Combustion Engine Laboratory at the Helsinki University of Technology (HUT) and the Energy Technology Department at the Lappeenranta University of Technology (LUT). So far, three master's theses, two SAE Papers and three Fisita Papers have been completed on the subject. Modern simulation tools, such as Star CD, GT-Power , Diesel RK and Chemkin have been used. Aumet's research project was a part of the Finnish Engine Technology Programme, ProMotor, and it was supported by the National Technology Agency Finland, TEKES. The prototype engine made its first start in December 2004 and testing of the engine has been made two years in a test bench at VTT (Technical Research Centre of Finland).The Z engine has until now got seven international patents, several are pending and Aumet Oy has got recently the Euro patent in February 2009

In the HCCI combustion simulation of the Z engine, a 4-dimensional ignition delay map, calculated with Chemkin and integrated in Diesel RK, has been used. The simulations and tests with the test engine show that the Z engine has a very good efficiency, especially at part load. A HCCI-combustion at all loads is possible in the Z engine, with lambda about 1,2-1,5 and EGR-rate 10-40%, depending of the load. The TDC-temperature at part load is about 800 K and at full load (bmep 30 bar) about 700 K. The HCCI- ignition, triggered with a pre chamber spark plug (Multitorch), occurs at full load between 15° - 20° ATDC and this limits the pressure and maximal temperature. NOx values are very low as the maximal temperature at full load is about 1900 K because of the low starting temperature of the combustion ,intern EGR and the expansion during the combustion.