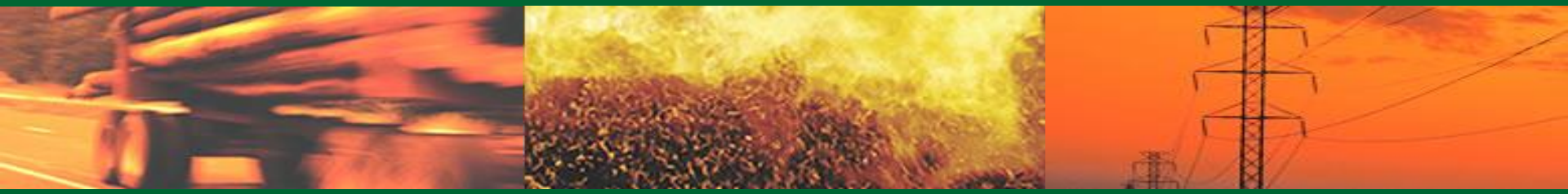

AN EXPERIMENTAL STUDY ON THE USE OF PYROLYSIS OIL AND DERIVATIVES IN DIESEL ENGINES FOR CHP APPLICATIONS

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- Engine test facility
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- Summary

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Introduction

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Introduction & Objectives

Main Objective BTG

Develop and demonstrate a cost-effective C(C)HP system based on conventional CI – engines and fuelled with pyrolysis oil or pyrolysis oil derived liquids for a capacity range of 50 - 1,000 kW_e.

Specific BTG Activities

- Chemical & physical treatment of pyrolysis oil to improve fuel characteristics;
- Development of pyrolysis oil tolerant engine components;
- Construction and testing of a modified CI – engine.

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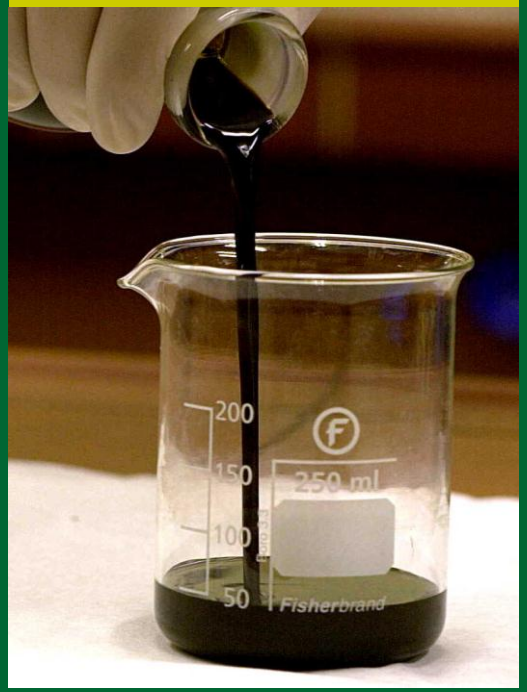
Introduction

- Oil is acidic: all piping/devices in contact with pyrolysis oil must be corrosion resistant;
- Oil contains water and small particles: severe abrasive wear is to be expected;
- Viscosity of pyrolysis oil is higher than of fossil diesel;
- Pyrolysis oil is sensitive to re-polymerisation above 50-60 °C resulting in small particles and higher viscosities;
- Pyrolyis oil is more difficult to ignite – Cetane Number is estimated to be in range of 10-25;
- Heating value of pyrolysis oil is lower (approx. ½ of diesel fuel on volumetric basis)

Property	Value	Unit
Water content	25,4	wt%
Solids content	0.04	wt%
Density	1,170	kg/m^3
LHV	16,1	MJ/kg
pH	2.85	-
MCRT	15,1	wt%
Viscosity (40 °C)	13,0	cSt



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Compression Ignition

(CI) Engine set-up

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CI - Engine test facility – basis

Basis: JIANG DONG Engine

Model	ZH1130
	1-cylinder
Piston displacement:	1,592 ml
Compression ratio:	17,6
Output:	23,5 kW
	(2,200 rpm)
Injection pressure:	200 – 250 bar
Fuel consumption:	240g/kW_e (diesel)
Generator output:	Max. 10 kW_e

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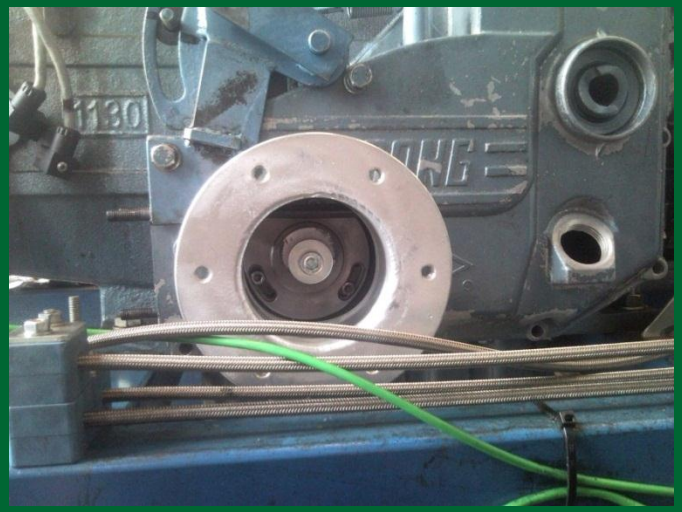
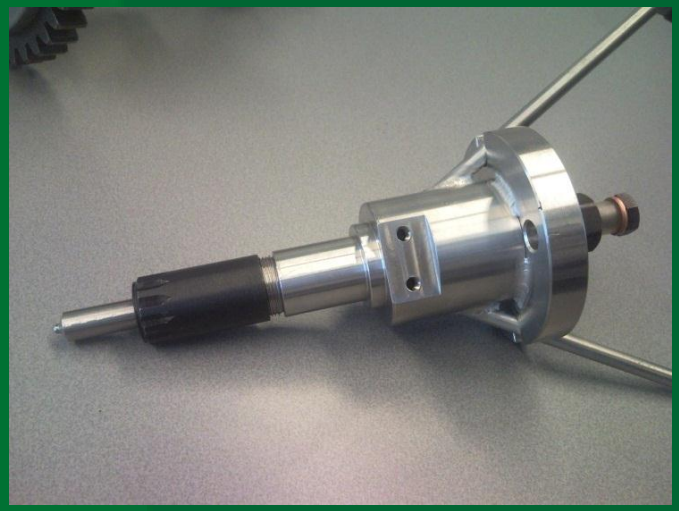
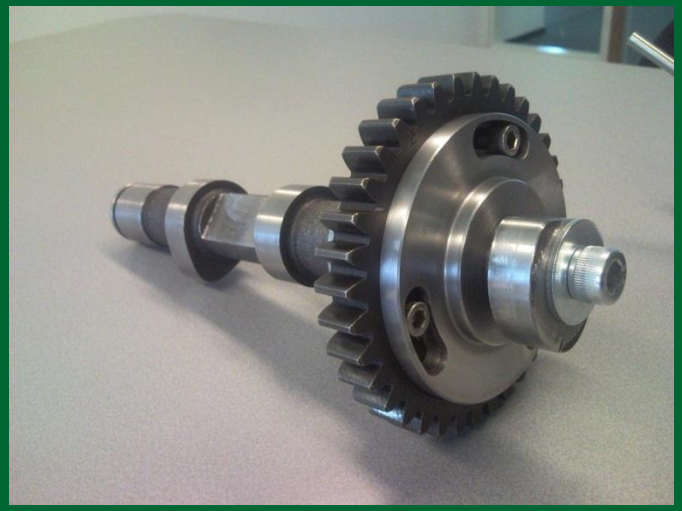
CI - Engine test facility - Modifications

Major modifications:

- Corrosion resistant fuel injector
- Corrosion resistant fuel pump
- Air preheating
- Fuel preheating
- Adjustable fuel injection timing







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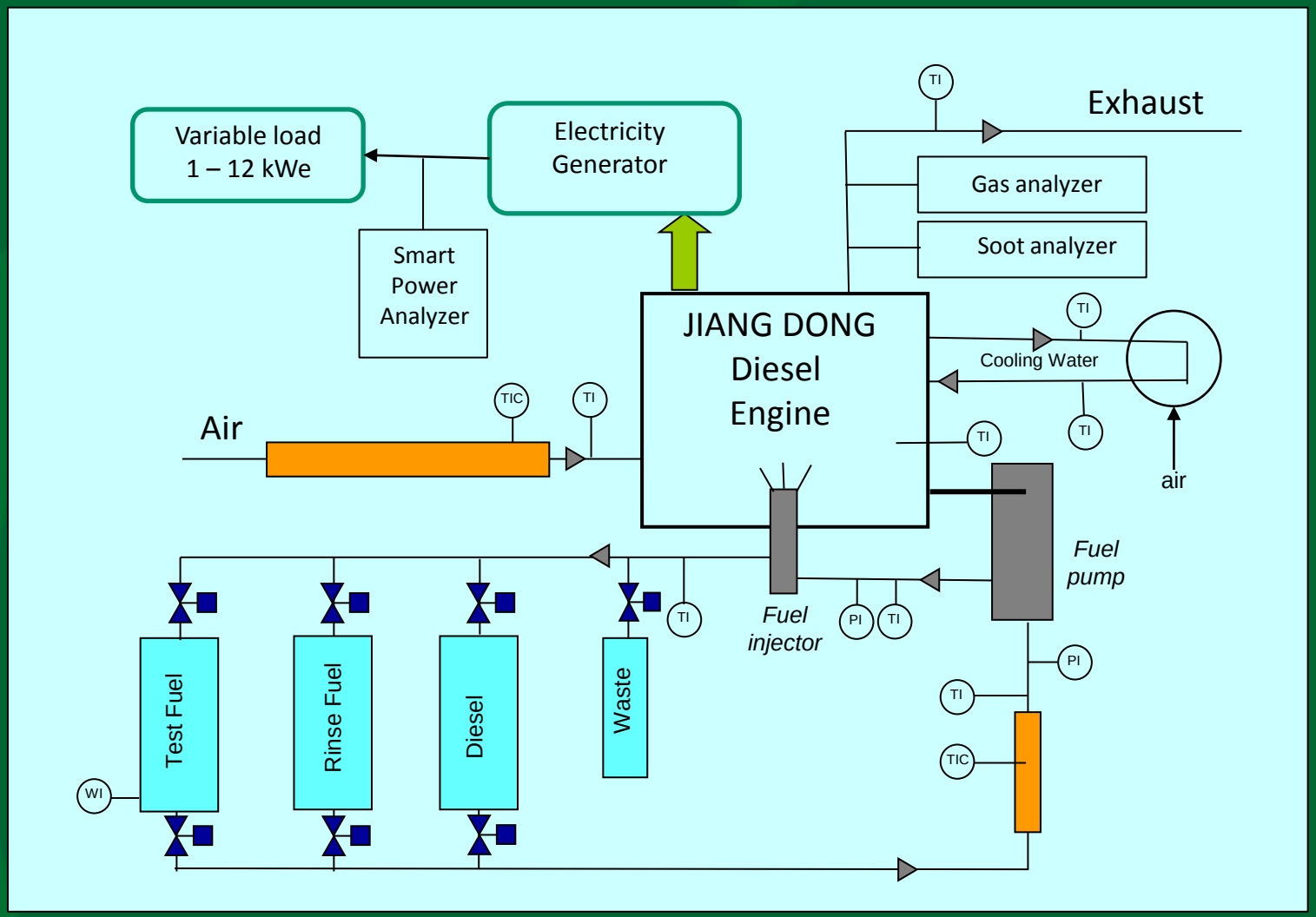
Engine test set-up



Schematic drawing of the engine test rig

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Engine test set-up

Energy dissipation (1-12 kWe)

Fuel feeding

Engine set-up

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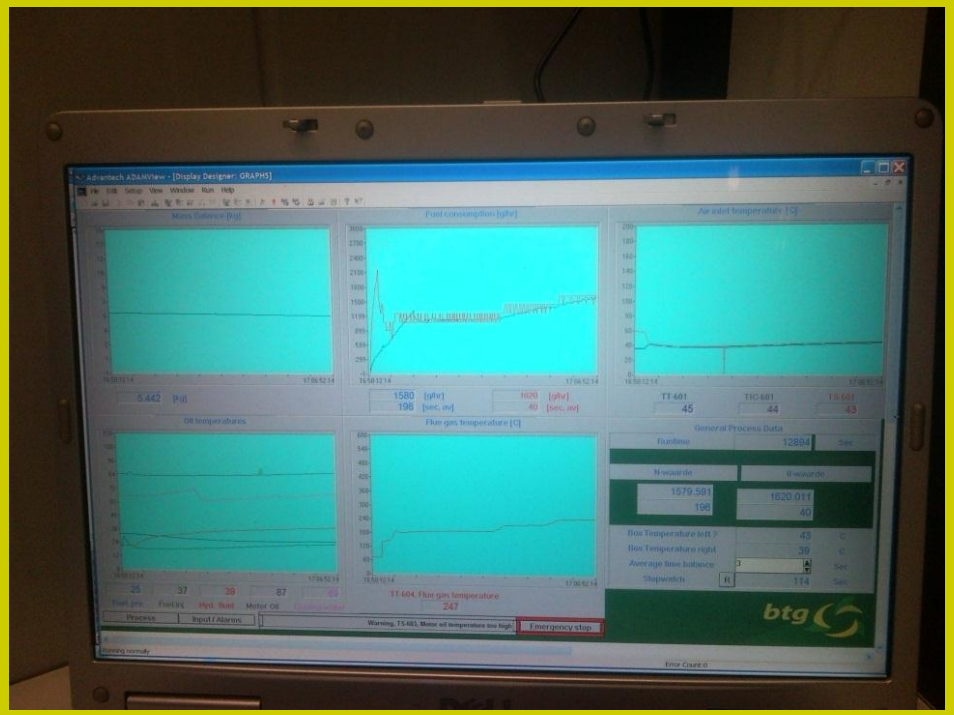
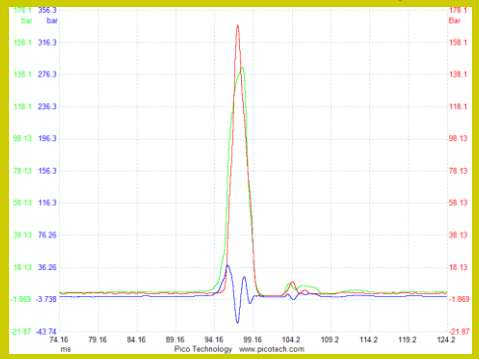
Engine test set-up - measurements



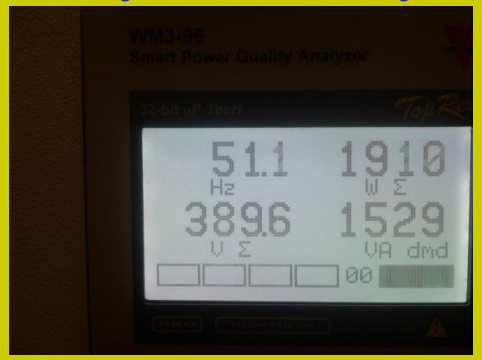
Data aquisition & control

Engine control & monitoring



Injector pressure

Gas composition & soot



Power output monitoring

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Results

- Air preheat temperature
- Fuel injection pressure
- Fuel injection timing
- Performance of different fuels
- ‘Duration’ testing

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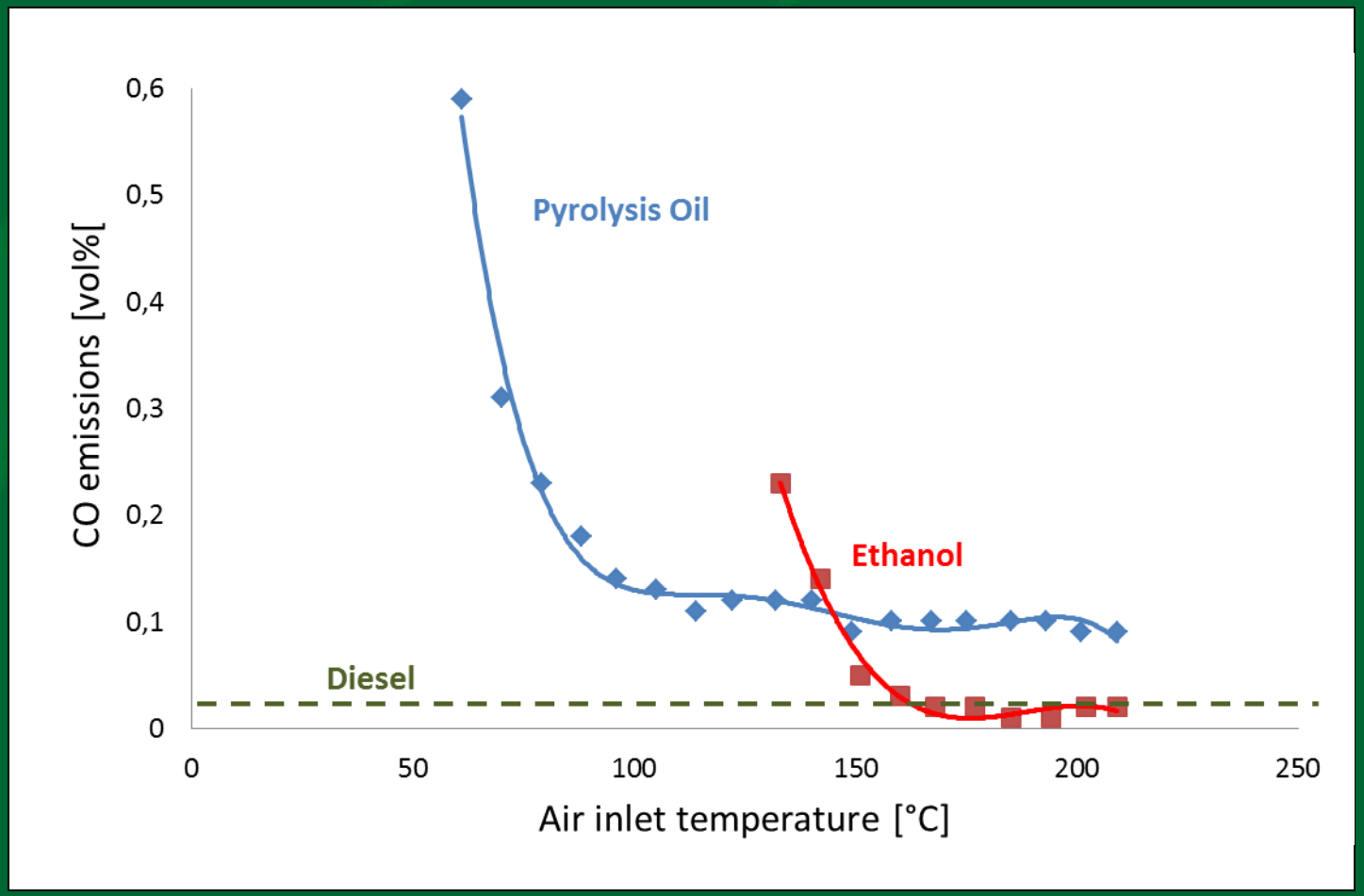
Air preheat temperature



CO emissions as a function of the air preheat temperature; Electrical load = 4 kW_e; Fuel preheat temperature = 40-50 °C

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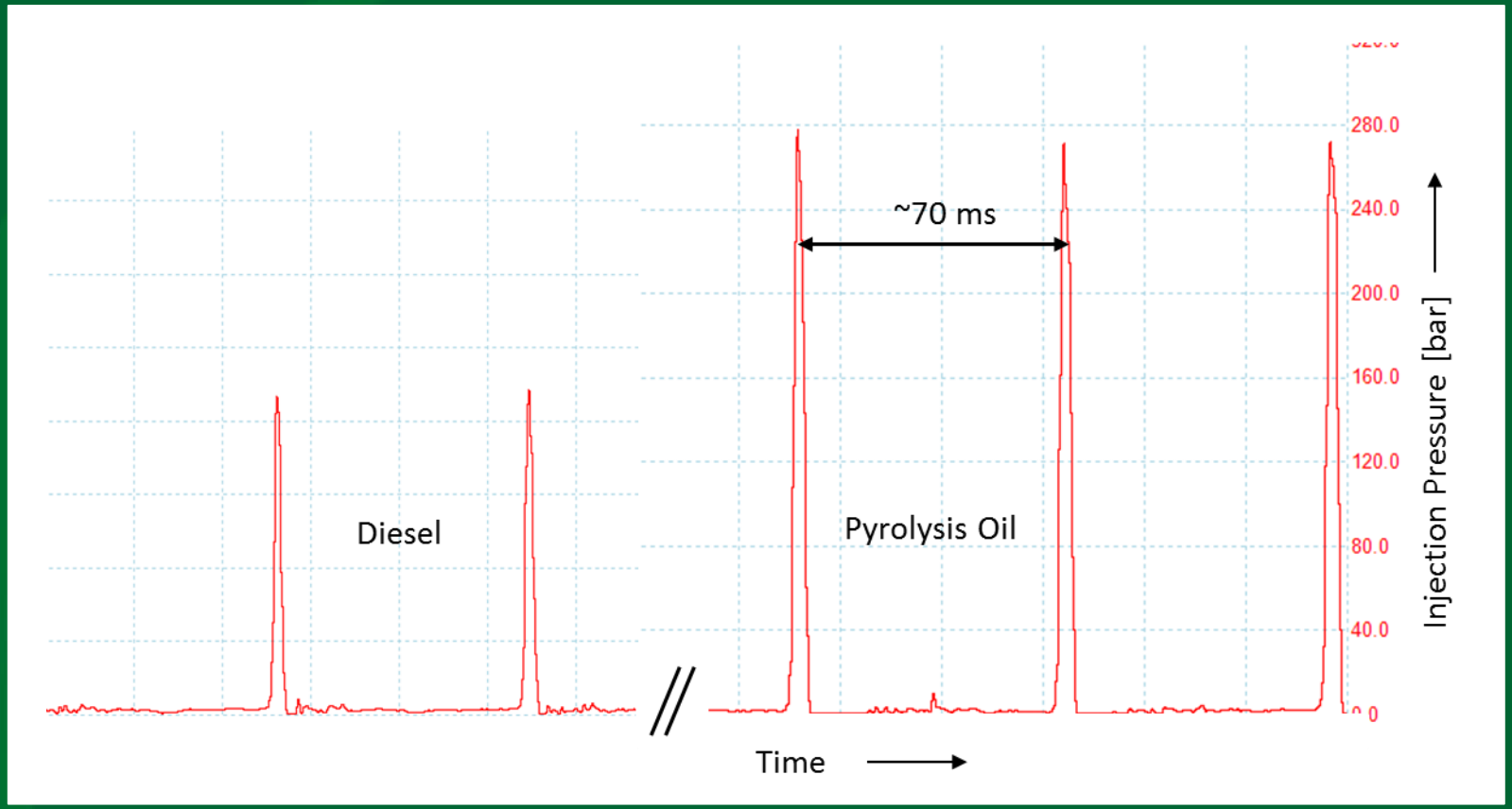
Fuel injection pressure



Diesel engine operation with diesel and pyrolysis oil; electrical load = 3 kW_e; in both cases the new stainless steel injector is used

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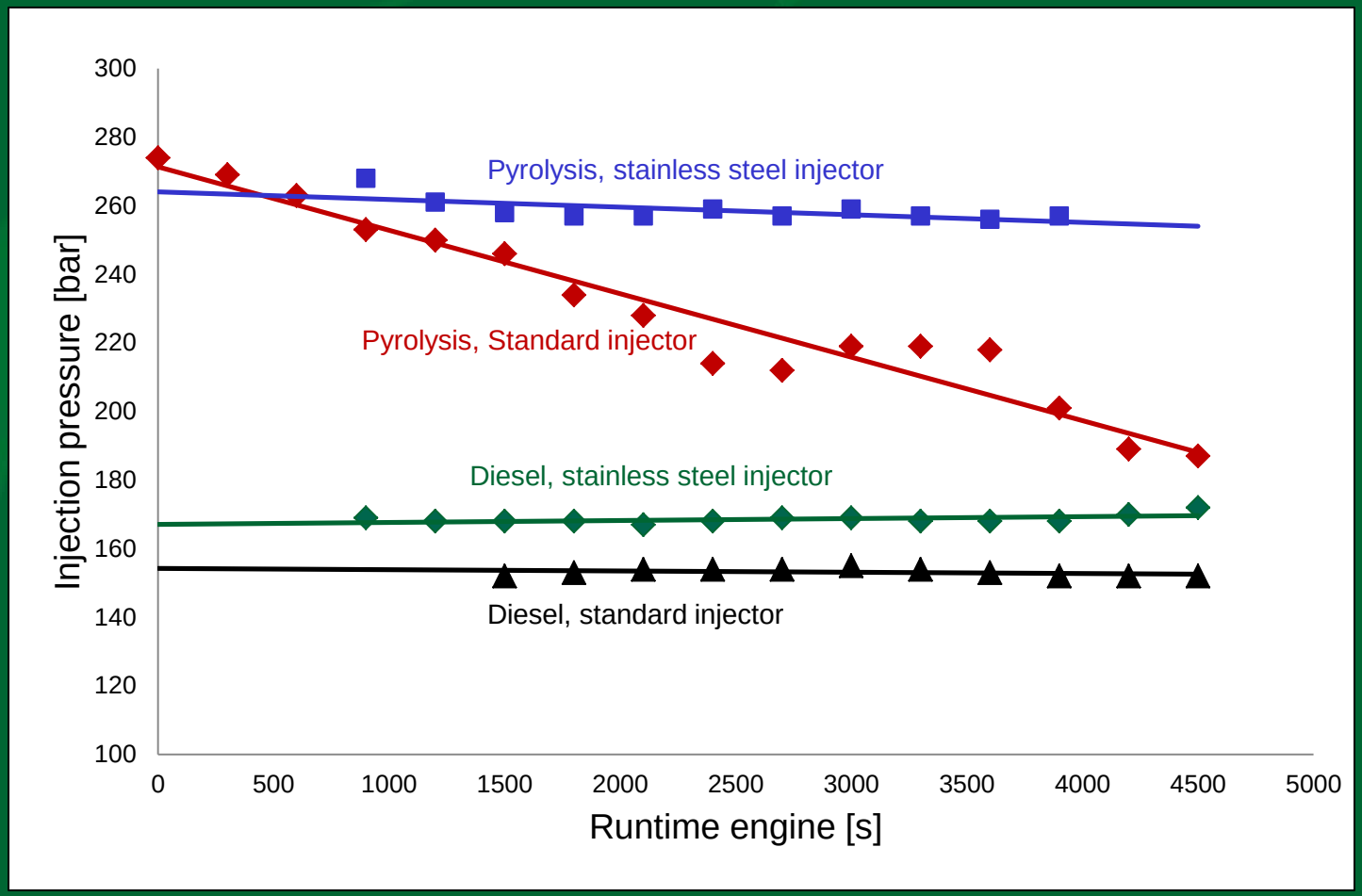
Fuel injection pressure



Diesel engine operation with diesel and pyrolysis oil with a standard injector and a stainless steel injector; electrical load = 3 kWe

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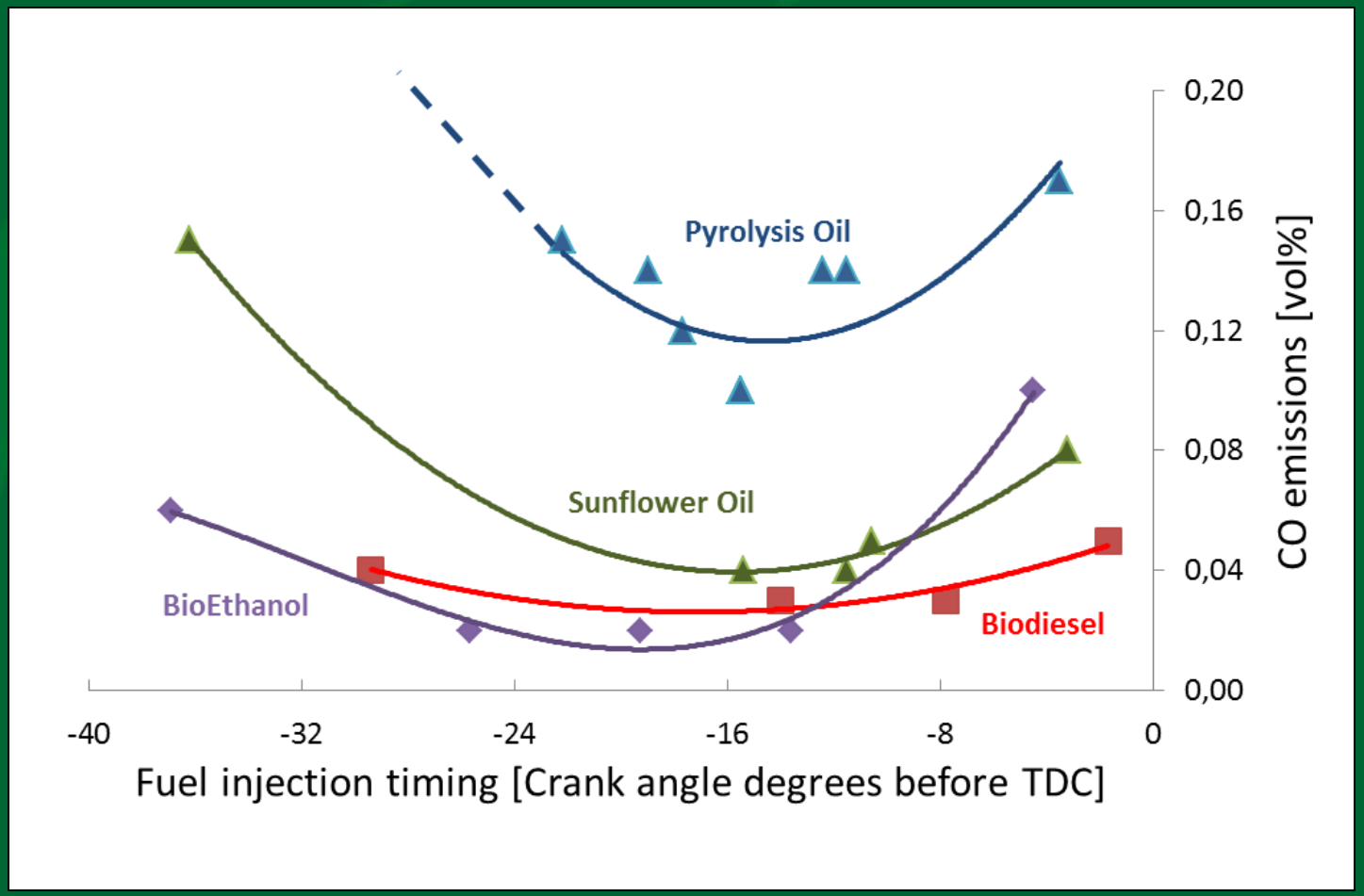
Fuel injection timing



CO emissions as a function of the fuel injection timing for different fuels; Electrical load = 4 kW_e

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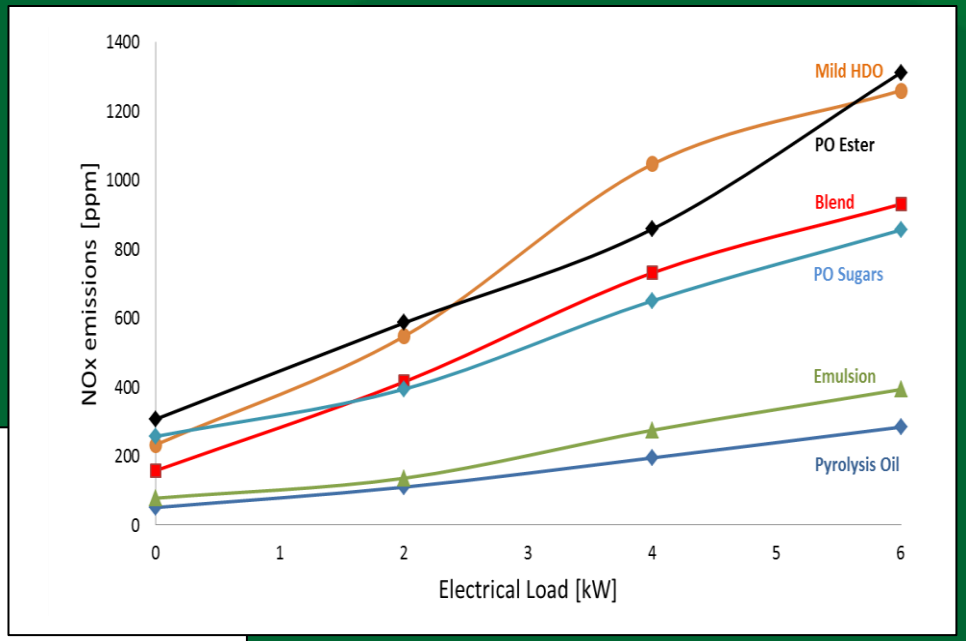
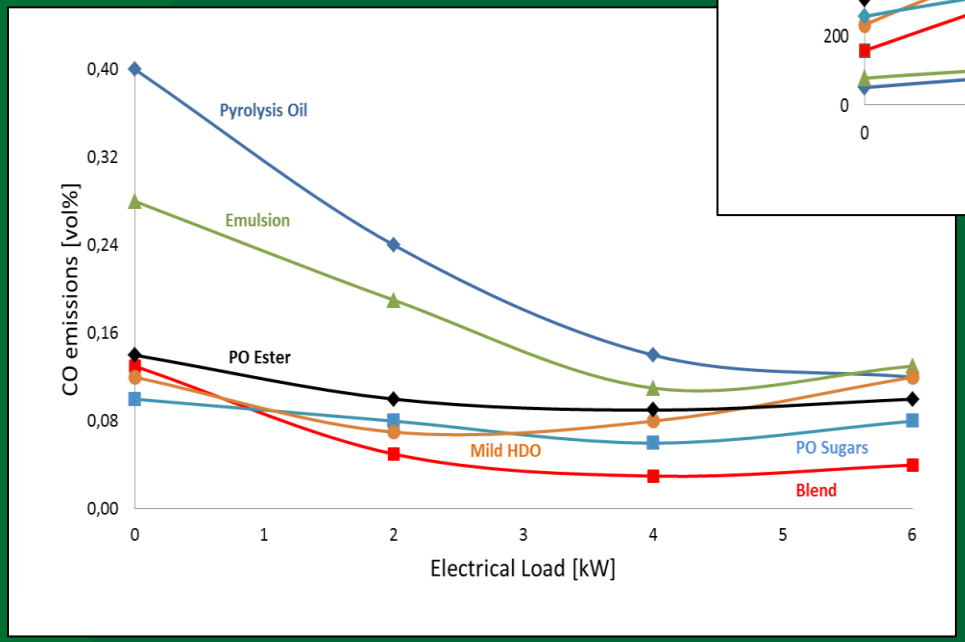
Different fuels

NO_x emissions for different fuels as a function of the electrical load;





CO emissions for different fuels as a function of the electrical load;

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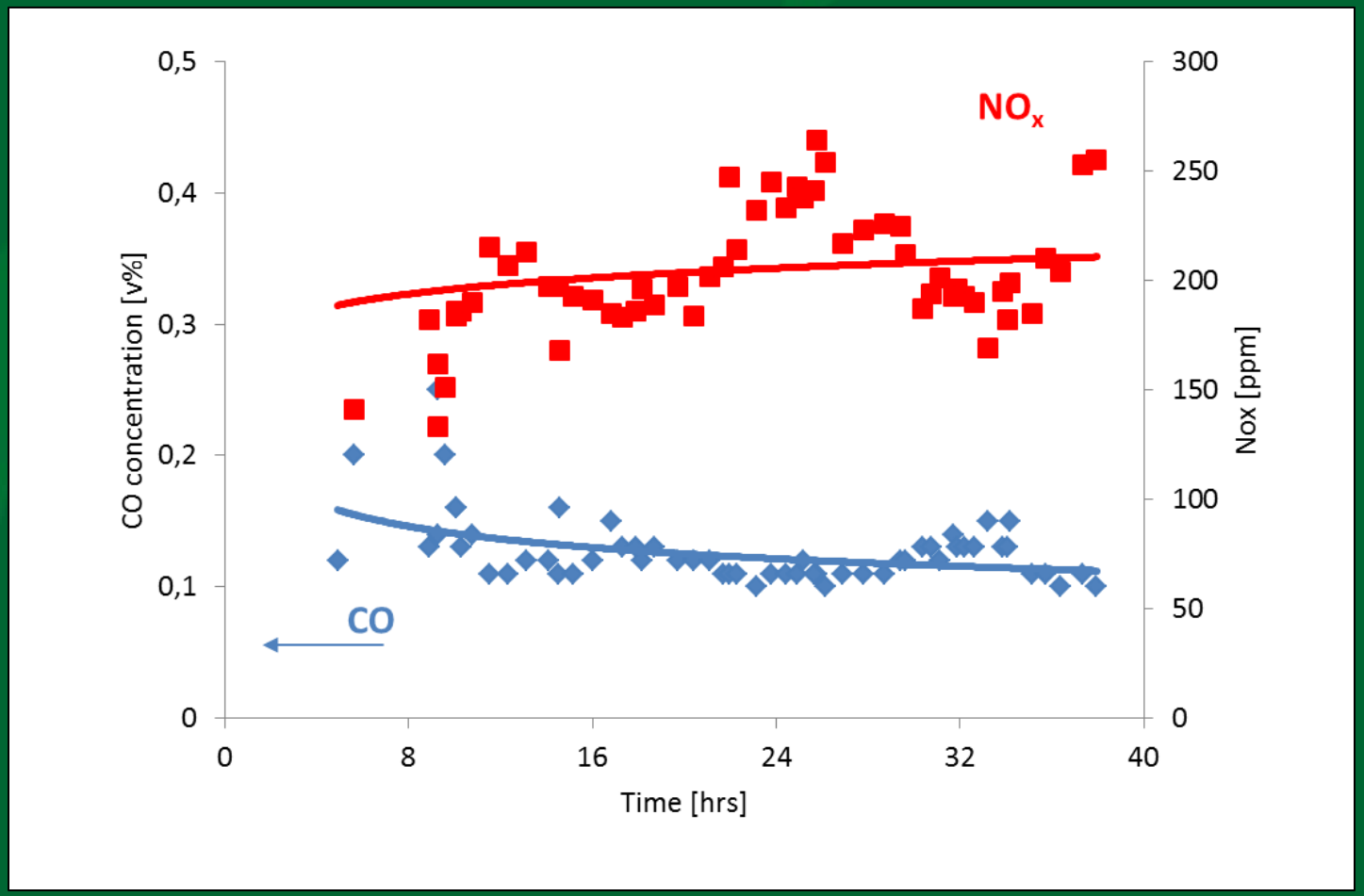
Duration test



CO and NO_x concentration in the flue gas as a function of the runtime; Fuel = pyrolysis oil; electrical load = 3 kW_e; Air inlet temperature = 120 °C

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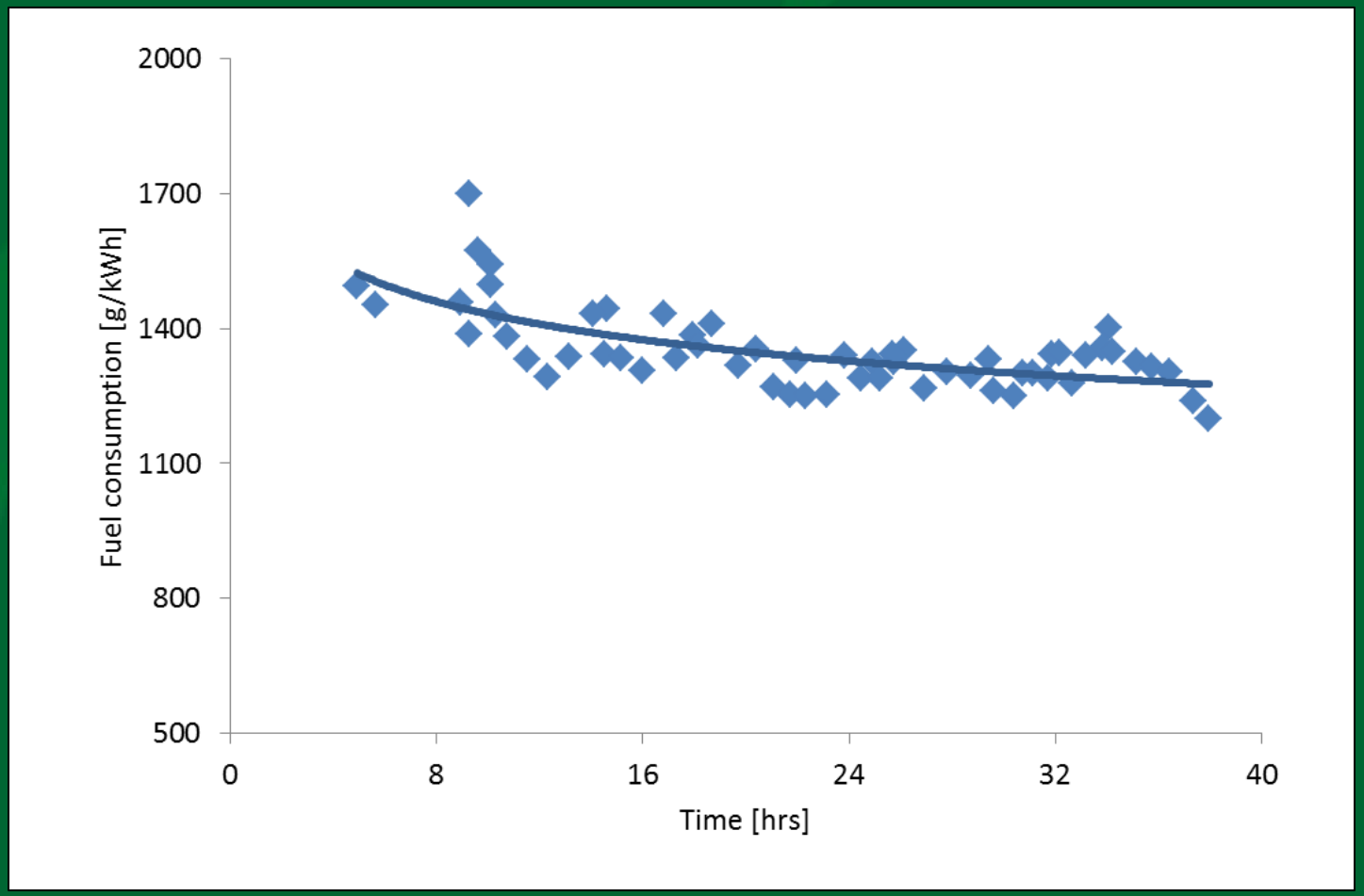
Duration test



Fuel consumption [g/kW$_e$] as a function of the runtime; Fuel = pyrolysis oil; electrical load = 3 kW$_e$; Air inlet temperature = 120 °C

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Summary

- A conventional CI-engine has been modified to enable the fuelling of pyrolysis oil and pyrolysis oil derivatives;
- Major changes to the engine concern:
  - the fuel feeding and injection system – corrosion resistant material;
  - Air preheating to overcome the poor ignition properties of pyrolysis derived fuels (mimic higher compression ratio);
- The modified pyrolysis oils have improved ignition/combustion properties compared to crude pyrolysis oil leading to lower CO emissions but higher NO_x emissions; However, these modified oils still require a complete, corrosion resistant fuel system;
- The optimal fuel injection timing for pyrolysis oil does not differ much from the other fuels;
- So far, running time on pyrolysis oil has been about 40 hours; obviously more duration testing will be required;

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Thanks for your Attention !

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