Heavy Duty DISI Gas Exchange Requirements with Renewable Fuels

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The project aims to provide insight on the requirements of the gas exchange system architecture while using renewable fuels in Direct Injection Spark Ignition (DISI) process. Efficiency improvement and emission reduction of the DISI engine will be studied using 1D engine modelling with experimental validation. This study focuses on Heavy-Duty (HD) engines constrained to run at stoichiometric conditions to reduce complexity of the after-treatment system.

Motivation:

Knock is one of the most important limiting factors for increasing specific torque at low speeds in a HD SI engines. The effect of higher flame travel distances associated with higher bore diameters was seen to be the critical for HD SI engines in knocking condition because of the higher residence time available for the end gas.

Three methods of reducing knock are seen to be promising based on literature:

- Higher octane - Renewable fuels
- Dilution using EGR maintaining $\lambda = 1$
- Higher in-cylinder turbulence levels at spark timing

Experimental investigation planned: HT 2018

Experiments Phase 1: *PFI, central spark plug, low squish*

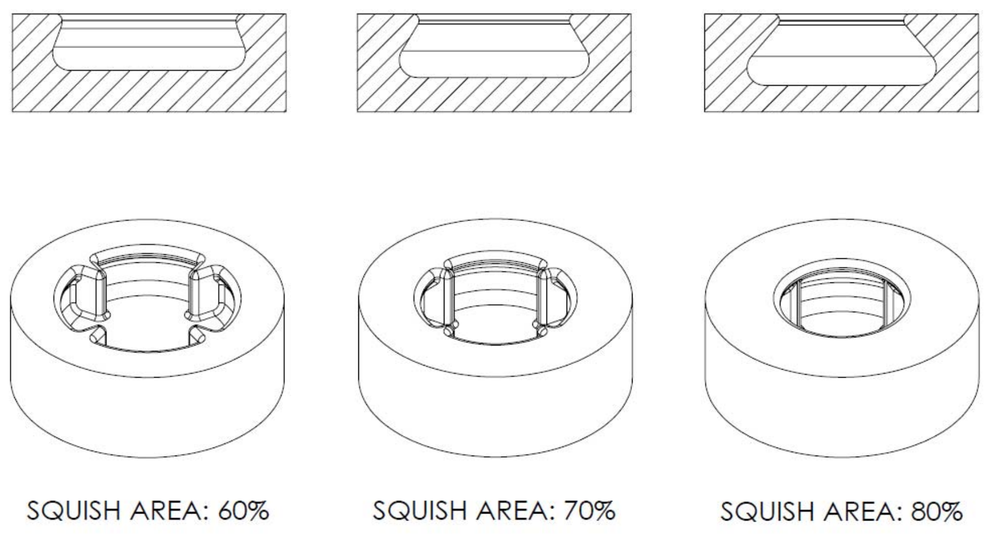
Effect of ethanol and methanol on knock reduction in HD single cylinder engine

- The influence of dilution on knock using these fuels is of interest
- Investigating dilution limit of oxygenated fuels at part load
- The effect of inlet temperature in combustion stability for high heat of vaporization fuels will be studied

The influence of high turbulence piston bowls on extending dilution limit and reducing knock will be performed in phase 2 experiments

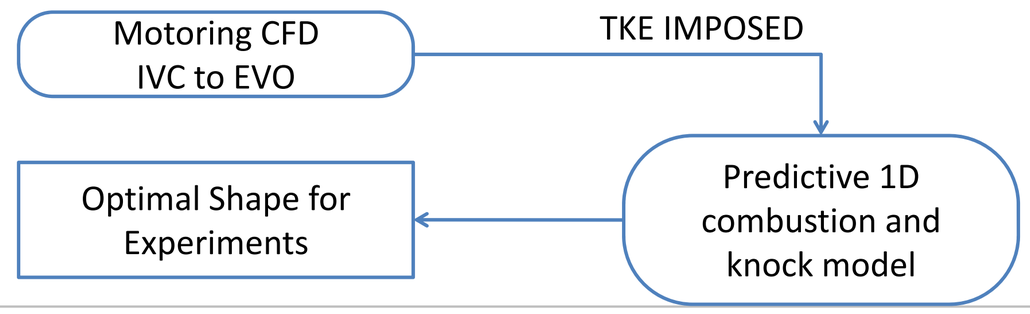
Current Research Study:

1. What is the impact of increased Turbulent Kinetic Energy (TKE) on knock reduction and BMEP increase in a HD engine
2. Which is a more efficient way to generate TKE: Re-entrant bowl or Quartette (different swirl break down mechanisms)



- For the most optimal squish area with each piston shape, their sensitivity with clearance height and initial swirl level will be studied

Method:



Research Activities HT17 – VT18

- Literature review titled "Challenges for Spark Ignition Engines in Heavy Duty Application - a Review" (SAE Paper Number: 2018-01-0907) was published at SAE World Congress 2018, Detroit
- 1D simulation tool evaluation for combustion modelling (GT Power SI Turb) completed using gasoline LD engine data

Research Activities HT18 – VT19

- Investigation of increasing turbulence through swirl breakdown on knock reduction using piston shapes
- Experiments planned for HD SI engine on KTH single cylinder engine using ethanol and methanol port fuel injection EGR effect on fuel will be captured.
- Combustion and knock modelling based on this dataset to follow experiments

Summary of Research Activities: HT17-VT18

- High octane fuels, EGR and high turbulence identified as methods to improve BMEP
- Miller timing has to potential to increase geometric compression ratio without being knock limited
- Turbulence model fit based on experimental or 3D CFD data was seen to be crucial for accurate combustion model prediction in GT power

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