Ultrasonic measurement of thin, high speed oil films between the piston and cylinder of internal combustion (IC) engines

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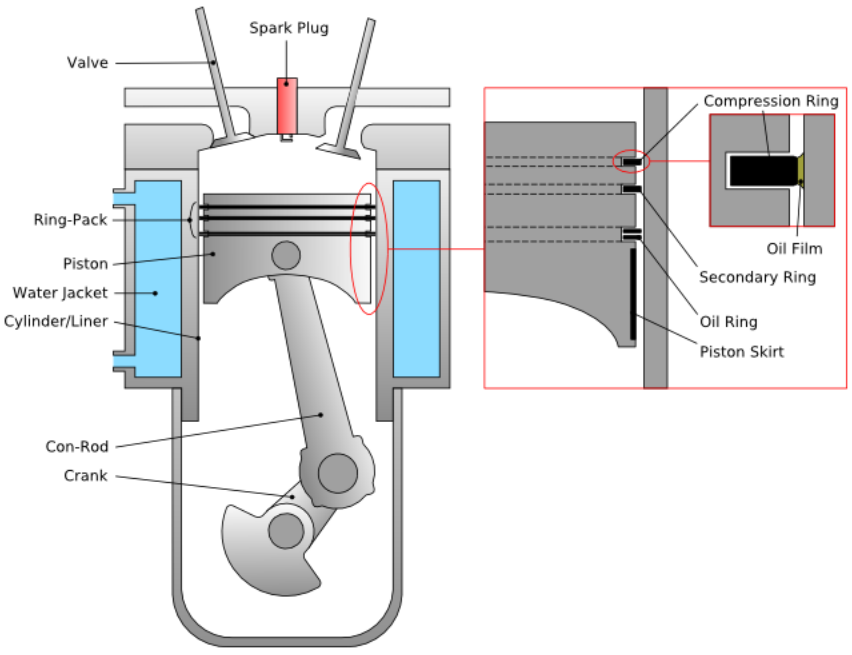
Why measure film thickness?

The energy lost due to friction between the pistons and cylinder of a typical engine costs the consumer around 4 pence for every litre of fuel. The layer of oil between these sliding components governs this energy loss and measurement of its thickness using ultrasound provides key information to help design both better engine components and lubricants.

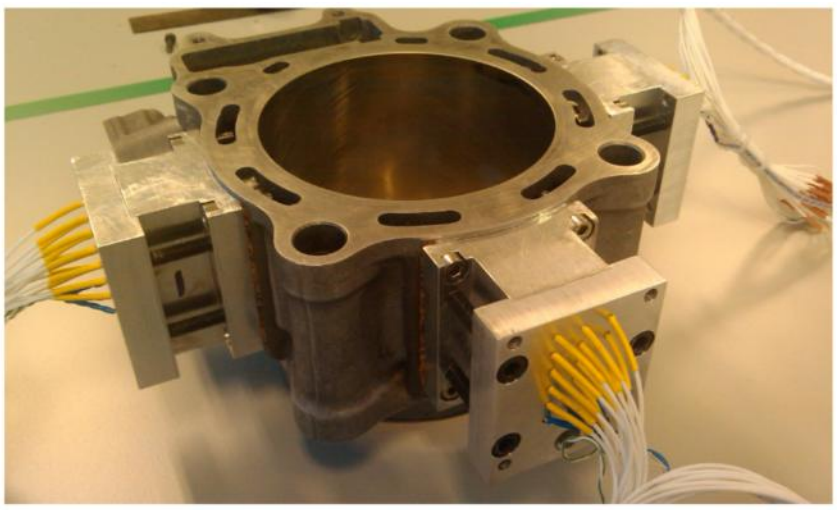


Project description

If an ultrasonic wave encounters a layer of oil sandwiched between two components where the wavelength of the ultrasound is large compared to the thickness of the oil layer, a portion of the sound energy will be transmitted through the oil layer, while the remainder is reflected.

By measuring the amplitude of the reflected portion of the wave (the reflection coefficient) and knowing the acoustic properties of the oil and engine components, the thickness of the lubricant layer can be calculated. Piezoelectric elements have been used to send ultrasonic pulses at 80,000 pulses per second through the cylinder wall.

Measurements on the thrust, anti-thrust and neutral sides of the engine have been obtained, showing how piston speed and combustion pressure affect the thickness of the lubricant film formed at both the piston rings and piston skirt. This work forms a part of a larger project termed 'Encyclopaedic', which is a collaboration of key front-line industrial and academic partners funded by the EPSRC.

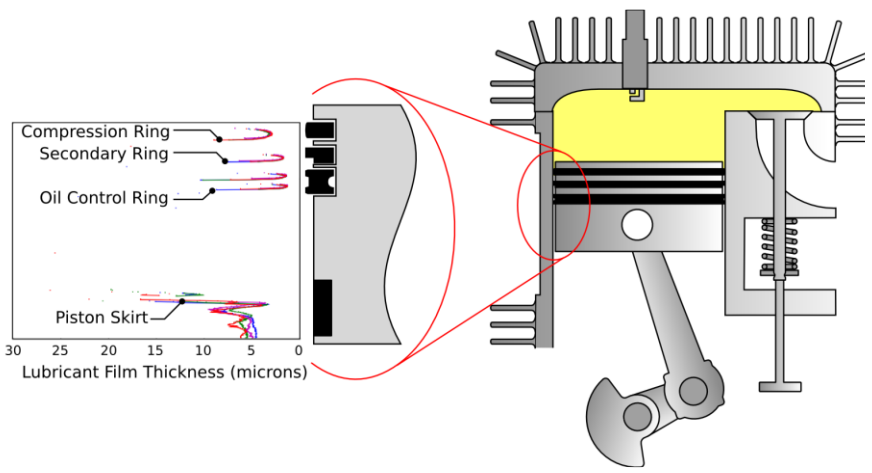


Why is this information useful?

Robust measurements of oil film thickness help validate numerical models that are being used more and more to improve the design engine components and lubricants. The ultrasonic method enables these measurements to be obtained when the engine is operating under fully fired conditions and with little modification, offering a key advantage over other techniques that are available.

By reducing the frictional losses, a direct improvement in engine efficiency is achieved, benefiting the consumer and the environment.

A better understanding of the lubrication conditions leads to improvements in design and results in extended operational life and longer periods between maintenance.



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