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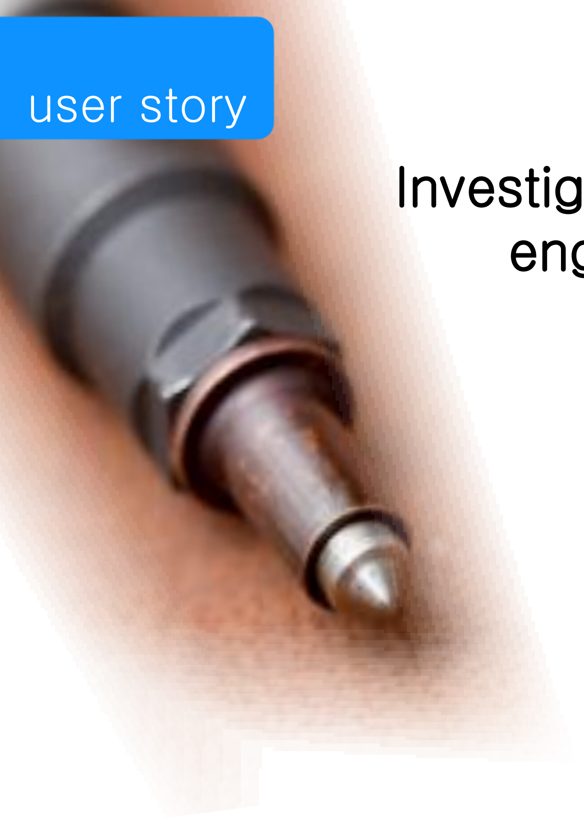

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Investigating fuel reforming in an HCCI engine with dual injection strategy

the effects of injection timing and fuel split ratio

Homogeneous Charge Compression Ignition (HCCI) offers improvements in efficiency and reductions in NO_x emissions when applied to a gasoline engine. It is characterised by low temperature fuel oxidation that occurs throughout the engine cylinder in a short period of time with multiple ignition sites.

HCCI may be achieved in a Spark Ignition (SI) engine by altering the valve strategy to produce a Negative Valve Overlap (NVO). With this strategy the exhaust valve closes early, trapping large amounts of residuals, increasing the in-cylinder temperature, at the same time as diluting the charge. Some of the fuel may be injected during NVO, which will release heat, further increasing the in-cylinder temperature. The large amount of exhaust gas that remains in the cylinder makes each cycle highly dependent on the previous cycle.

To investigate an engine mode in which each cycle is very dependent on the previous, requires multi-cycle simulations. The short computational times achieved by srm suite enables multi-cycle simulations to be performed, whilst taking into account the chemical effects of fuel reforming, with its impact on ignition, combustion and emissions. Once characterised, this model can be adopted to identify optimal operating strategies for injection timing and fuel concentration.

This document outlines some of the results obtained when the srm suite in-cylinder combustion software was applied to simulating an HCCI engine, operated with NVO and a dual injection strategy.

THE CHALLENGE

Investigate the effect of fuel reforming in an HCCI engine operated with NVO and a dual injection strategy.

THE SOLUTION

An injection timing and fuel mass parameter sweep was conducted using srm suite coupled with commercial software to enable multi-cycle simulations.

THE RESULTS

•HCCI combustion with a dual injection strategy was simulated with srm suite.

•Injection timing and Fuel Split Ratio were varied.

•Trends in combustion phasing and emissions matched experimental results.

•The cause of the trends was investigated by decoupling parameters in simulations.

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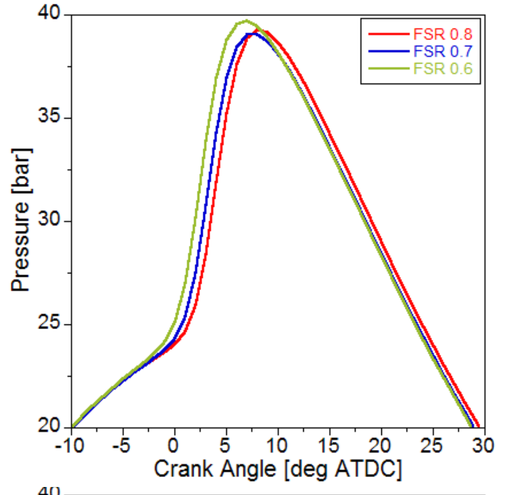
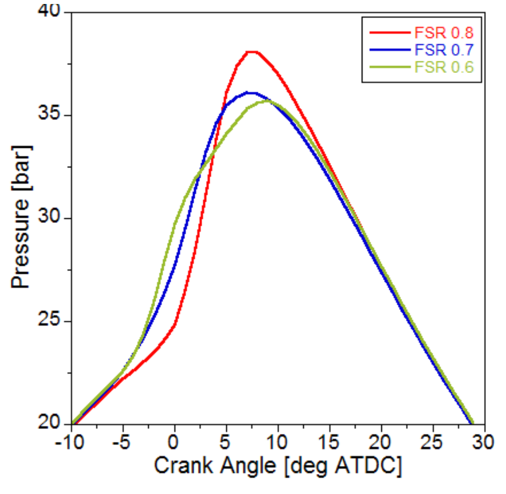




Above: Averaged pressure profiles over 200 experimental (top) and 40 simulated (bottom) cycles with different Fuel Split Ratios (FSR). The FSR is the fraction of fuel injected after NVO, in the main injection.

APPLICATION AREAS

- HCCI
- Alternate fuel injection strategies
- EGR
- Emissions

PRODUCTS USED

- srm suite

THE RESULTS

•Increased FSR retards combustion phasing

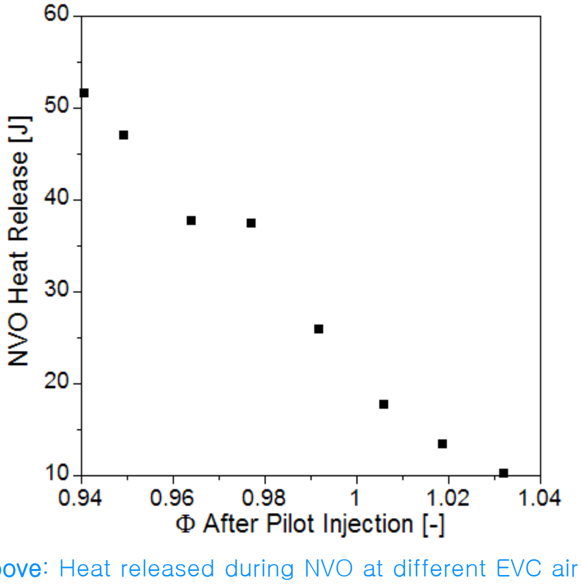
Increasing the Fuel Split Ratio (FSR) caused the combustion phasing to be delayed in both the experiment and simulation. The Fuel Split Ratio is the fraction of fuel injected during the main injection, after NVO. The delay in combustion phasing was caused by lower in-cylinder temperatures when less heat release occurred during NVO.

•Fuel reforming retarded combustion phasing

The chemical effect of fuel reforming on combustion phasing was investigated using a detailed gasoline oxidation model. Increasing the O_2 concentration increased the NVO heat release at the conditions examined. The reformed fuel proved less reactive as the reactions proceeded towards complete oxidation during NVO.

•Early injection advanced combustion phasing

Advancing the pilot injection timing caused an increase in NVO heat release and advanced the main combustion phasing. The higher in-cylinder initial temperatures caused by increased NVO heat release had a greater effect on combustion phasing than the reactions during NVO, which made the fuel less reactive.



Above: Heat released during NVO at different EVC air mass fractions.