Technologie- und Förderzentrum
im Kompetenzzentrum
für Nachwachsende Rohstoffe

Biodiesel in Stage V Tractors

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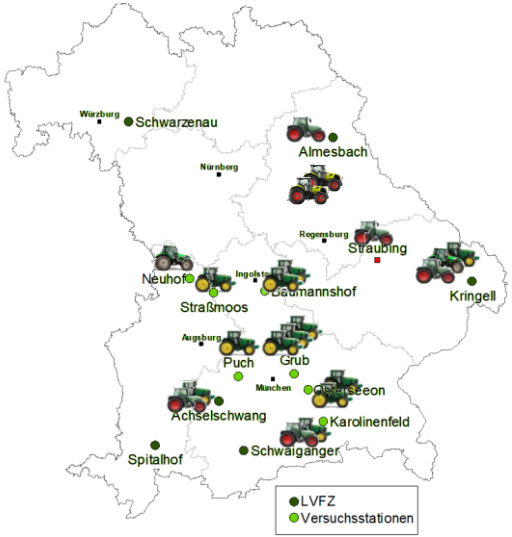
Dr. Johannes Ettl, TFZ
Fabian Wohlfahrt, Claas

Outline

- Overview of the KlimaBeSt project
- Test vehicle and field test operation
- Field test and emission measurements on the tractor test stand
- Real driving exhaust emissions during cultivating with B100
- Conclusion after 15 months and 700 operating hours

Project KlimaBeSt
Climate-friendly operation of state farms

- Duration: 01.07.2022 until 31.12.2025
- Objective: Support of the 'Bavarian Climate Protection Program'
- Conversion of 400 machines to climate-friendly drives
- Monitoring of operating and exhaust behavior
- Identification of weak points and troubleshooting
- Knowledge transfer and documentation



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Cooperation with

BaySG, LfL, LWG, LWF, Bayerische Staatsforsten – Nachhaltig Wirtschaften., CLAAS, FPT Powertrain Technologies, John Deere, BayWa, AGCO – Your Agriculture Company

Link to the project homepage:
www.tfz.bayern.de/biokraftstoffe/projekte/316296/index.php

TFZ

Test vehicle

- Start of field test 06/2023. The tractor only operates on biodiesel B100 (no blending)

Tractor	Claas Axion 830 CMATIC
Engine	6 cylinders / 6.7 l displacement
Max. Power	176 kW / 239 hp
Injection system	Common rail
Year of construction	2023
Exhaust gas stage	V
Fuel system	One-tank system Reinforced fuel pump (US package)
Exhaust gas aftertreatment	Oxidation catalytic, particulate filter, SCR system

- A Claas Arion 470 tractor is expected to be the second test vehicle for the field test year 2025

Photo: TFZ

Field test methods

- Analysis of the quality of the fuel
  (relevant quality parameters of EN 14214, AGQM)
- Analysis of the engine oil quality (every 100 operating hours;
  parameters: oil dilution, wear metals, TAN, TBN ...)
- Monitoring the operating behavior on the basis of a diary
  (type of work, refueling, maintenance, malfunctions ...)
- Support and documentation in the event of a malfunction
- CAN data analysis (fuel pressure, DPF pressure ...)

Photos: TFZ

B100 quality of the first delivery of 7,000 l - May 2023

Test parameters (TFZ Nr. 222)	Test result	DIN EN 14214 limits	Unit
Ester content	>99	> 96.5	% (m/m)
Linolenic acid ME content	9.1	< 12	% (m/m)
Density (15 °C)	883.2	860 - 900	kg/m³
Kin. Viscosity (40 °C)	4.417	3.55 - 5	mm²/s
Flash point	167	> 101	°C
CFPP	-13		°C
Sulphur content	<5(<1)	< 10	mg/kg
Cetane number (ICZ)	51.1	> 51	-
Sulphated ash (775 °C)	<0.005	< 0.02	% (m/m)
Water content	379	< 500	mg/kg
Total contamination	**50**	**< 24**	**mg/kg**
Corrosion effect on copper	1	1	rating
Oxidation stability	**7.3**	**> 8**	**h**
Acid number	0.38	< 0.50	mg KOH/g
Iodine value	112.6	< 120	g Iod/100g
PUFA	<0.60	< 1	% (m/m)
Methanol content	0.03	< 0.20	% (m/m)
Free glycerol content	0.005	< 0.02	% (m/m)
Monoglyceride content	0.32	< 0.70	% (m/m)
Diglyceride content	0.13	< 0.20	% (m/m)
Triglyceride content	0.09	< 0.20	% (m/m)
Total glycerol content	0.113	< 0.25	% (m/m)
Saturated monoglycerides	0.03	-	% (m/m)
Alkali content (Na+K)	<1.0	< 5	mg/kg
Alkaline earth content (Ca+Mg)	<1.0	< 5	mg/kg
Phosphorus content	<4.0 (<0.5)	< 4	mg/kg
Cloudpoint	-6	-	°C

- Problems in the fuel system due to B100 contamination with bleaching earth
- Subsequently: Fuel exchange and installation of safety filter (5 µm) on the on-farm filling station, addition of antioxidants (Baynox®) to increase oxidation stability

Photos: TFZ

B100 quality of the second delivery of 7,000 l - April 2024

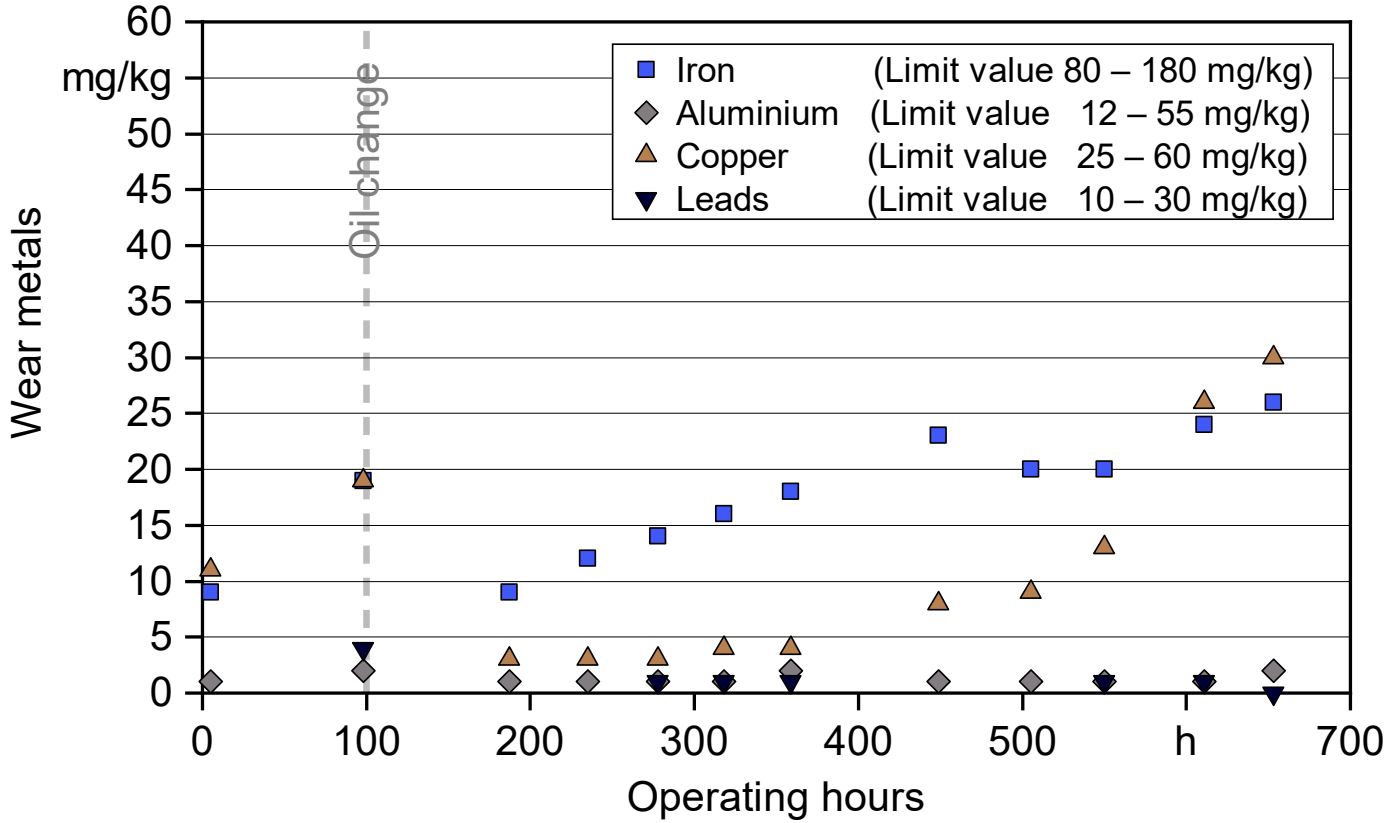
Test parameters (TFZ Nr. 357)	Test result	DIN EN 14214 limits	AGQM limits	Unit
Ester content	98.6	> 96.5	> 96.5	% (m/m)
Linolenic acid ME content	7.9	< 12	< 12	% (m/m)
Density (15 °C)	882.4	860 - 900	860 - 900	kg/m³
Kin. Viscosity (40 °C)	4454	3.55 - 5	3.55 - 5	mm²/s
Flash point	171.5	> 101	> 101	°C
CFPP	-15		0	°C
Sulphur content	<5(1.1)	< 10	< 10	mg/kg
Cetane number (ICZ)	54.3	> 51	> 51	-
Sulphated ash (775 °C)	<0.005	< 0.02	< 0.02	% (m/m)
Water content	**120**	**< 500**	**< 300**	**mg/kg**
Total contamination	**3**	**< 24**	**< 20**	**mg/kg**
Corrosion effect on copper	1	1	1	rating
Oxidation stability	**10,8**	**> 8**	**> 9**	**h**
Acid number	0.34	< 0.50	< 0.50	mg KOH/g
Iodine value	107.6	< 120	< 120	g Iod/100g
PUFA	<0.60	< 1	< 1	% (m/m)
Methanol content	0.02	< 0.20	< 0.20	% (m/m)
Free glycerol content	0.006	< 0.02	< 0.02	% (m/m)
Monoglyceride content	0.37	< 0.70	< 0.70	% (m/m)
Diglyceride content	0.08	< 0.20	< 0.20	% (m/m)
Triglyceride content	0.05	< 0.20	< 0.20	% (m/m)
Total glycerol content	0.118	< 0.25	< 0.25	% (m/m)
Saturated monoglycerides	**0.02**	**-**	**< 0.12**	**% (m/m)**
Alkali content (Na+K)	**<1.0**	**< 5**	**<.2.0 each**	**mg/kg**
Alkaline earth content (Ca+Mg)	**<1.0**	**< 5**	**< 1.0 each**	**mg/kg**
Phosphorus content	**<4.0 (<0.5)**	**< 4**	**< 2**	**mg/kg**
Cloudpoint	-4	-	-	°C

- Quality according to DIN EN 14214
- Complies with the AGQM guidelines for a B100 specification

⇒ Important for EATS

Source: www.agqm-biodiesel.de/application/files/3416/9354/5483/AGQM_Leitfaden_eine_B100_Spezifikation_komp.pdf
Photos: TFZ

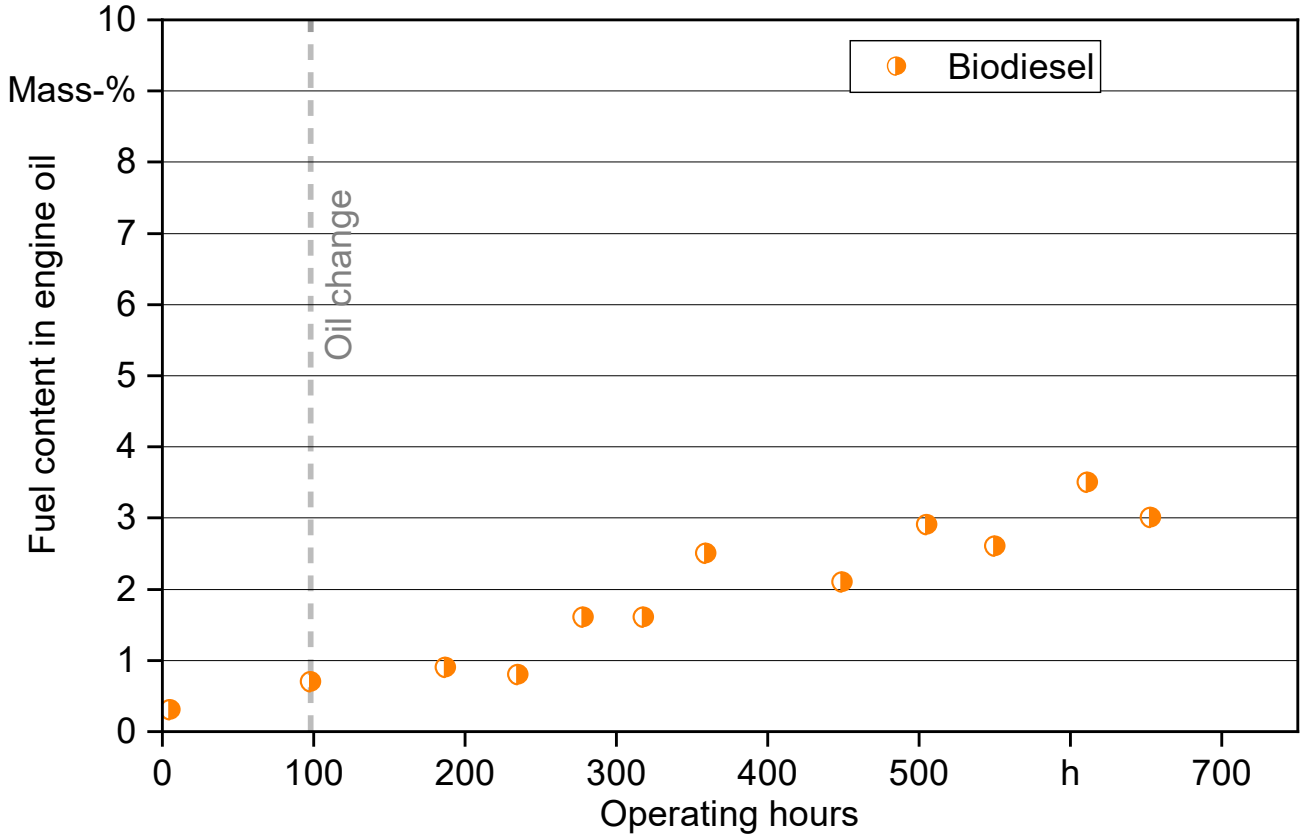
Engine oil quality (1) - Claas Axion 830 CMATIC



Source limit values: Oelcheck

TFZ

Engine oil quality (2) - Claas Axion 830 CMATIC

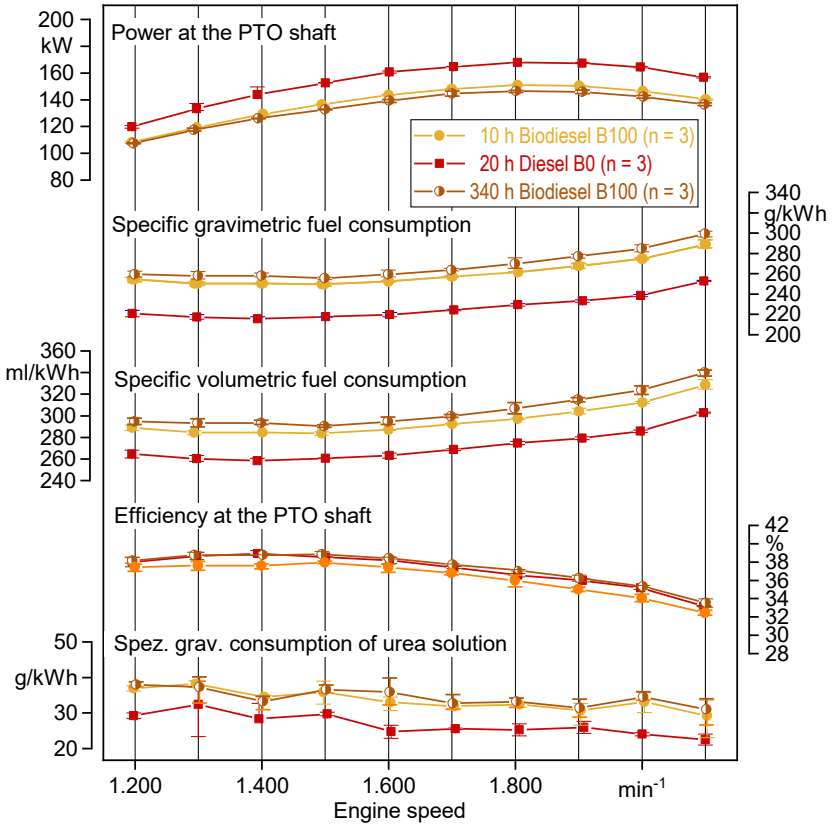


Tractor test stand of the TFZ

Photo: TFZ

Performance and fuel consumption at tractor test stand

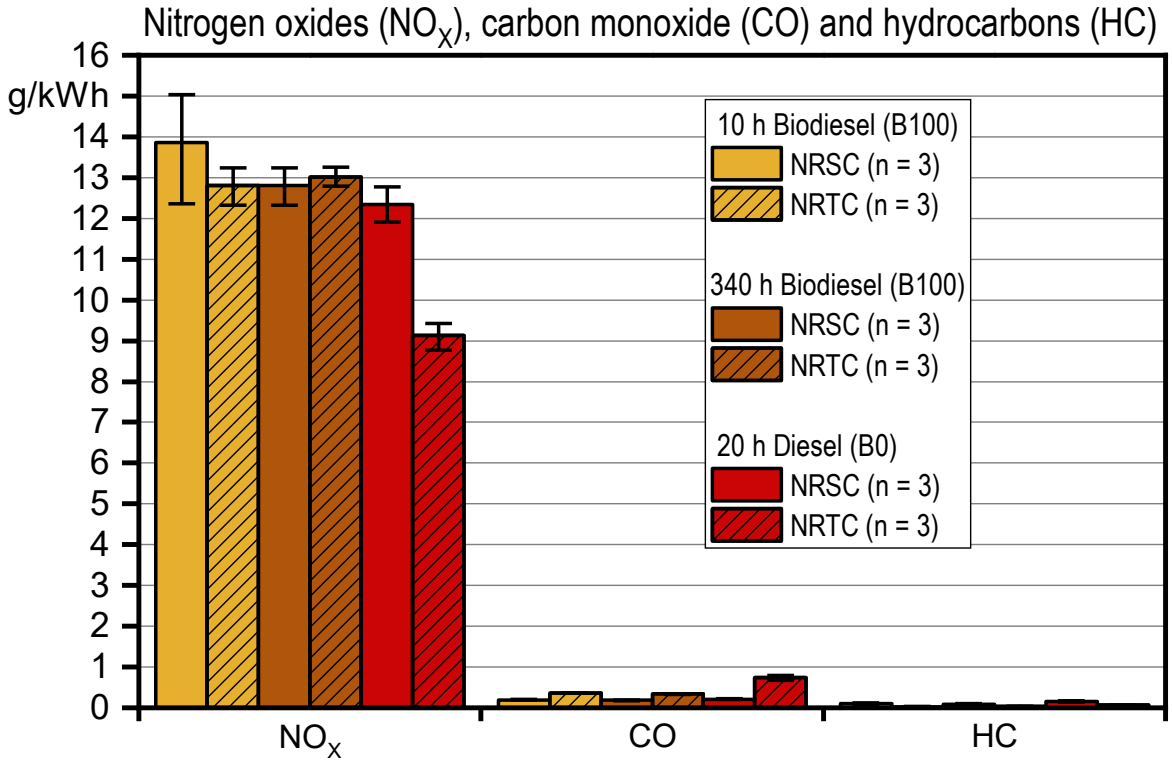
Claas Axion 830 CMATIC at tractor test stand



- 12 % lower PTO power with B100 than with B0
- 8 % higher specific volumetric fuel consumption (ml/kWh) with B100 than with B0
- 2 % lower absolute volumetric consumption (l/h) with B100
- Equal efficiency with both fuels
- 9 % higher urea consumption (g/kWh) with B100 than with B0

Raw emissions before exhaust gas aftertreatment

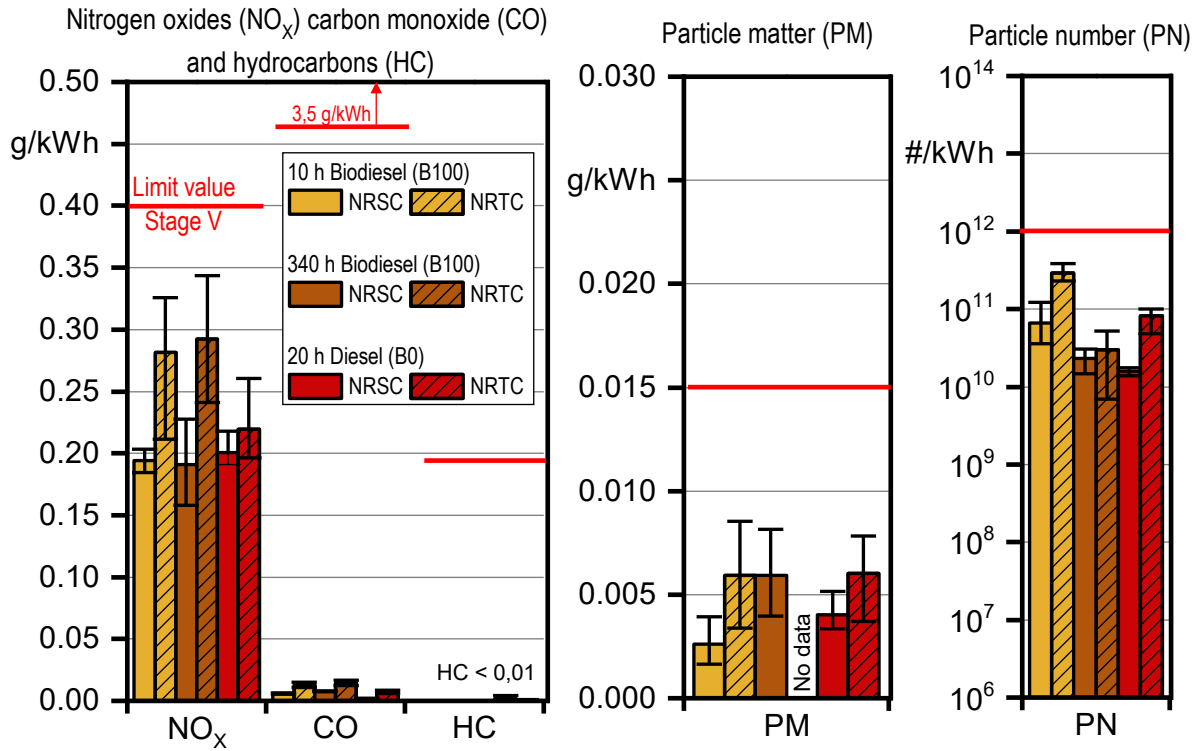
Claas Axion 830 CMATIC at tractor test stand



Emissions before exhaust gas aftertreatment in the Non-Road Steady Cycle (NRSC) and Transient Cycle (NRTC)

Emissions after exhaust aftertreatment

Claas Axion 830 CMATIC at tractor test stand



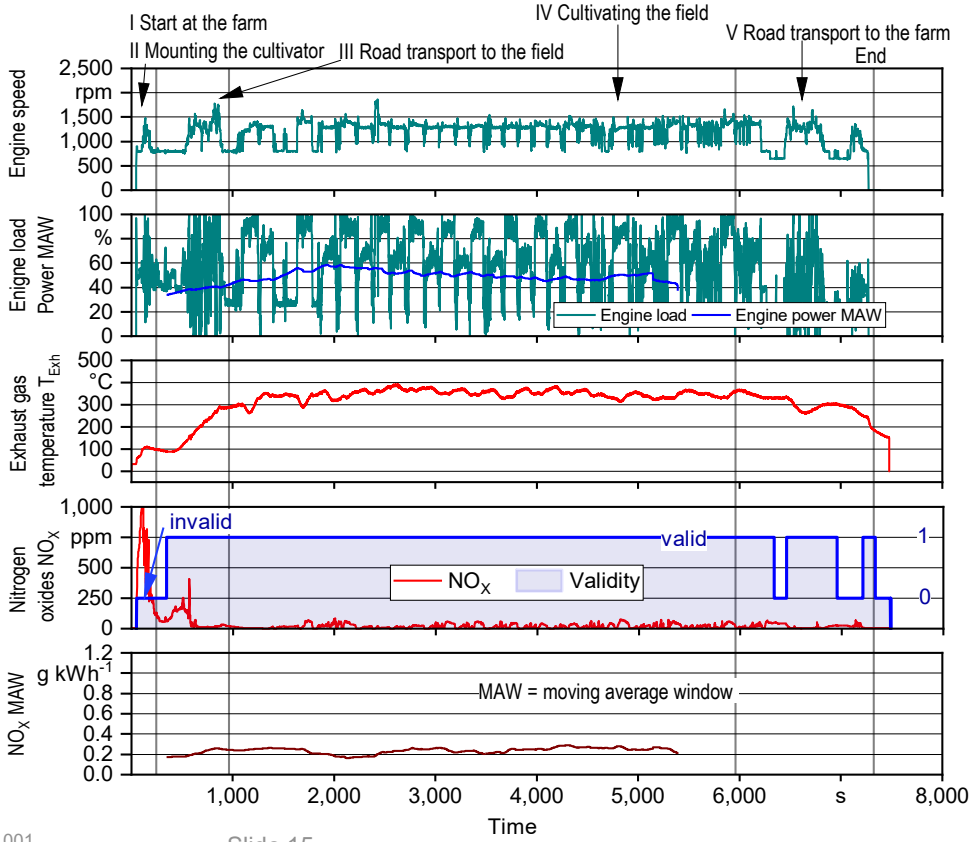
Emissions after exhaust gas aftertreatment in the Non-Road Steady Cycle (NRSC) and Transient Cycle (NRTC)

Portable emission measurement (PEMS) at the Claas Axion 830 CMATIC during cultivating

Photos: TFZ

Portable emission measurement with B100 at 185 hours

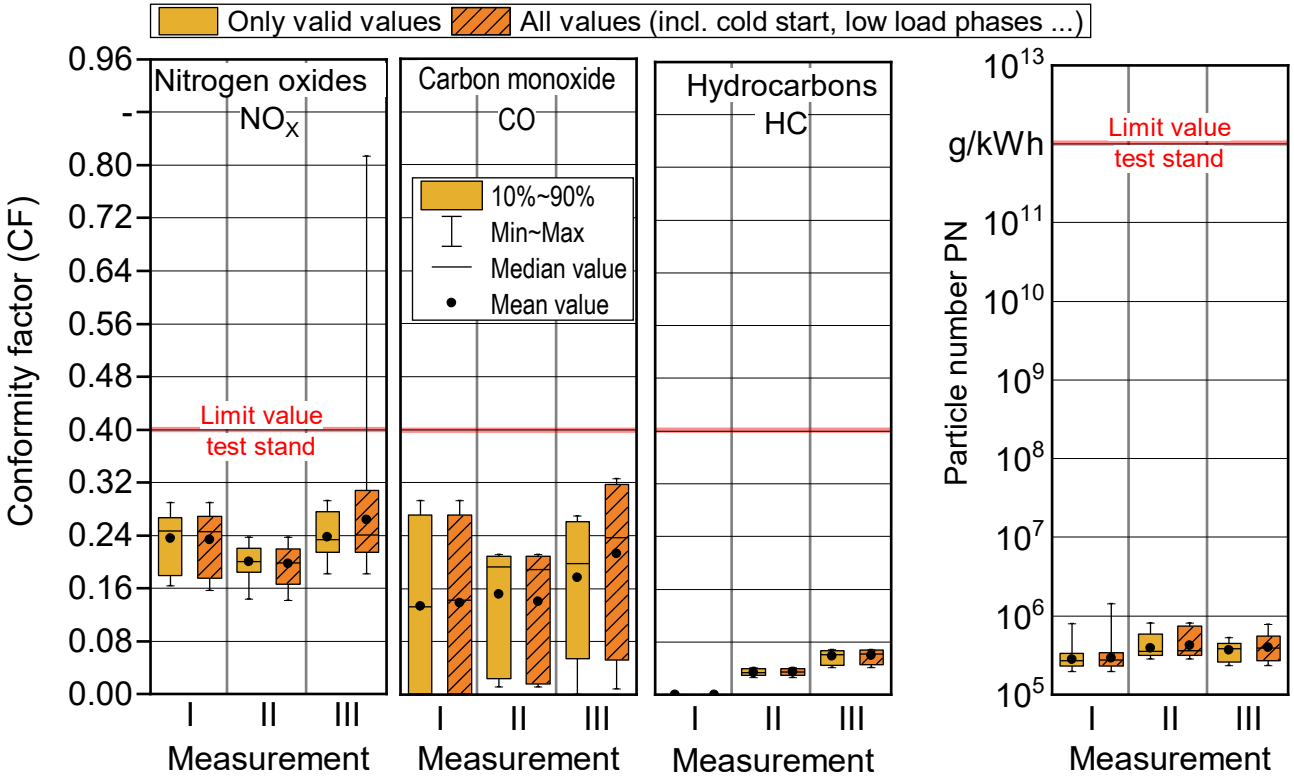
Claas Axion 830 CMATIC during cultivating



Photos: TFZ

Emissions when cultivating with B100 at 185 hours

Claas Axion 830 CMATIC during cultivating



Conclusion after 15 months and 700 hours - Claas Axion 830 CMATIC

- The tractor has completed 700 operating hours with B100 in the field so far
  - 2023: Additional fuel filter change required due to poor biodiesel quality
  - 2024: Trouble-free operation
  - Particulate filter regeneration without problems
    (low ash content in AGQM-compliant fuel)
  - Low engine oil dilution and small share of wear metals
  - The starting behavior is rated as "very good"
  - Drivers are very satisfied with the operating behavior
- Power and emission measurements
  - 12 % lower PTO power with the same efficiency with B100 compared to B0
  - Emissions with B100 are under the limits of emission stage V
  - Real emissions during cultivating are at a very low level (conformity factor < 0.6)
- For final assessment, results over the service life of the machine need to be checked

Photos: TFZ

Thank you!

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Ernährung, Landwirtschaft, Forsten und Tourismus