Emissions of an agricultural tractor with experimental e-diesel and commercial diesels

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Electrofuels

Electrofuels (e-fuels) are synthetic fuels manufactured using electricity as the main source of energy

Hydrogen is a basic component in electrofuels:
Electrolysis of water → **Hydrogen** + Oxygen

Carbon monoxide is a component providing carbon to the fuel
Carbon dioxide + Hydrogen → **Carbon monoxide** + Water

Syngas:
Hydrogen + Carbon monoxide

Fuel examples:

Hydrogen + Nitrogen → **Ammonia**

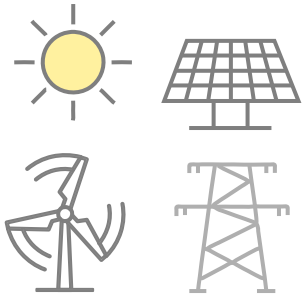
Hydrogen + Carbon monoxide → **Methanol**

Dimethyl ether (DME)
Poly-oxymethylene dimethyl ether (OME)

Hydrogen + Carbon monoxide → **Hydrocarbons** + Water
(Fischer–Tropsch process)

Existing FT-processes:
CTL, GTL, BTL
(not electrofuels)

E-fuel project



Clean electricity

H_2O

High-temperature electrolysis

Solid oxide electrolyser

O_2

H_2

Industrial flue gas

CO_2

CO_2 capture

FT* synthesis

H_2 ,CO

CPOX / RWGS**

Synthesis unit

Upgrading

E-diesel

FT-crude

* Fischer-Tropsch
**Catalytic partial oxidation / Reverse water-gas shift

Fuels

	Fossil EN 590 B0	HVO EN 15940	E-diesel	EN 590 B0 + E-diesel 35%
Density (kg/m^3)	825	781	**766**	805
Flash point (°C)	60	69	64	-
Cloud point (°C)	-30	-36.5	-44	-30
Viscosity 40 °C (mm^2/s)	1.962	2.995	**1.787**	1.935
Sulfur (mg/kg)	6.3	<1	**<1**	4.5
Total aromatics (wt-%)	16.1	0.4	**0.3**	14.4
Cetane (IQT)	53.4	71.2	**66.1**	60.5

HVO = Hydrotreated Vegetable Oil

Tractor

Valtra T235D
AGCO Power 74LFTN engine
6-cylinder, 7.4 L
Turbocharged diesel
Common-rail fuel injection
Stage V
DOC, DPF, SCR
New tractor (2023)

Fuel line modified: separate canister as a fuel tank

Weather
0...-7 °C (mostly -1...-3 ° C)
70...100 %RH
Cloudy

Test measurements

Two type of tests:

- Power-takeoff (PTO) dynamometer: Fromet Sigma
- On-road

PTO tests

5-mode cycle, each mode 3 min:

1 700 RPM, IDLE
2 1500 RPM, 25%
3 1500 RPM, 75%
4 2100 RPM, 25%
5 2100 RPM, 100%

At least 3 cycles per fuel

Fuels (4): EN 590B0, HVO, E-diesel, EN 590 B0 + E-diesel 35%

On-road tests

5 km route, 10-12 min duration

No large uphills or downhills

Fuels (3): EN 590 B0, HVO, EN 590 B0 + E-diesel 35%

No differences

Instrumentation

Two simultaneous sampling points:
- Engine-out (before ATS)
- Tailpipe (after ATS)

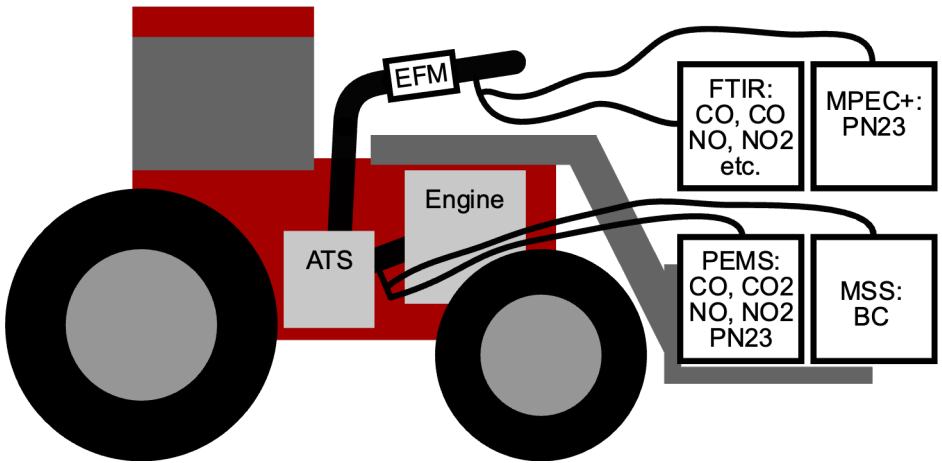
Engine-out (before ATS)
AVL MOVE PEMS:
- CO, CO2, NO, NO2, PN23

AVL Micro Soot Sensor:
- Black Carbon

Tailpipe (after ATS)
A&D Best Sokki BOB-1000 FTIR:
- CO, CO2, NO, NO2, etc.

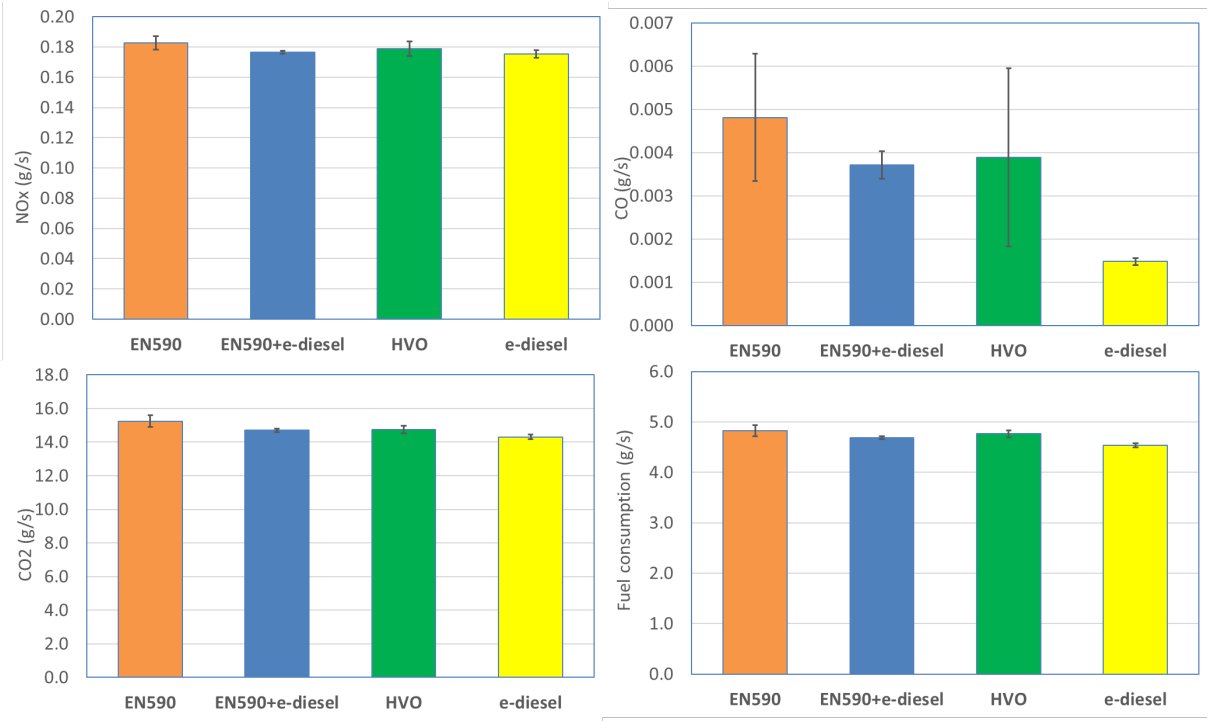
Dekati MPEC+:
- PN23

AVL Exhaust flow meter (EFM)

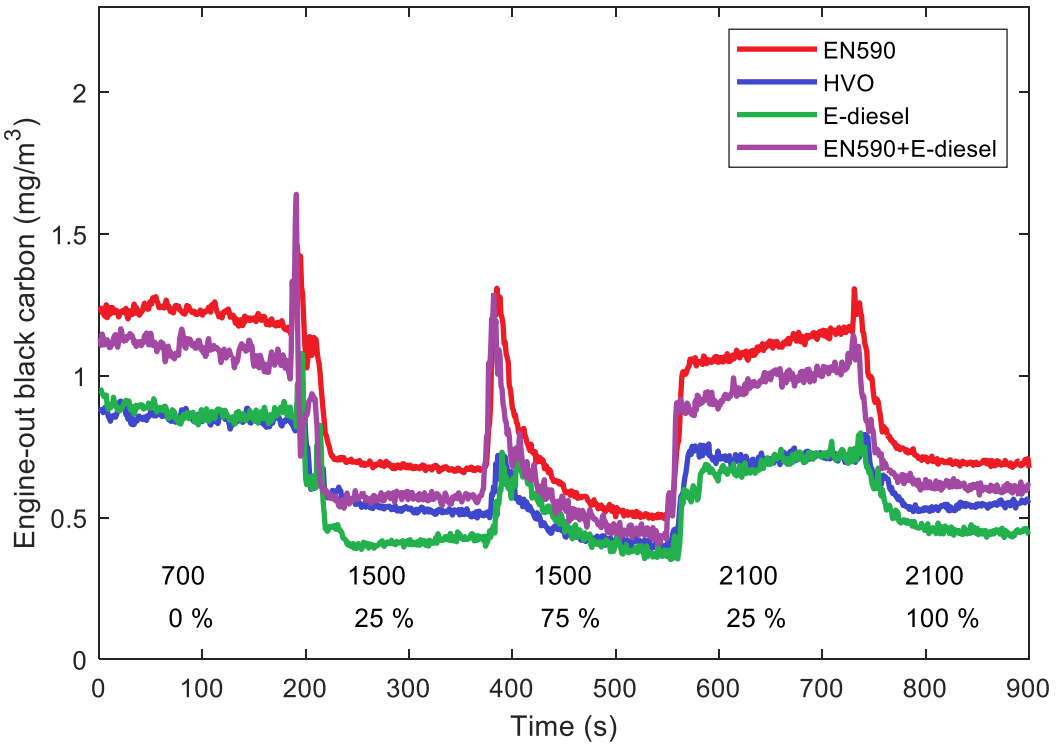


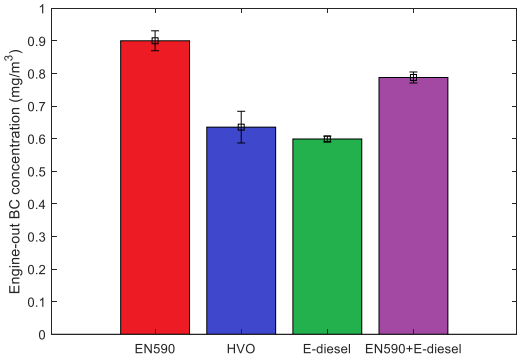
ATS = Aftertreatment system

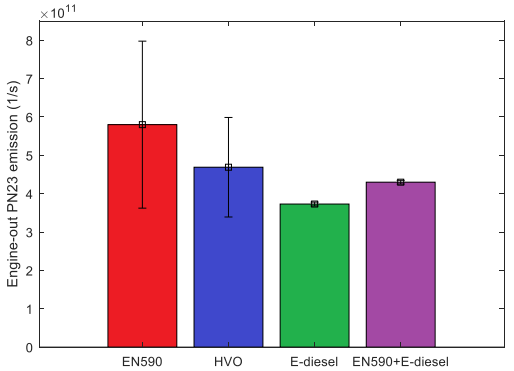
Results: Gaseus emissions before ATS (engine-out)



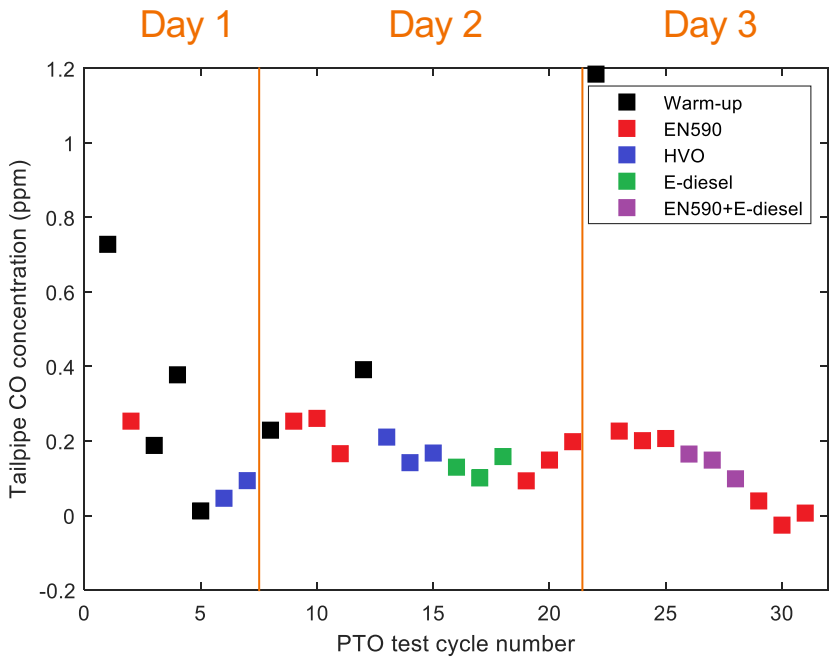
Results: Soot and PN before ATS (engine-out)



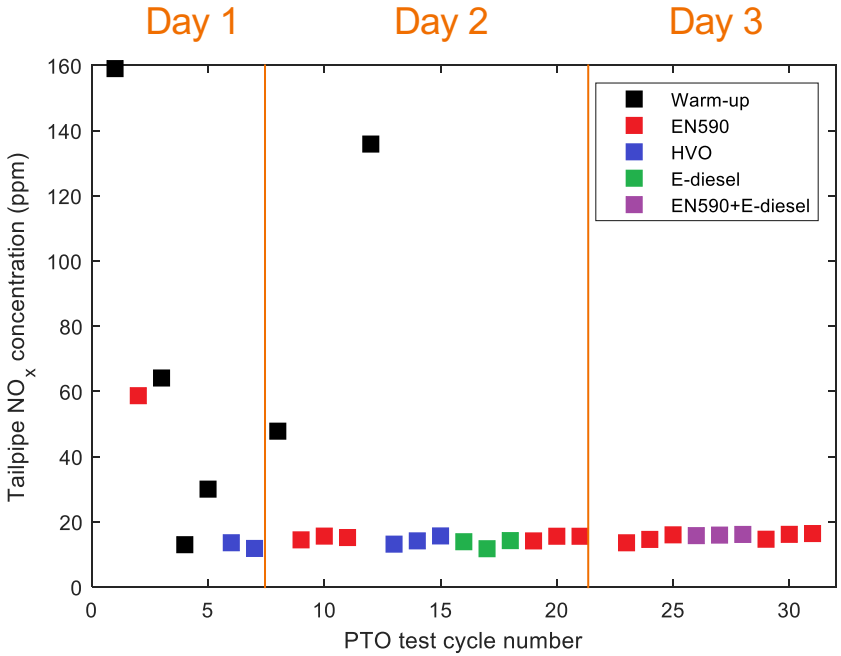




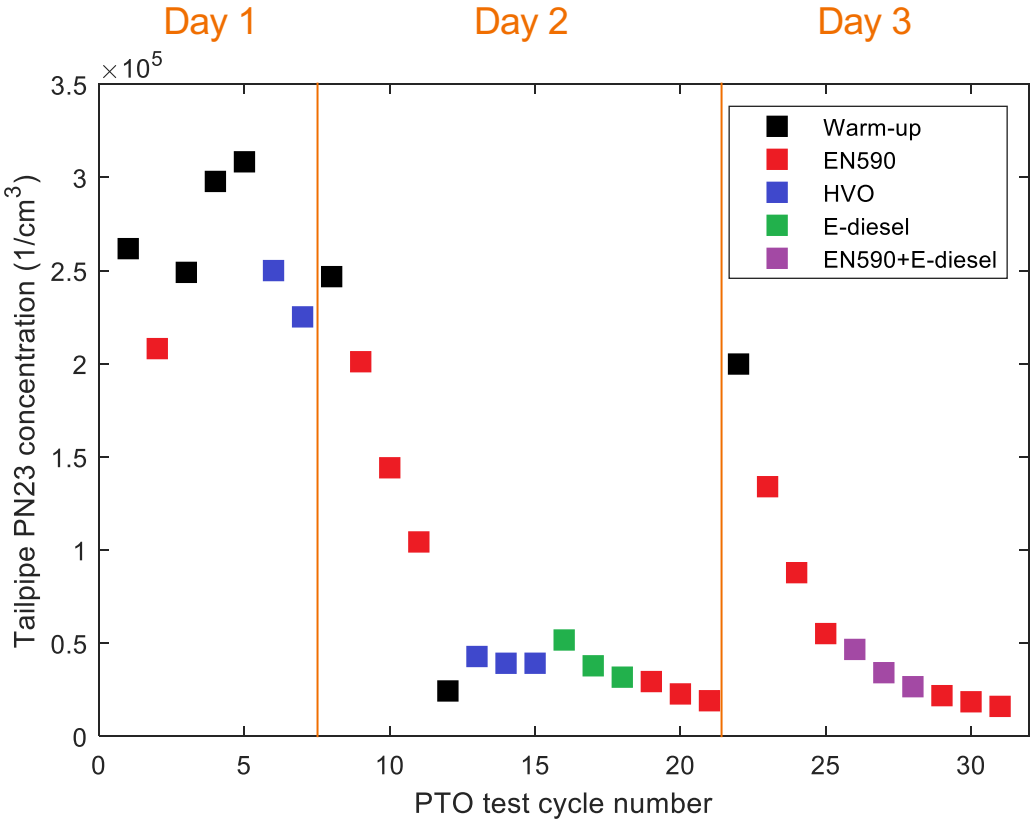
Results: Gaseus emissions after ATS (tailpipe)



Results: Gaseus emissions after ATS (tailpipe)



Results: PN after ATS (tailpipe)



Conclusions

- E-diesel was produced from electricity, water and carbon dioxide
- E-diesel was tested in an agricultural tractor
- The tractor was running normally with the e-diesel

- Before ATS (engine-out) emissions of the e-diesel:
  - Low for CO, black carbon and non-volatile PN23 concentrations
  - Mixing of e-diesel with fossil lowers black carbon and nv PN23 concentrations

- After ATS (tailpipe) emissions
  - Operation of the ATS has the main role in the emissions
  - Low nv PN23 concentrations after engine warm-up and some DPF loading

E-fuels are potentially high quality fuels with clean combustion

THANK YOU !

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Parallel company projects

ANDRITZ, convion, Fuel cell technology elcogen, NESTE

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beyond
the obvious

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