Dual-fuel combustion for the introduction of renewable alcohol fuels in heavy-duty diesel engines

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Project overview

- **Title:** Dual-fuel combustion for the introduction of renewable alcohol fuels in heavy-duty diesel engines
- **Timeline:** August 2016 – Fall 2020
- **Research Program:** Fordonsstrategisk Forskning och Innovation (FFI)
- **Project partners:**
  - KTH – ICE DIVISION
  - NICOLA GIRAMONDI
  - SCANIA
  - AVL
  - Energimyndigheten
Summary

• Project motivation
• Research questions
• Research methodology
• Project status and plan
Project motivation

Diesel pilot-ignited alcohol direct injection in heavy-duty engines
Motivation

**Alcohol-Diesel Direct Injection**

- **Controllability (Injection strategy):** ↑ Indicated efficiency
- **Diffusion combustion (At high loads):** ↓ Cycle-to-cycle variations
- **Oxygen content:** ↓ UHC, soot
- **↑ Heat of vaporization (↓ In-cylinder peak temperature):** ↓ NOx

**References:** Boretti (2012); Haraldson (2014); Gao et al. (2013); Sarjovaara, Alantie and Larmi (2013); Zheng, Li and Han (2015).
Dual-fuel engine for marine applications

Wärtsilä Gas Diesel Concept

Reference: Haraldson, 2014

Wärtsilä methanol-diesel concept

→ Mixing-controlled combustion
Research questions

Injection system geometry and injection strategy
Dual-fuel injection system prototype

Design of the dual-fuel injection system
Influence of the geometrical parameters of the injection system on:

- Ignition timing, combustion phasing
- Ignition and combustion characteristics
- Alcohol-diesel spray-spray interaction

→ With different injection strategies...
Injection strategy

At low and high loads
With respect to a pure diesel baseline
Research methodology

Coupling CFD simulation and single-cylinder engine testing
Tools and methods

- **Combustion simulation**
  - CFD method development + Injection system pre-design
  - Sweeping: Nozzle geometry and injection strategy
  - Targeting: Ignition and combustion characteristics

- **Metal engine testing**
  - Prototype testing
  - Sweeping: Nozzle geometry and injection strategy
  - Targeting: Emissions, performance and combustion variability

- **Combustion simulation**
  - CFD method validation

- **Optical engine testing**
  - Combustion optical diagnostics
  - Targeting: Ignition characteristics + Spray-spray interaction
Project status and plan
Project status and plan

Accomplishments
- Research questions
- Injection system design
- Preliminary CFD simulation campaign
- Combustion simulation method
- MATLAB post-processing tools

On-going work
- Experimental system set-up
- CFD method refinement
- CFD simulation campaign

Near-future work
- Publication of CFD results
- Experimental campaign
- Publication of experimental results
- CFD method validation
Thanks for your attention!
References


