1. Introduction

- The homogenous charge compression-ignition (HCCI) concept offers a promising alternative to current modes of combustion in internal combustion engines.
- In HCCI, the start and rate of combustion are solely dependent on the thermo-chemical conditions inside the combustion chamber. The lack of external control results in operational difficulties at low and high load operation.
- A dual-fuel strategy to control combustion phase during HCCI transients is investigated using a detailed-chemistry full-cycle modelling approach.
- A detailed chemistry zero-dimensional stochastic reactor model is coupled with a one-dimensional GT-Power engine model to account for the full engine cycle. GT-Power simulates the open-volume portion of the cycle and passes the closed-volume initial conditions to the SRM at the IVC point.
- The model simulates steady-state and transient operation of a single-cylinder HCCI engine fuelled with primary and secondary fuels (mixtures of iso-octane and normal-heptane). The combustion phase is controlled by varying the octane number or the hydrogen ratio in the base fuel.

2. Modelled Engine

<table>
<thead>
<tr>
<th>Engine specifications:</th>
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<tbody>
<tr>
<td>Cylinder displacement (litres)</td>
<td>0.981</td>
</tr>
<tr>
<td>Bore × Stroke (mm)</td>
<td>102 × 120</td>
</tr>
<tr>
<td>Connecting rod length (mm)</td>
<td>192</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>13.81</td>
</tr>
<tr>
<td>Number of valves</td>
<td>4</td>
</tr>
<tr>
<td>IVO (CA)*</td>
<td>357</td>
</tr>
<tr>
<td>IVC (CA)*</td>
<td>-155</td>
</tr>
<tr>
<td>EVO (CA)*</td>
<td>120</td>
</tr>
<tr>
<td>EVC (CA)*</td>
<td>-352</td>
</tr>
</tbody>
</table>

*CA (crank angle) measured with respect to firing TDC

A schematic of the modelled engine. A Cummins six-cylinder medium-duty diesel engine is converted to a single-cylinder HCCI engine. The five remaining cylinders are deactivated but kept for dynamic balancing. The engine is equipped with both port and direct injection capabilities [3].

3. GT-Power Engine Model and Controller

A GT-Power map of the modelled engine. The model accounts only for the active cylinder and part of the intake and exhaust systems, and only considers the pre-mixed fueling option.

4. Coupling GT-Power with SRM

A GT-Power map of the modelled engine. The phasing (CAS0) is either controlled by changing octane number or hydrogen ratio. Pressure rise rate (PRR) signal is used to limit the phasing at the knocking and misfire boundaries.

5. Results

A GT-Power map of the PID combustion phasing controller. The phasing (CAS0) is either controlled by changing octane number or hydrogen ratio. Pressure rise rate (PRR) signal is used to limit the phasing at the knocking and misfire boundaries.

6. Conclusions

1. The coupling of GT-Power, SRM and closed-loop control provided an effective tool to simulate HCCI transients and investigate potential strategies to control HCCI combustion.
2. The results suggest that both octane number and hydrogen addition can be effectively used to control combustion phasing in HCCI engines. Further investigations are needed, however, to fully understand their limits and effects on the operating window.

7. References


8. Acknowledgement

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