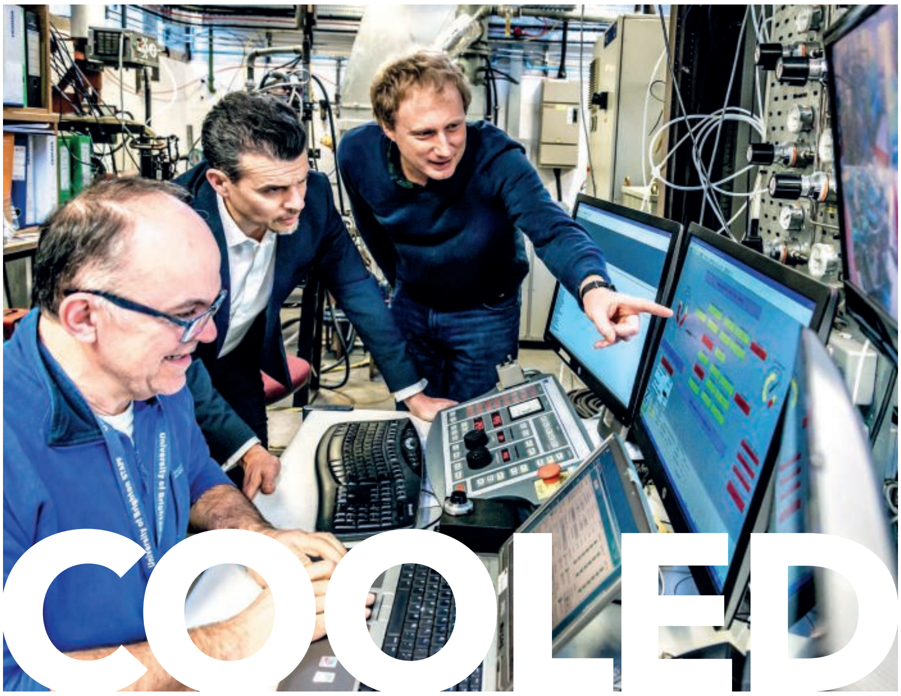
New internal combustion engine (ICE) technology, which could be in production by 2023, might potentially secure the long-term future of the diesel-powered heavy truck. Peter Shakespeare reports



ICE-COOLED

Over the past ten years, Ricardo and the University of Brighton have developed a two-stroke split-cycle ICE, employing liquid nitrogen as the charge coolant. A heavy-duty demonstrator is due in the next 18 months.

Ricardo says that, if the technology and current performance can be scaled up, it will provide a heavy-duty ICE capable of power and torque outputs matching today's long-haul diesel engines. Crucially, it will use up to 30% less fuel, whether traditional or renewable (either liquid or gas), and has the potential to produce less NOx and PM emissions than the most advanced Euro 6 diesel engines. It has launched a spin-out company, DolphinN2, to take its 'CryoPower' project to market.

The idea behind the technology is based around maximising the thermal efficiency of the engine. DolphinN2 CEO Simon Brewster (pictured at centre, above) explains that only 45% of the fuel energy that goes into a modern engine results in useful work; approximately 55% is lost as heat, largely through the exhaust gases.

Waste heat can be recovered now, using add-on devices, but Ricardo wanted to design an ICE where the heat was recovered within the engine cycle. Brewster says the split-cycle principle moves the cooler compression stage away from the hotter combustion stage.

Intake air in the compression cylinder is supercooled by injecting liquid nitrogen and raised to much higher pressure. On its journey to the combustion cylinder, this highly-compressed air passes through a gas-to-gas heat exchanger, or recuperator. Hot exhaust gas from the combustion cylinder runs in from the other end through a separate channel. The large temperature differential means the cool, highly compressed intake air takes much of the heat energy from the exhaust gas. When this air enters the combustion cylinder, the air is already energised and therefore requires less fuel to produce the same work. Brewster says that this principle is used in recuperated gas turbines for defence applications.

As a result, the engine is expected to burn 30% less fuel, resulting in a reduction of CO_2, NOx and PM emissions by at least that fraction. But the CryoPower combustion process is also cleaner than a standard ICE. Concentrations of NOx and PMs are generated in a conventional diesel when the fuel is injected, producing a hot flame front in quite fuel-rich areas. But, in the new design, the air enters the combustion chamber at very high velocity. As a result, there is a much better air/fuel mix, while the combustion process is itself much cooler. These qualities have the potential to substantially reduce soot and NOx. (Some after-treatment will still be needed, cautions Brewster, but it is anticipated to be less than now.)

A six-cylinder engine would have two compression cylinders and four combustion cylinders. Since the engine cycle is two-stroke, there will be four power pulses per revolution, as opposed to the conventional three. Brewster is confident that power and torque outputs will match those of current heavy truck engines.

Achieving such a highly efficient, stable and clean combustion on the test bench has been the big breakthrough in the last 12 months. But Brewster reckons that, once in production, the new engine will be cost-comparable with existing engines, as much of its architecture will mirror conventional ICEs.

One big difference is the liquid nitrogen required, in a similar quantity to fuel. (Dearman is also using it for trailer cooling: ***https://is.gd/kilixo***.)

DolphinN2 is working with a tier one heat exchanger supplier and an injector manufacturer, and is already in discussions with a US-based global OEM to license the technology. TE