Engine downsizing

A new engine developed by Finland-based Aumet Oy, claims to halve the volume of work cylinders in four-stroke diesels.

Aumet Oy's Z engine aims to combine the best parts of the two- and four-stroke processes. Each work piston produces a full four-stroke work cycle at its every stroke. The efficiency of the Z engine is high, especially at part load.

The Z process has been studied using different simulation tools, and a one-cylinder prototype engine has been built. The first run took place in December 2003, since when, the unit has been on the testbench at VTT (the technical research center of Finland). So far, three Masters theses, two SAE papers, and one Fisita paper have been written on the subject.

Aumet Oy has also developed a virtual two-cylinder engine, with a displacement of 1-liter for demonstration purposes. Its power output is 134bhp at 3,600rpm and the engine is the equivalent of a modern four-stroke, four-cylinder, turbodiesel engine in its balancing and power output.

The main principle of the Z engine involves part of the compression being done outside of the hot work cylinders using an external compressor. The compressed air is brought into the work cylinder through the poppet valves when the piston approaches the top dead center.

The compression is made by a two-stage compressor set: the first stage is an impulse turbocharger and the second stage is a piston compressor that is integrated into the engine.

There is an adjustable intercooler after each compressor stage to control the temperature. The pressure level of the external compression varies from seven to 15bar, depending on the speed and load of the engine. Thanks to the high intake pressure level, the intake cycle is very short, typically 20" of the crankshaft. After the intakdscavenging, the air is further compressed in the work cylinder.

The work cycle is similar to a four-stroke engine. The exhaust valves are opened at about 60' before bottom dead center. The rising piston pushes the exhaust gases out of the cylinder until the exhaust valves are closed and the intake valves are opened, typically 60" to 40" BTDC.

The amount of the internal EGR can be controlled by adjusting the overlap of the valves. The hot EGR acts as an internal heat exchanger in the Z process. The high pressure of the incoming air is converted into a high-flow speed and directed tangentially Into the cylinder, which enables high-swirl Z cdmbustion to be used through a controlled, locally homogenous combustion.

The fuel is injected at 400 to 500bar into the rotating air, and there is no injection to the flame. The fuel droplets evaporate completely during the ignition delay, therefore allowing local homogeneous combustion to be achieved.

Z combustion is analogous to swirl chamber combustion, although without such known disadvantages as HC emissions and heat and flow losses. A stoichiometric airlfuel equivalence ration can be reached with Z combustion, thanks to the effective turbulence in the heat-isolated combustion chamber, located in the middle of the piston crown. The hot combustion chamber takes only 15 per cent from the piston surface, allowing heat exchange to the rotating air to be kept to a minimum until the last moment of compression.

Two-stage homogeneous combustion leads to a low NOx and varticle emission. Due to heat transfer caked by high turbulence, the heat-isolated combustion chamber lowers the maximum temperature during combustion and acts as an internal heat exchanger during the process.

The Z combustion does not require any exhaust gas aftertreatment to comply with future environmental legislation. It is possible to make the exhaust gas aftertreatment using a common cost-effective, three-way catalyst, if necessary (for SULEV). In addition, the Z engine is about 25 per cent lighter and smaller than the equivalent turbodiesel engine. *ETI*

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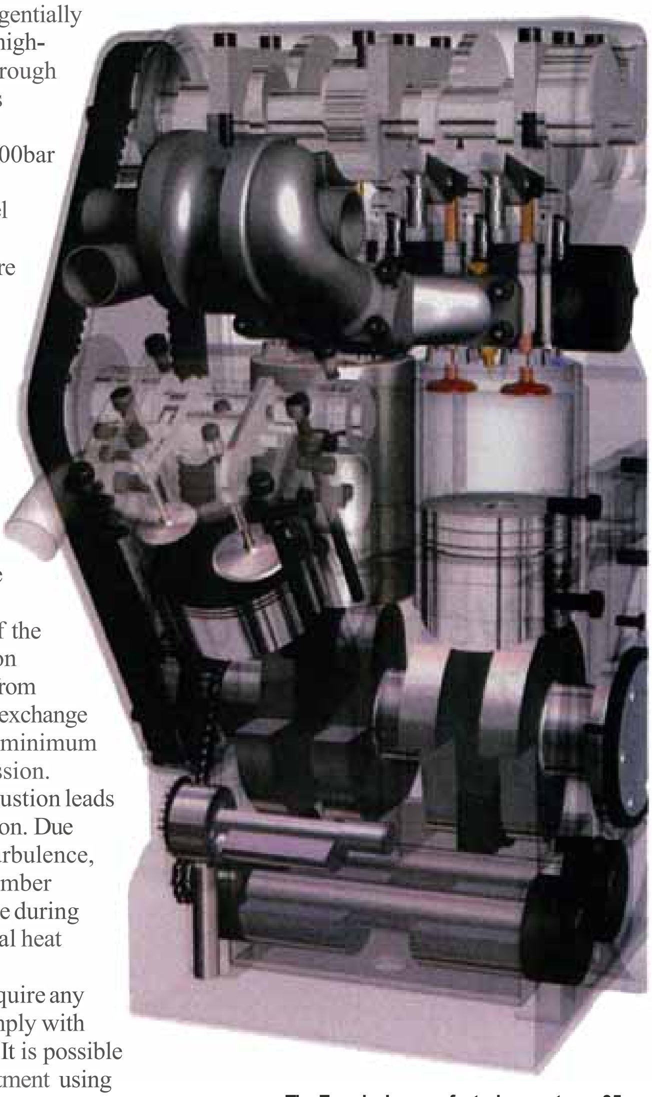

The Z engine's manufacturing costs are 35 per cent lower than equivalent turbodiesel