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MAHLE Powertrain

Authors:
Adrian Cooper, Anthony Harrington, Mike Bassett and Simon Reader

Application of a Passive Pre-Chamber Ignition System as an Enabler for Increased Efficiency across a Range of Hybrid and Conventional Powertrains

Engine and vehicle manufacturers are facing increasing legislative, economic and social pressure 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 at the same time satisfying the more stringent forthcoming emissions regulations. This necessary focus on techniques to reduce the tailpipe CO2 is increasing the interest in both, hybrid and electric vehicle technologies, and in novel combustion technologies, such as dilute combustion, as a means to improve gasoline engine efficiency.

The pre-chamber based Jet Ignition concept produces high energy jets of partially combusted species that induce ignition in the main combustion chamber and enables rapid, stable combustion, even with dilute mixtures. The beneficial synergies of the pre-chamber system with high geometric compression ratio, Miller cycle operation and cooled external EGR are discussed. This presentation then focusses on the potential for application of this technology across a range of both hybrid and conventional powertrains, including MAHLE's Modular Hybrid Powertrain (MMHP) concept.
This hybrid concept features a cost effective and high-efficiency, two-cylinder gasoline engine, utilising a pre-chamber combustion system, achieving over 40% brake thermal efficiency from a very low-cost architecture. This compact engine is combined with an electric traction system which can satisfy the full-dynamic requirements of the vehicle, even during pure-electric operation. A compact multi-speed transmission then enables the internal combustion engine to be operated in either series hybrid, or direct drive modes. Pure electric vehicles require bulky and expensive battery packs, with a high embedded CO2 content, to enable an acceptable driving range. The MMHP concept partly overcome the limitations of current battery technology through the ability to maintain battery state of charge that allows a reduction of the traction battery storage capacity, whilst still maintaining an acceptable vehicle driving range.