

WP1: Systems for increased fuel flexibility

Objectives / Expected results

To develop **engines able to switch between fuels**, whilst operating in the most cost effective way and complying with the regulations in all sailing regions.

WP Leader: Andreas Schmid
DWP leader: Kaj Portin

- **Development** of a **fuel injection system** for multi fuel purposes
- **Demonstration** of **fuel flexible engine operation**

WP 1

1.1 Fuel flexible engine

Identify, design, manufacture, test, and validate systems for flexible engine operation

2-Stroke: Winterthur Gas & Diesel

Andreas Schmid

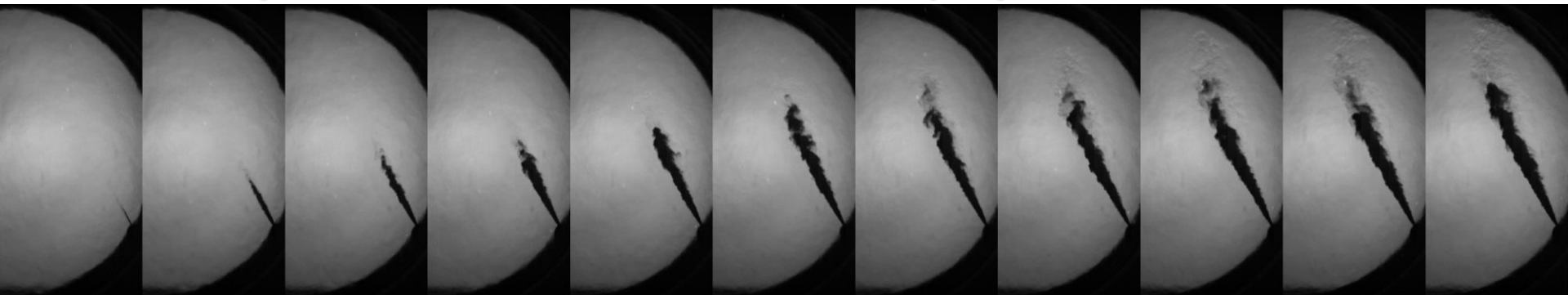


4-Stroke: Wärtsilä

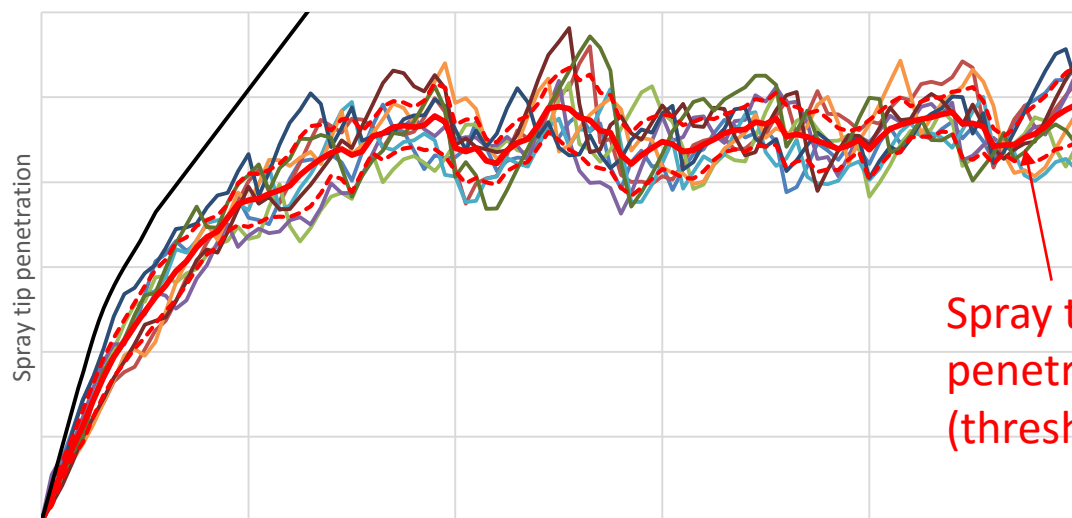
Kaj Portin



Preliminary results on the SCC: Bio Ethanol spray

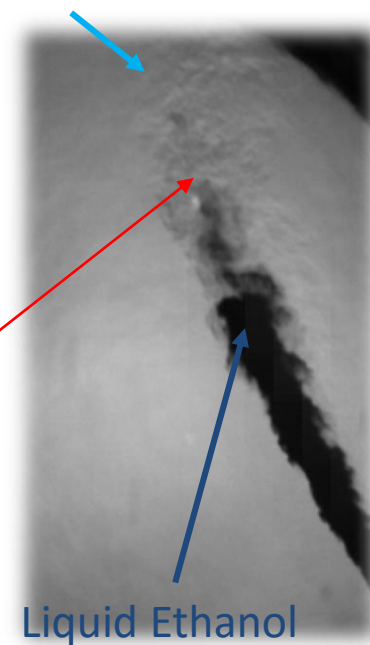


Spray tip penetration (Ethanol vs. HFO)



- | | | | | |
|-----------|-----------|-------------|---------|---------|
| Series1 | Series2 | Series3 | Series4 | Series5 |
| Series6 | Series7 | Series8 | Series9 | Mean |
| Upper Std | Lower Std | HFO, 90/900 | | |

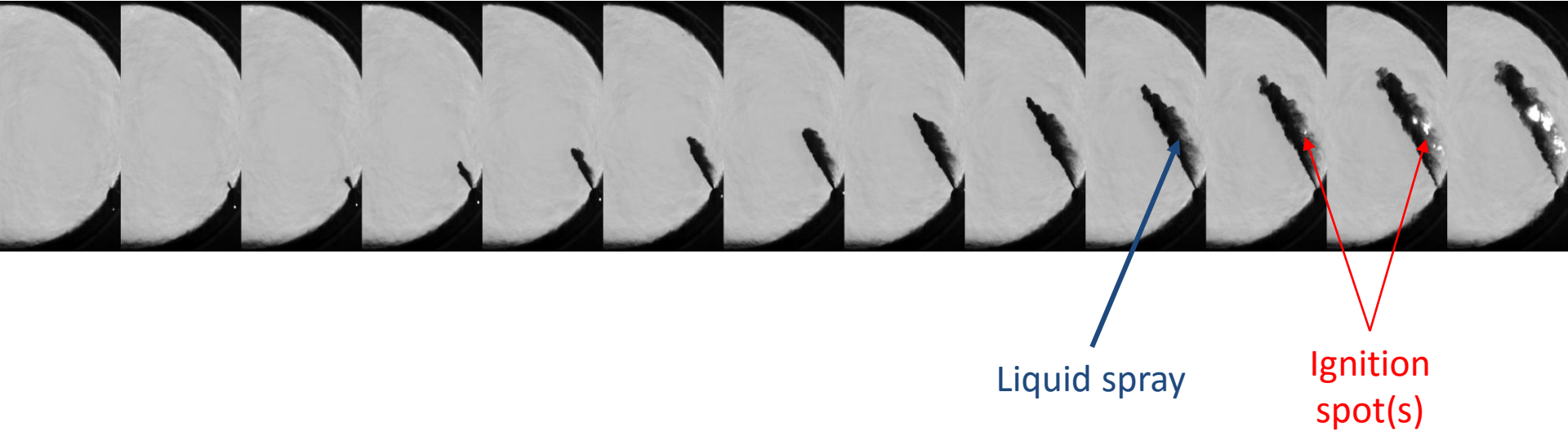
Ethanol vapour



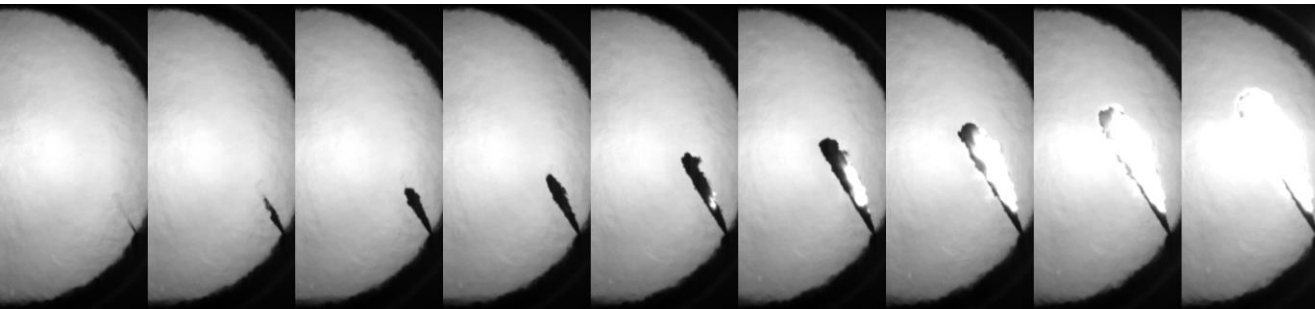
Spray tip penetration (threshold)

Liquid Ethanol

Preliminary results on the SCC: Bio fuel spray (reactive conditions)

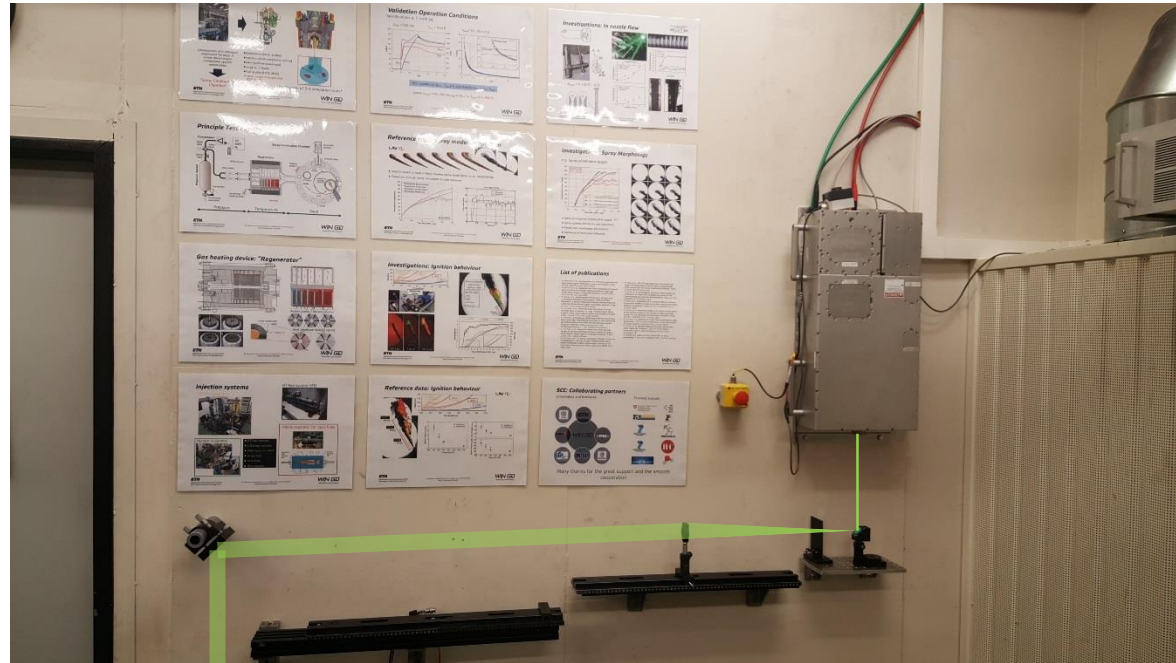


Comparison to classic fuel



WP1: Sub project 1.1 Fuel flexible engine (2-stroke)

SCC - setup



- New cover installed
- Injector adapters installed
- New heating system installed
- New illumination setup (based on Mie scattering)
- Next steps:
 - First measurements with reference injection system (RTX-6)
 - Commissioning Multi fuel injection system
 - Spray tests with alternative fuels
 - Reactive tests with alternative fuels

DWP Leader: Kaj Portin

How

Measurement technology for intermediate combustion products formed inside the combustion chamber will be developed and tested.

The impact of switching between different fuels on possible after-treatment devices and engine components will be part of the investigations.

Expected Results

A fully fuel flexible optical injection and ignition test platform for low-speed Diesel engines will also be produced. A fully optical medium-speed multi-fuel engine will be developed and tested for the first time.

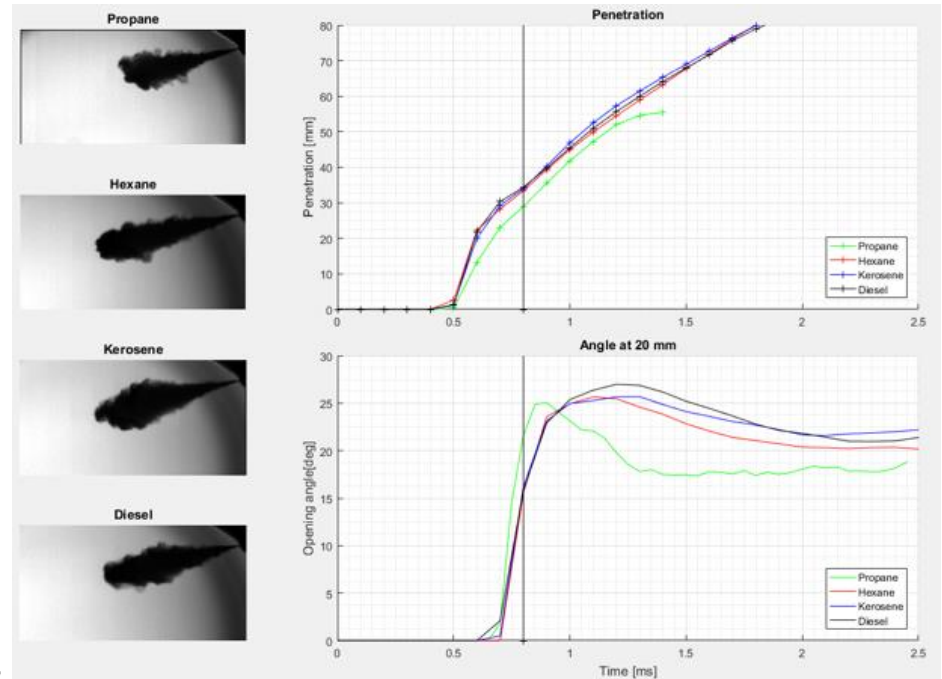
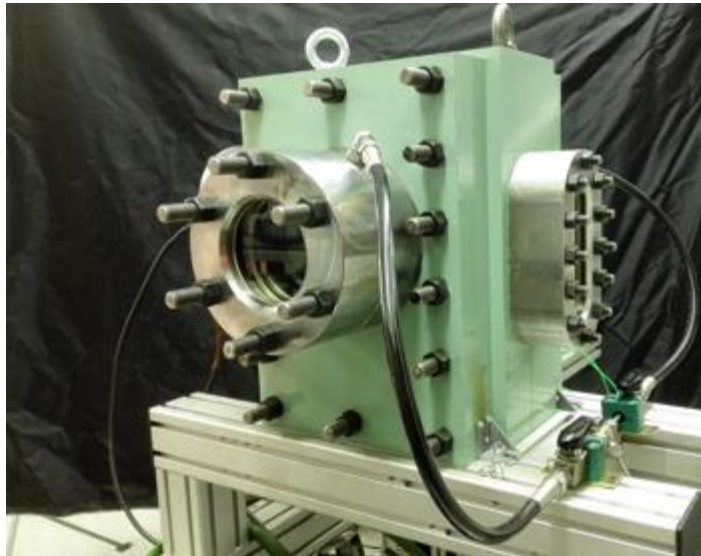


Partners:



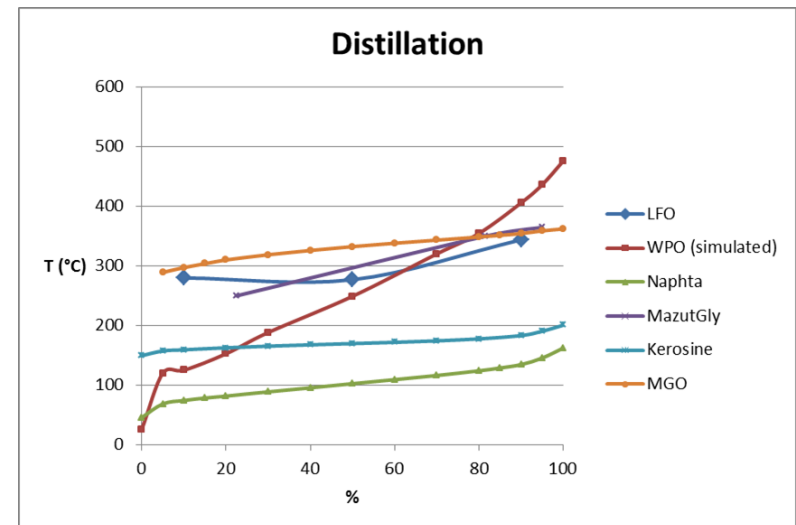
Activities Plan Year 2 (Status and progress September 2016)

- Fuel injection measurements in spray chamber with high speed camera
 - The objective is to determine the opening angle and penetration with different fuels.
 - Kerosene, Hexane, and Propane. Diesel used as reference fuel
 - Injection pressures used: 550 bar and 1000 bar
 - Chamber density: 1,2 kg/m³, 35 kg/m³ and 100 kg/m³



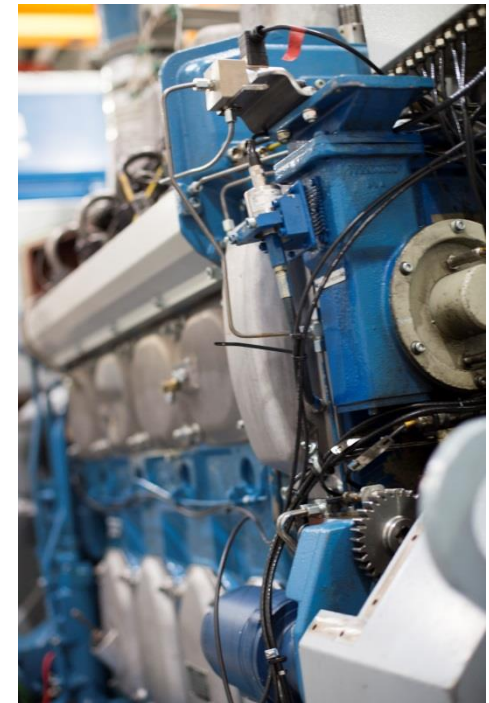
Activities Plan Year 2 (Status and progress September 2016)

- Flex fuel pre-study (Identify requirements for flexible injection system)
 - Investigation started with 5 fuels
- Ignition studies for non-auto-igniting fuels
 - Background material collected
 - Selected fuels: Reference fuel LFO, Naphta, Kerosene, Glycerin+Mazut, MGO, Wood Pyrolysis oil
 - Studies of fuel properties completed-> WPO fuel was seen unsuitable for engine measurements



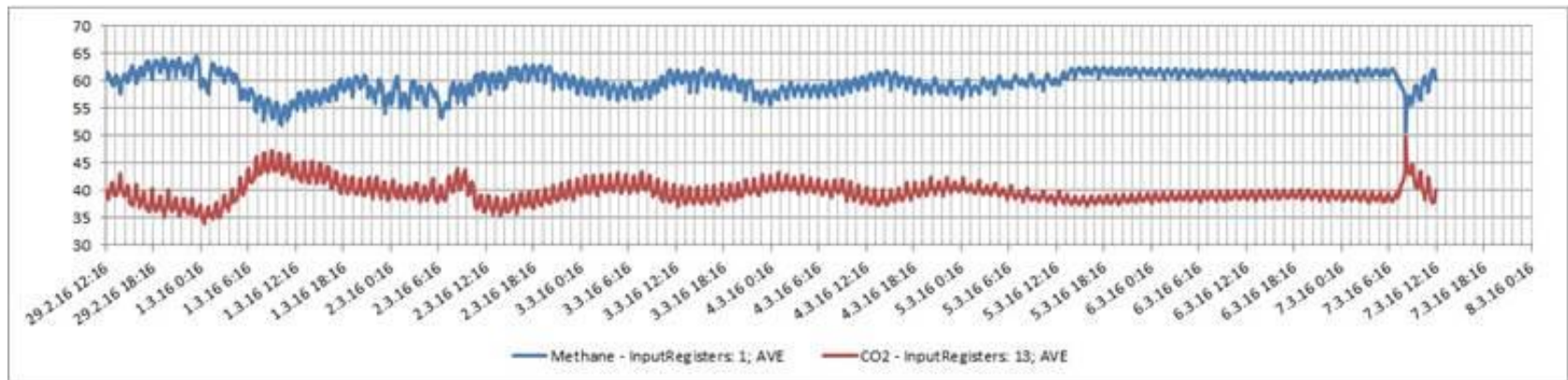
Activities Plan Year 2 (Status and progress September 2016)

- Ignition studies for non-auto-igniting fuels
 - Engine measurements with high-speed off-road diesel engine planned in October 2016 with as many fuels as possible
 - Later, also experiments with medium speed marine engine
 - Simultaneously, fuel safety aspects will be determined and documented
 - Setup of test platform to be also started in October 2016



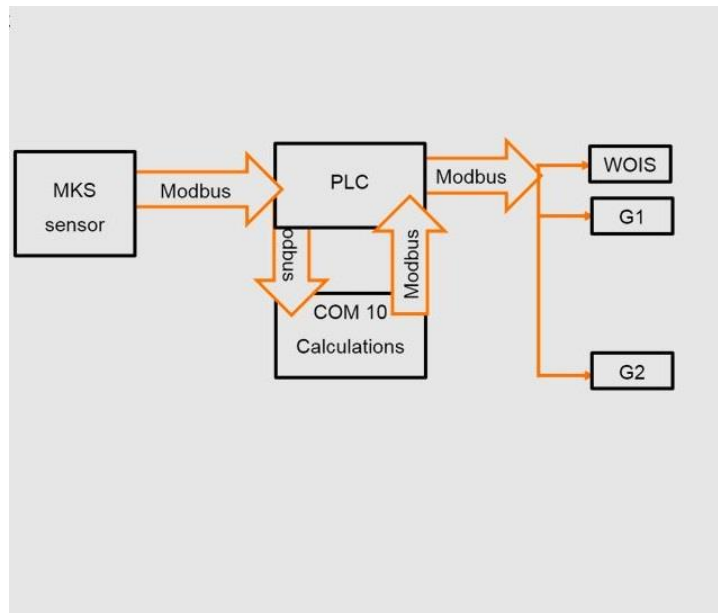
Activities Plan Year 2 (Status and progress September 2016)

- The landfill biogas quality fluctuations were monitored
 - Were analyzed during the gas production process when using collected organic waste. Using an optical gas analyzer, the biogas quality was characterized as the variation of methane, carbon dioxide and contamination components compositions measured online. Below, recorded methane and CO₂ fluctuations are shown against a time period.



Activities Plan Year 2 (Status and progress September 2016)

- Gas quality online measurement
 - Master Thesis finalized in May 2016
 - Measurement equipment installed in Spain in September 2016 for endurance test and new functionality testing



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ONLINE GAS QUALITY MEASUREMENT AND ENGINE CONTROL

Master's thesis for the degree of Master of Science in Technology
submitted for inspection, Espoo, 23 May, 2016.