

Use of water injection to control autoignition and knock in a heavy duty, hydrogen fuelled, reciprocating engine¹

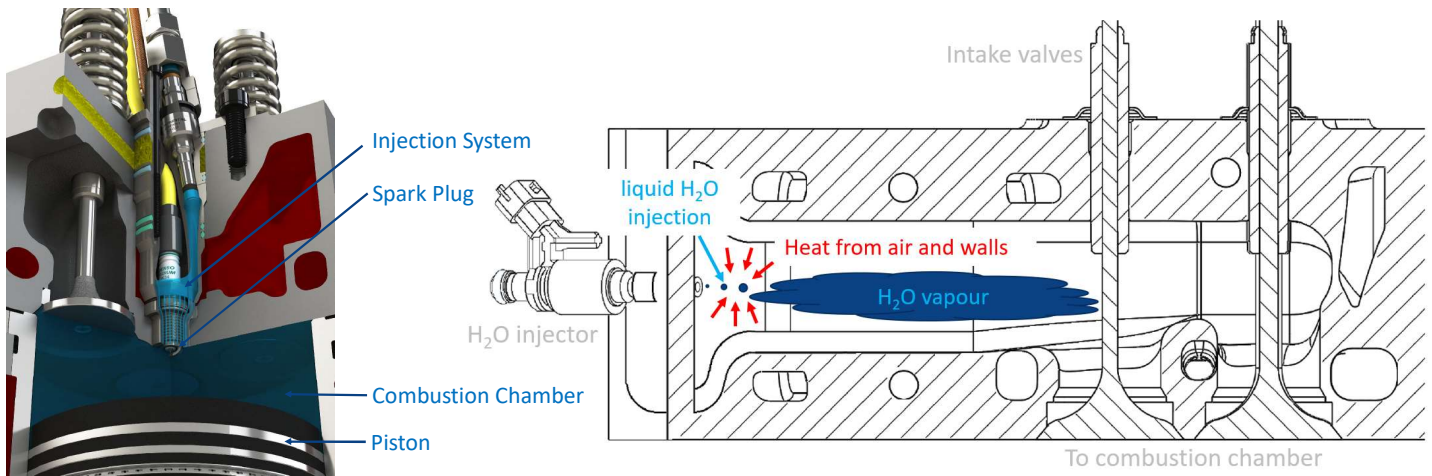
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Motivation

- Hydrogen has potential as a clean and flexible fuel
- However its high flame speed can lead to high rates of pressure and temperature rise when used in engines
- This can lead to thermal autoignition and damaging knock
- Water injection can be used to lower fuel-air temperatures and control autoignition

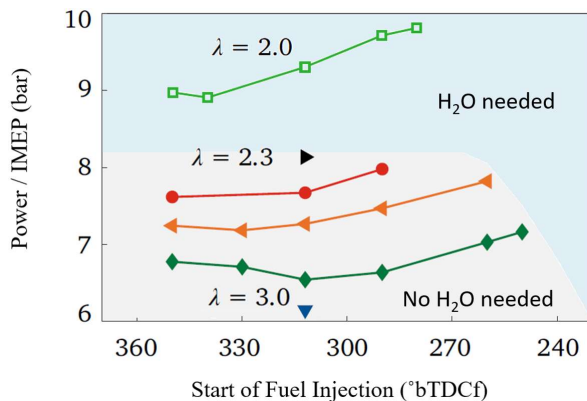
Experimental Setup

- Caterpillar C15 500 kW Genset
- Custom 3D printed Hydrogen injection and ignition system in 1 out of 6 cylinders
- Water injection into airstream in intake manifold



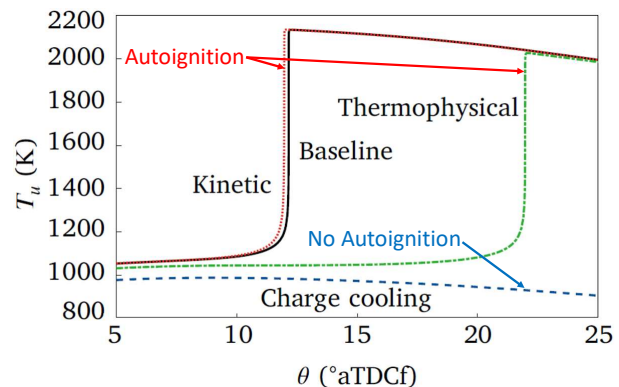
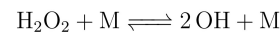
Experimental Results

- Water injection allowed higher power output due to richer mixture able to be used without autoignition
- Close to 25% more power gained at efficient combustion phasing



Modelling Results

- Kinetic modelling using Chemkin Pro found the following factors:
 - Charge cooling due to vaporisation of injected H₂O
 - Thermophysical effect due to the high heat capacity of H₂O
 - Kinetic effect of H₂O is to slightly promote autoignition, as it acts an effective third body molecule in the reaction:



Conclusions

- 25% more power gained at efficient combustion phasing
- Charge cooling and high heat capacity of H₂O largely responsible

Acknowledgements

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¹ Mortimer, Joel, et al. "Extending the knock limits of hydrogen DI ICE using water injection." *Fuel* 335 (2023): 126652.