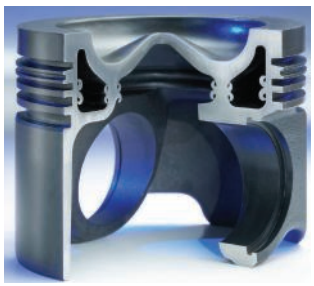

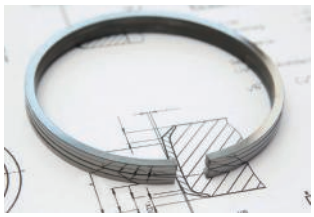

Engine bearing materials, coatings, piston materials and designs, and piston rings and their coatings are all contributing to future CO_2 emissions reductions. John Kendall reports

Fighting friction

Federal Mogul may be better known to you for vehicle components, such as Ferodo brake parts and Champion spark plugs, but the company also has a long-established business that includes piston rings and engine bearings. Indeed, according to Joachim Häring, European application engineering manager for bearings, the firm introduces 20 innovations per year from its bearing technical centre, at Wiesbaden in Germany.

Among bearings Federal Mogul manufactures for heavy-duty diesel engines are con-rod bushes, main and flange bearings, rocker arm bushes, fan drive and oil pump bushes, gear train bushes and crankshaft thrust washers. And now that Euro 6 emissions limits are in force, and future legislation looks likely to focus on reducing carbon dioxide emissions and fuel consumption, the spotlight may well turn on further reducing friction in the engine – with bearings playing a key part.

Lead-free opportunities

There are opportunities. As Häring explains, lead (originally introduced for its lubrication properties) was banned from bearings for light-duty engines in the EU from 1 July 2011. Since that time, all cars and light CVs up to 3.5 tonnes gvw have used lead-free bearings. Admittedly, the directive does not apply to heavier vehicles, but Häring reckons that will come.

Why? First, engines are facing higher in-cylinder pressures as the drive for more efficient combustion increases. Peak pressures could reach 250bar or higher, so bearings must handle greater forces. Secondly, stop/start systems are contributing to bearing wear, with truck and bus engines facing around 1.2 million stop/start cycles over the lifetime. Thirdly, oil viscosity and temperature can be more variable in stop/start engines, affecting how well the fluid lubricates moving parts – particularly with the trend towards lower viscosity types. But above all, the drive to reduce CO_2 emissions will favour further reduced engine friction and that means lead just has to go.

Federal Mogul's latest materials have certainly demonstrated improved wear resistance, increased fatigue performance, good resistance to seizure and low sensitivity to particles. One, dubbed IROX, is iron oxide based, with a polymer resin coating delivering further improvements and an optimised interaction with the oil film. Solid lubricants in the coating also maximise lubricity in the mixed lubrication states caused by stop/start.

Häring also points to a trend towards aluminium bearing materials for heavy-duty engines – popular for their low wear rates and ability to tolerate main bearings' high loads. Aluminium also offers excellent corrosion, seizure and wear resistance. Aluminium-based bearings can be upgraded with IROX.

Beyond bearings, though, reducing piston friction is another means of improving efficiency and here, the trend is away from aluminium, in favour of steel pistons, certainly for larger capacity diesels. Increasing cylinder pressures is one of the drivers. A few years ago, steel was the piston material of choice for 13-litre engines, but now it is also used in 9- and 10-litre engines. A double seam in the piston design creates a large sealed gallery under the crown to help promote piston cooling. This can reduce temperature by 50–100°C on the piston crown.

In addition, optimising the design of the piston skirt can reduce friction by 14.5%, according to Federal Mogul. It is even possible to reduce the weight of a mono-steel piston, compared with aluminium, because it can be smaller, meaning that the engine block can also be shorter and hence lighter, which also contributes to fuel and carbon dioxide reductions. By using Federal Mogul's DuroGlide piston ring coating, which incorporates amorphous carbon, as well as shorter pistons, friction can be further reduced by up to 8%. This could translate into a fuel consumption reduction of around 3.5%.