Simulation and Optimisation of a Variable Valvetrain System for a Compression Ignition Engine

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Abstract

Variable valve actuation is now a common method of improving both the performance and economy of spark ignition engines. Its application to compression ignition engines has been more limited, in part due to the higher compression ratio restricting the opportunity to adjust inlet valve opening or exhaust valve closing events without clash, limiting the usefulness of a simple cam phaser.

This paper describes how 1D cycle simulation has been used to investigate and optimise the MAHLE CamInCam® system applied to the inlet camshaft of a 4 valve turbocharged diesel passenger car engine. This allows phasing of the two intake valve events relative to each other to adjust the duration of the intake valve event while leaving intake valve opening unchanged.

The performance characteristics of the ports were determined at different combinations of valve lifts and timings, allowing the 1D model to be used to simulate phasing of the individual cams and predict in-cylinder charge motion. Design of Experiments techniques were used to analyse a range of valve lift profiles and cam timings to determine their effects on engine performance, fuel economy and emissions at a range of speed load points.

Altering the valve events allows the in-cylinder charge motion to be controlled by varying the relative flow between the two intake ports. It was found that the range of charge motion available was similar to that provided by the fully variable swirl flap on the baseline engine.

The model was used to investigate CamInCam® with both early and late inlet valve closing strategies. The simulation showed how this has the potential to reduced in-cylinder charge temperatures, improving both combustion and emissions. Pumping work was also reduced leading to improved fuel economy.