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Simulation of Exhaust Gas Residuals in a Turbocharged, Spark Ignition Engine

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ABSTRACT

Highly downsized, Direct Injection (DI) engines benefit strongly from cylinder scavenging where possible, to reduce internal residuals thereby reducing the occurrence of knock. Some researchers also suggest that non-homogeneous distribution of internal residuals at high load could contribute to pre-ignition or 'mega-knock' with much higher pressure amplitude than that of common knock.

For this reason, a computational study was conducted to assess the residual gas fraction and in-cylinder distribution, using the combustion geometry of the three cylinder, 1.2L MAHLE Downsizing engine, which has proven to be a very robust and reliable research tool into the effects of combustion effects under a number of different operating conditions. This study used a CFD model of the cylinder gas exchange. ES-ICE coupled with STAR-CD was employed for a moving mesh, transient in-cylinder simulation. The boundary conditions were provided by a correlated 1-D (GT-power) model, with several scenarios simulated including engine speed, valve overlap and port geometry. The residual distributions at part load with different inlet ports were also assessed.