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Knock Mitigation Benefits Achieved through the Application of Passive MAHLE Jet Ignition Enabling Increased Output under Stoichiometric Operation

Engine and vehicle manufacturers are facing increasing pressure from legislation to reduce vehicle emissions and deliver improved fuel economy. Significant reductions in carbon dioxide (CO₂) emissions will need to be achieved to meet these requirements whilst also satisfying the more stringent forthcoming emissions regulations. This focus on techniques to reduce the tailpipe CO₂, whilst also being able to operate over the whole map without the use of fuel enrichment for component protection, is increasing the interest in novel combustion technologies. The pre-chamber-based Jet Ignition concept produces high energy jets of partially combusted species that induce ignition in the main combustion chamber to enable rapid and stable combustion.

The present study focusses on the potential of passive jet-ignition to enable increased output whilst maintaining stoichiometric operation through reduce knock sensitivity. Results demonstrating this capability will be presented, along with those showing a lower sensitivity to the research octane number (RON) of fuels and the ability to further extend the stoichiometric operating boundary, through the combined use of the passive pre-chamber with external exhaust gas recirculation (EGR). Measurements from MAHLE's high specific output 1.5-liter downsizing demonstrator engine will be used to illustrate the benefits achievable through these combined technologies. The pre-chamber concept has been further developed such that it can both be packaged within the same envelope as a conventional M12 spark plug and operate under all conditions without the need for a second ignitor in the main combustion chamber, enabling application into existing cylinder head architectures.