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Minimising Autoignition for optimum efficiency in high specific output spark-ignited engines

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ABSTRACT

From the very outset of the development of spark-ignited IC engines, the need to avoid autoignition has limited both the geometric compression ratio and the boost pressure that can be employed, thereby effectively restricting both engine efficiency and specific performance levels that can be achieved.

The current trends for downsizing in the meantime require ever increasing specific power and torque output levels on the one hand, and lead to increased engine residency time at higher load on the other. These factors mean that a greater proportion of real-world driving time is spent within regions of the operating map where combustion phasing is limited by knock. Compounding this, the combination of high boost pressures and retarded combustion phasing have also significantly increased the propensity for pre-ignition at low engine speeds.

Due to these effects, the fuel efficiency of vehicles is becoming increasingly sensitive to the knock limit, and reducing the tendency for fuel/air mixtures to auto-ignite is key to delivering improvements in real-world fuel consumption. To this end, a systematic and holistic approach to minimising knock is required and a detailed understanding of the interaction between engine systems in this respect is vital.

This paper focuses on selected examples of MAHLE's approach, taken from development work conducted with its own agressively downsized 1.2 litre three-cylinder engine, to illustrate the effectiveness of the integrated technologies in providing optimum resilience to auto-ignition. It concludes with an outlook on future powertrain developments that will be required to ensure that engine operating efficiency can be maintained with increased specific power outputs.