user story

the impact of fuel properties on “knocking” combustion in boosted spark ignition engines

THE CHALLENGE

To simulate combustion in SI engines under knocking conditions for a variety of fuels. Complete a *“blind test”* of the model.

THE SOLUTION

Using the srm suite software to simulate DISI engine combustion with detailed chemical kinetics

THE RESULTS

•A validated combustion model for spark ignition engine applications

•Knock onset times and heat release rates were obtained

•A blind test of the model was completed for a range of fuels and cycles

In recent years, in order to achieve the required fuel economy benefits, DISI engine designs have moved toward further downsizing and increased boosting. In addition, frictional losses have been minimised through “downspeeding”, both steps have increased the possibility of unwanted “knocking” combustion. Regular operation under such modes can result in catastrophic failure of engine components.

Computational modelling tools have been employed to facilitate the development process through the use of “virtual” engines. Such an approach enables for major design steps to be partially completed on an engineer’s desktop rather than in expensive and time consuming experimental test programs. Potential designs might include testing combinations of fuel specification (ULG95 or ULG98), determining suitable boost pressures (and temperatures), matching compression ratios and finally through mitigation by testing potential alternative operating strategies.

THE CHALLENGE

To simulate combustion in SI engines under knocking conditions for a variety of fuels. Complete a *“blind test”* of the model.

THE SOLUTION

A series of computations using srm suite with its advanced fuel oxidation and emissions models were completed.

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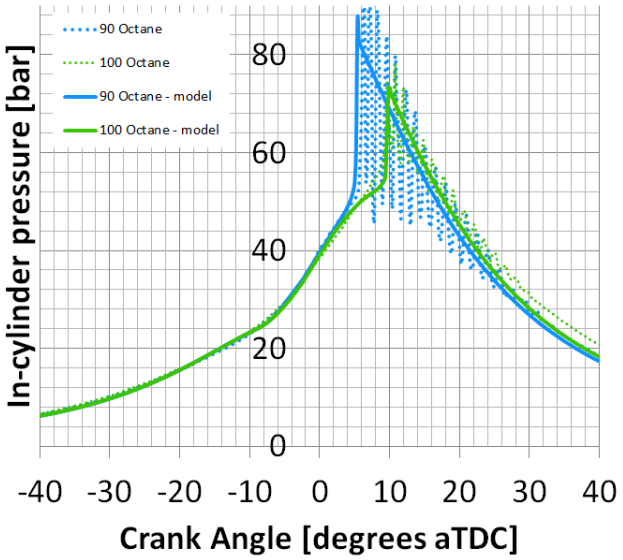


Above plots the in-cylinder pressure for 90 and 100 octane rated fuels. Experimental data was obtained from a manifold injection engine, engine speed 1500rpm, spark timing -20 CAD aTDC. The srm suite robustly computes heat release rates and the onset of knock.

APPLICATION AREAS

- DISI
- Port injected SI
- SI "knock"
- fuel development

PRODUCTS USED

- srm suite

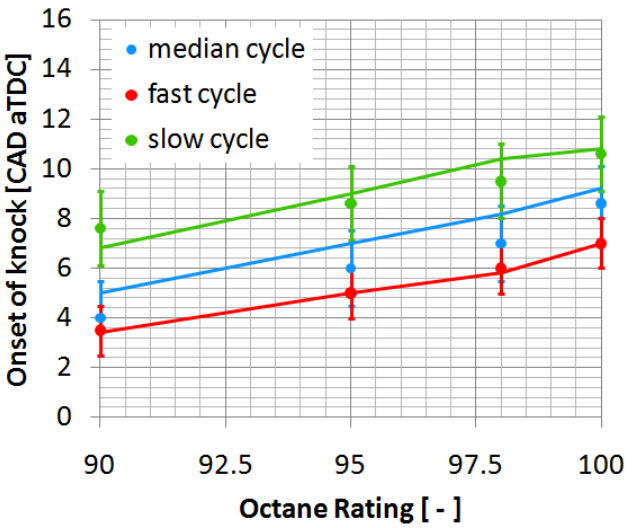
THE RESULTS

•The srm suite was used to analyse knocking combustion in boosted SI engines

Mixture preparation, turbulence, flame propagation and end gas knock were predicted using the model. Heat release was simulated using both empirical and semi-physical turbulent entrainment models. Model parameters were calibrated to data obtained with the median cycle for the 100 octane rated fuel. The model was then applied as a *blind test"* to all other cases. The onset of ignition was predicted well with respect to experiments.

•Blind testing for a range of fuels and impact of cycle-to-cycle variations

The results of the blind test demonstrated the robustness of the solution, resulting in accurate predictions of knock over a range of fuels and engine cycles.



srm suite was used in *"blind test"* mode to simulate (solid lines in the above diagram) mean, fast and slow cycles including uncertainty for a range of automotive fuels. The model robustly predicted onset of knock with respect to experiments (represented by solid marks).

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