The N_2O Wastewater System

- Maintenance Training UK -

measure to kN_2Ow

online

Bastian Piltz

14.03.2024

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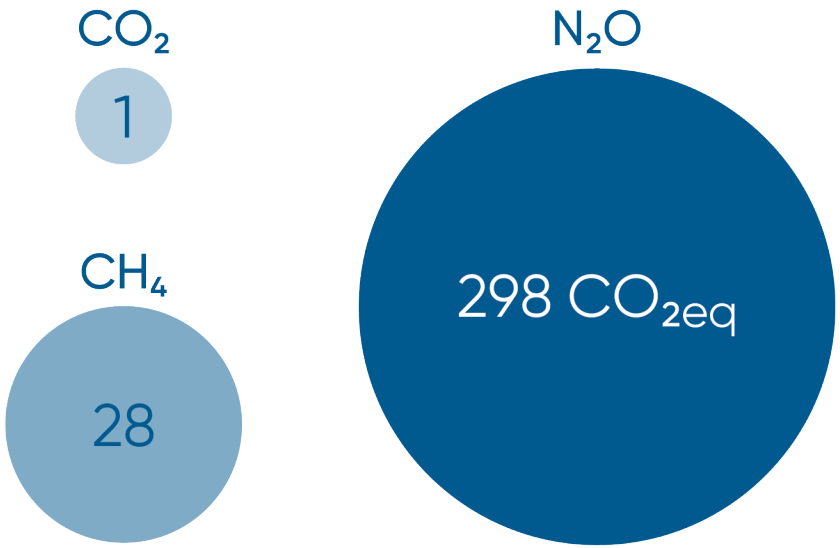
The climate challenge



Wastewater treatment plants produce ~2% of all GHG emissions.

This is equivalent to the emissions of global air traffic!

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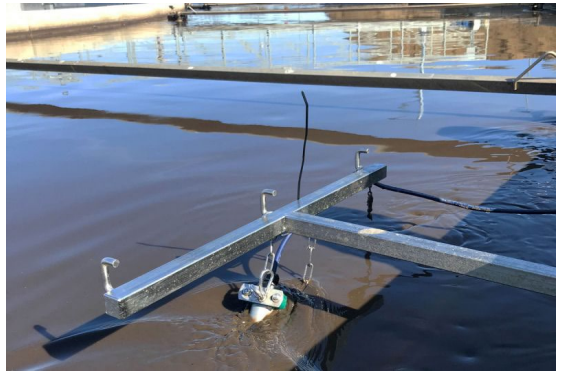
N_2O Wastewater System

- Unique nitrous oxide process sensor
- Real time reliable data
- Longterm measurements

- Process optimization WWTP

→ Greenhouse gas reduction

- Emission calculation

→ Sustainability accounting

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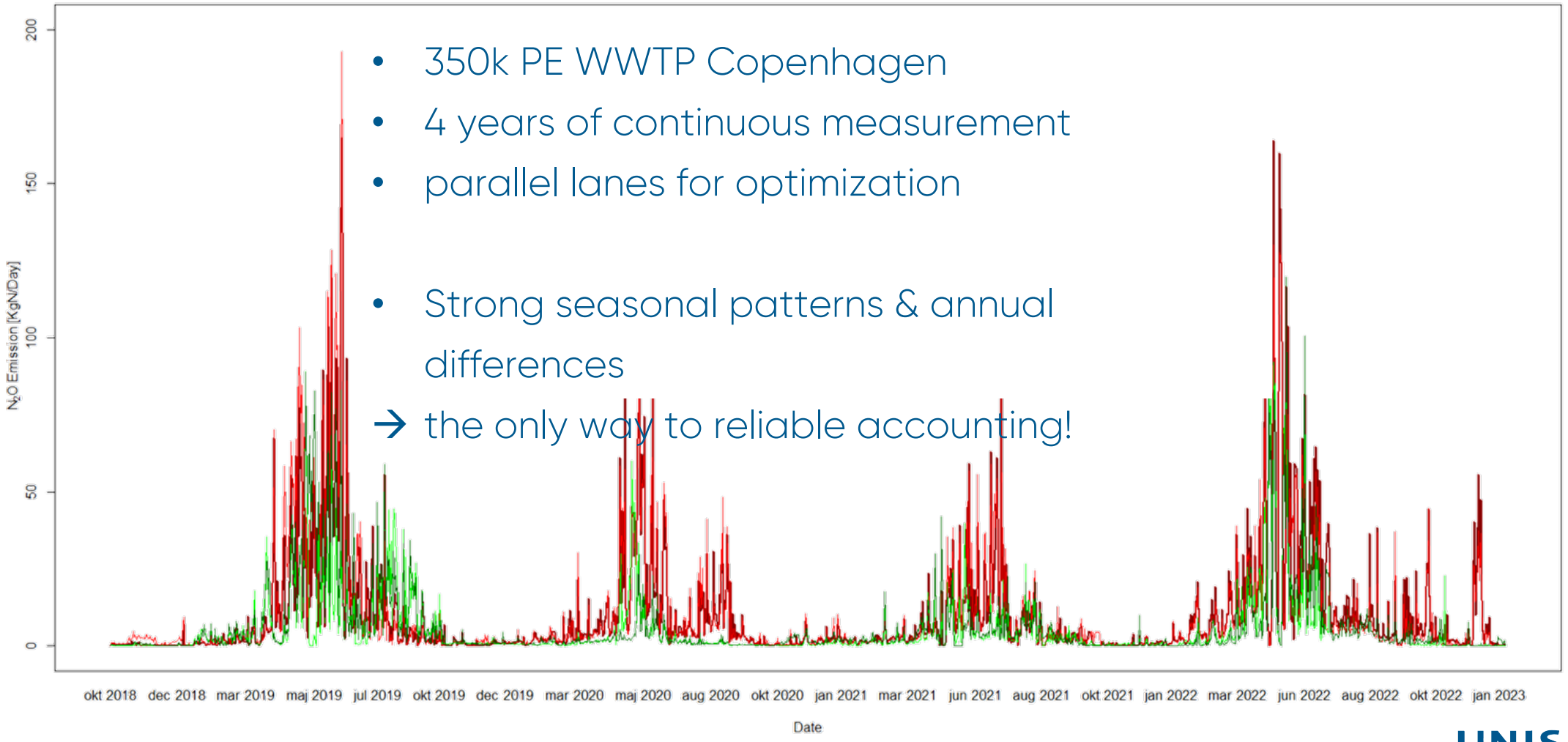
The value of long term measurements



- 350k PE WWTP Copenhagen
- 4 years of continuous measurement
- parallel lanes for optimization

- Strong seasonal patterns & annual differences

→ the only way to reliable accounting!

N_2O Wastewater System

Controller

Sensor body

Sensor head

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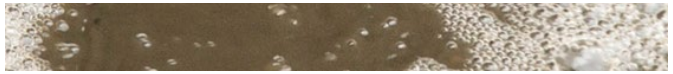
Installation - considerations

- Sensor body fully submerged & (<90°)
- Weight not on cable (chain mount)
- Rigid pipe if in turbulent conditions
- Protected from carrier materials
- Sensor body never in water w/o head

Installation - considerations



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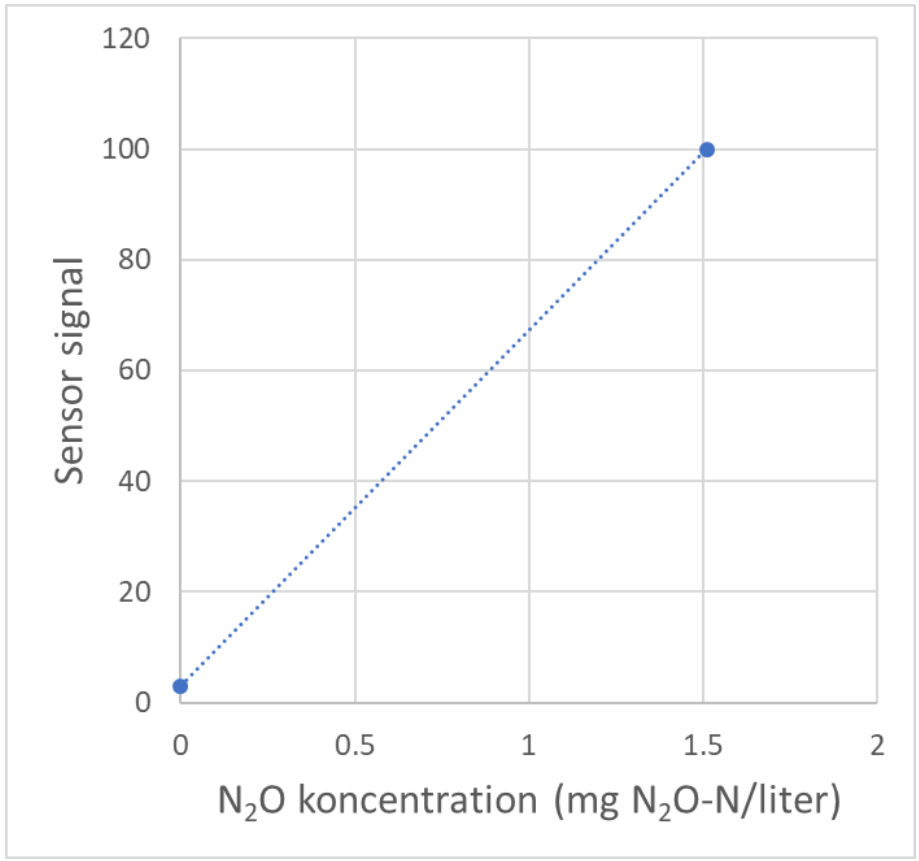
Installation – considerations

"Sensor Basket"

- Sensor body fully submerged & (<90°)
- Weight not on cable (chain mount)
- Rigid pipe if in turbulent conditions
- Protected from carrier materials (MBBR)
- Sensor body never in water w/o head

Calibration



- Calibration at process temperature
- 1°C higher or lower in spring/autumn
- Temperature correction ± 3°C
- If larger changes, extra calibration

Calibration kit

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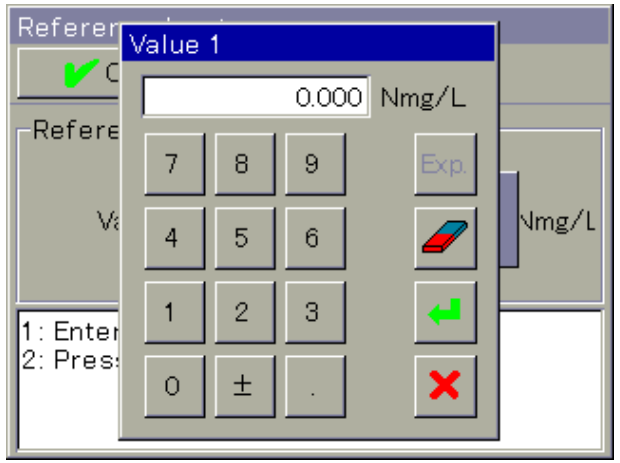
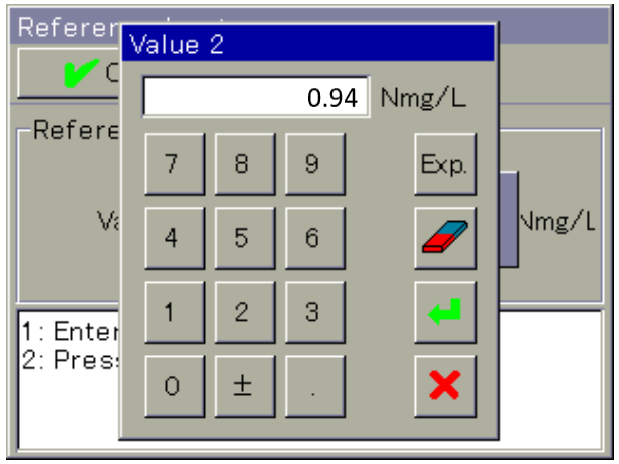
Calibration – step by step





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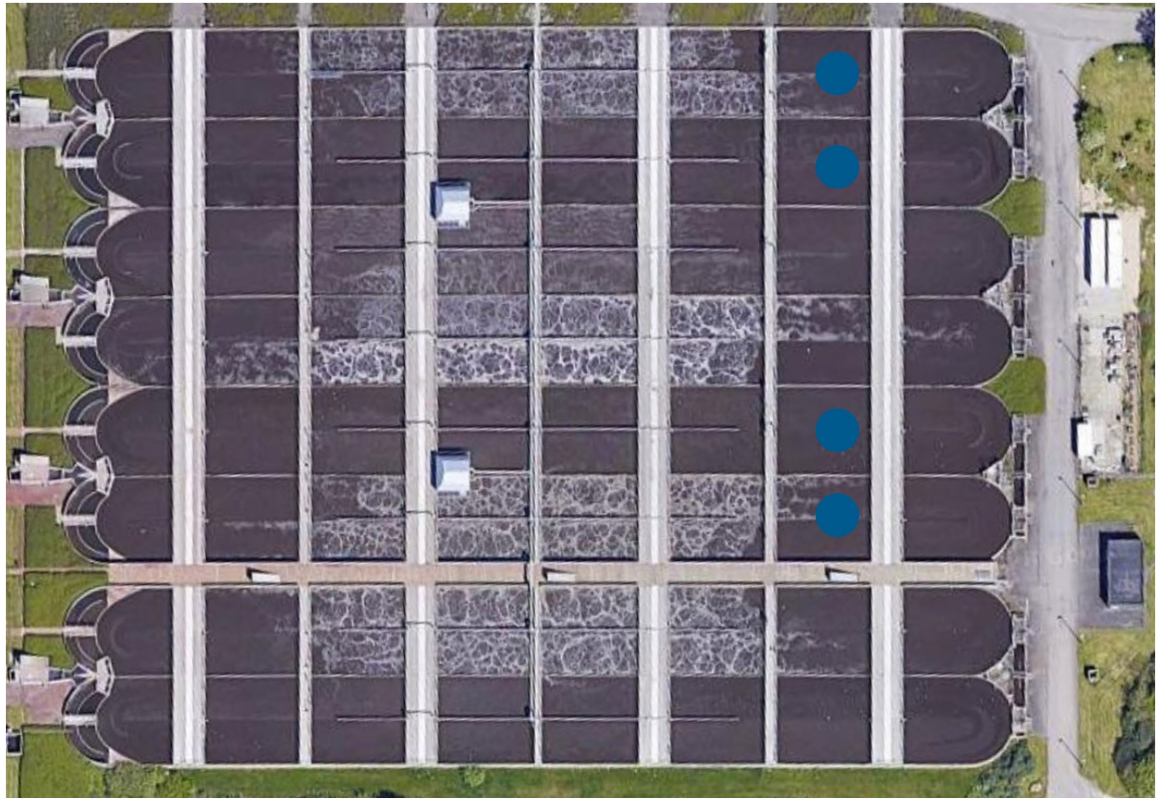
Calibration – tools

- 5L Laboratory pitcher with scala
- Tap water
- >5L insulated buckets (2x)
- Thermometer
- If water temperature challenging
  - Ice pack / Fridge
  - Water boiler

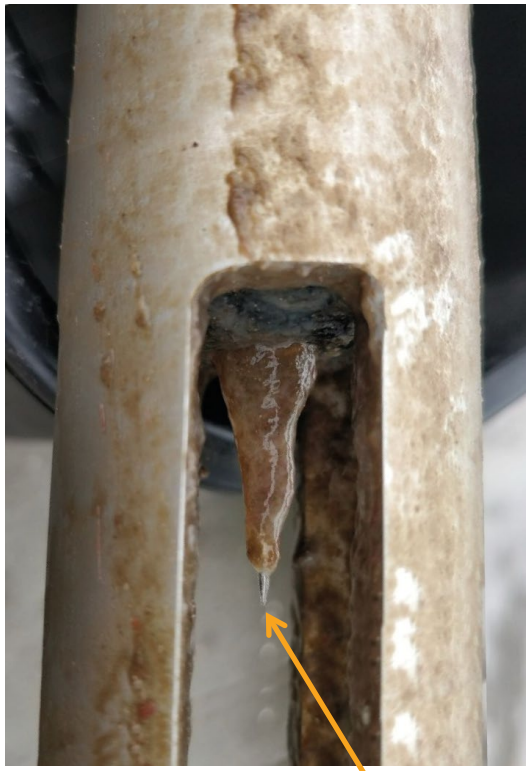
Sequential calibration

- Calibration liquid stable for 20 min (if not shaken)
- 2-4 calibrations can be done after one another

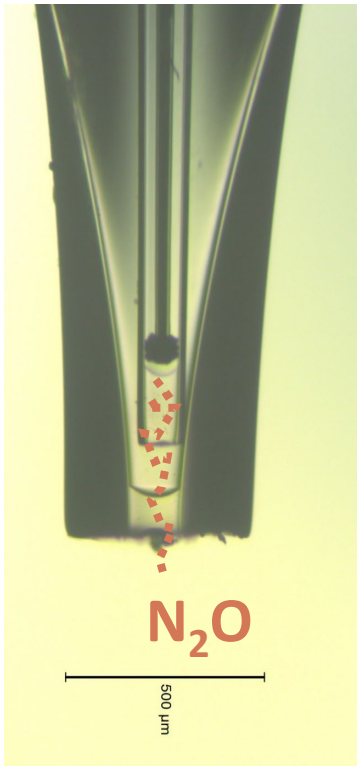


● N_2O Sensor

Cleaning



Functional tip



- Clean body when calibrating
- Tip cleaning rarely needed!
- If required, use HCL, water + soft brush / paper

Replacement of sensor head

Lifetime

- Expected lifetime = 6 months (warranty 4 months)
- Recommend replacing sensor heads regularly to ensure continuous data quality
- Perform at a stable workplace
- Leave sensor head 12h to stabilize before calibration

Sensor concentration range

PRODUCT	WORKING RANGE N_2O-N	DETECTION LIMIT N_2O-N	TEMPERATURE RANGE	APPLICATION
E-N_2O Head SR	0-1.5 mg/L	0.005 mg/L	0-27°C	Most ASP
E-N_2O Head MR	0-9 mg/L	0.03 mg/L	0-27°C	
E-N_2O Head HR	0-110 mg/L	0.4 mg/L	0-27°C	
E-N_2O Head HT SR	0-1.5 mg/L	0.005 mg/L	27-40°C	Tropical conditions
E-N_2O Head HT MR	0-9 mg/L	0.03 mg/L	27-40°C	Deammonification and other side stream
E-N_2O Head HT HR	0-110 mg/L	0.4 mg/L	27-40°C	

Change range on Controller (output, logger) & in Telemetry!

MANUALS
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Time for questions

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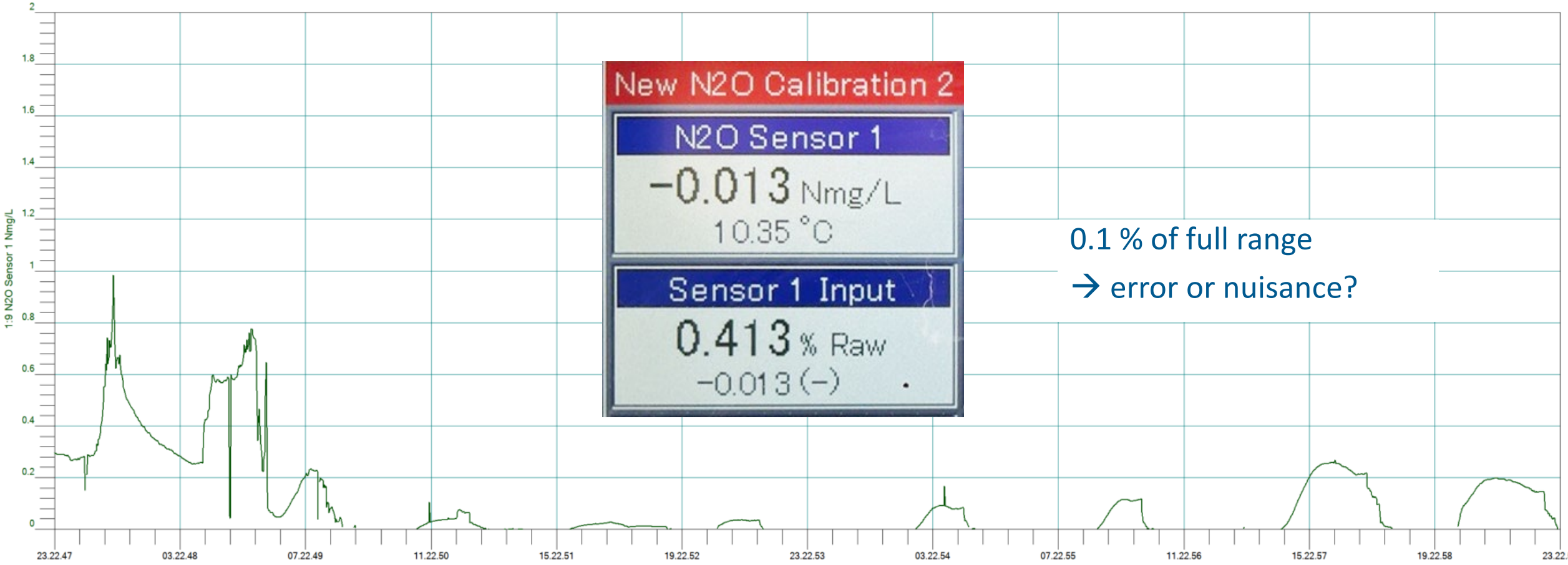
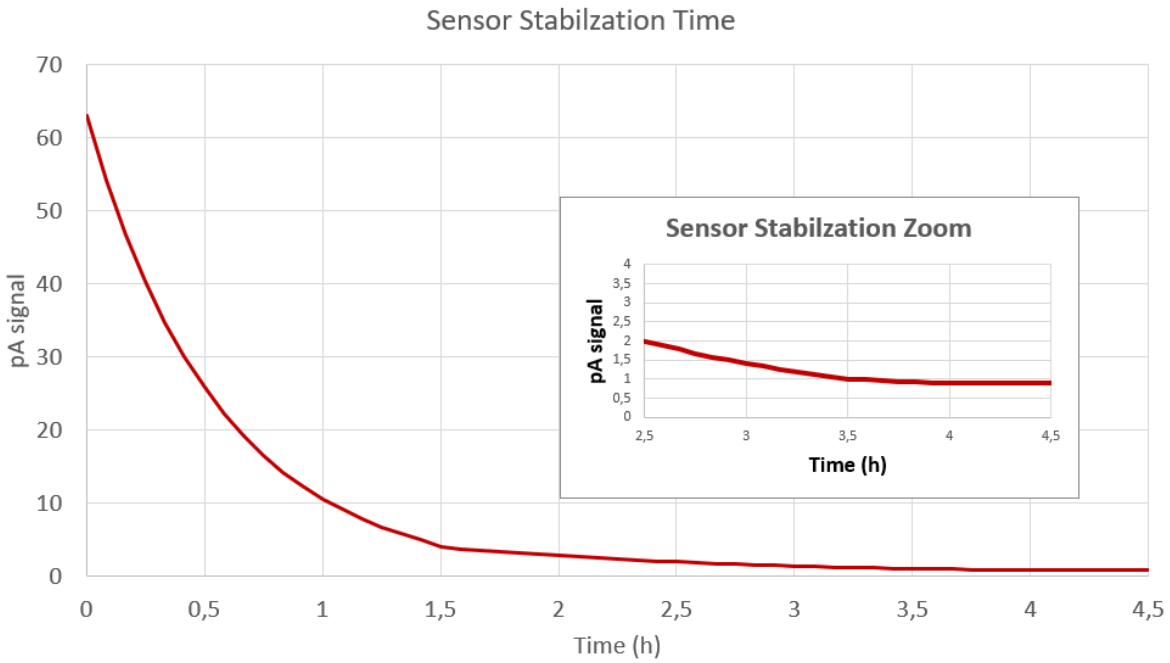
N_2O Wastewater System – Negative concentrations



0.1 % of full range

→ error or nuisance?

N_2O Wastewater System – Negative concentrations



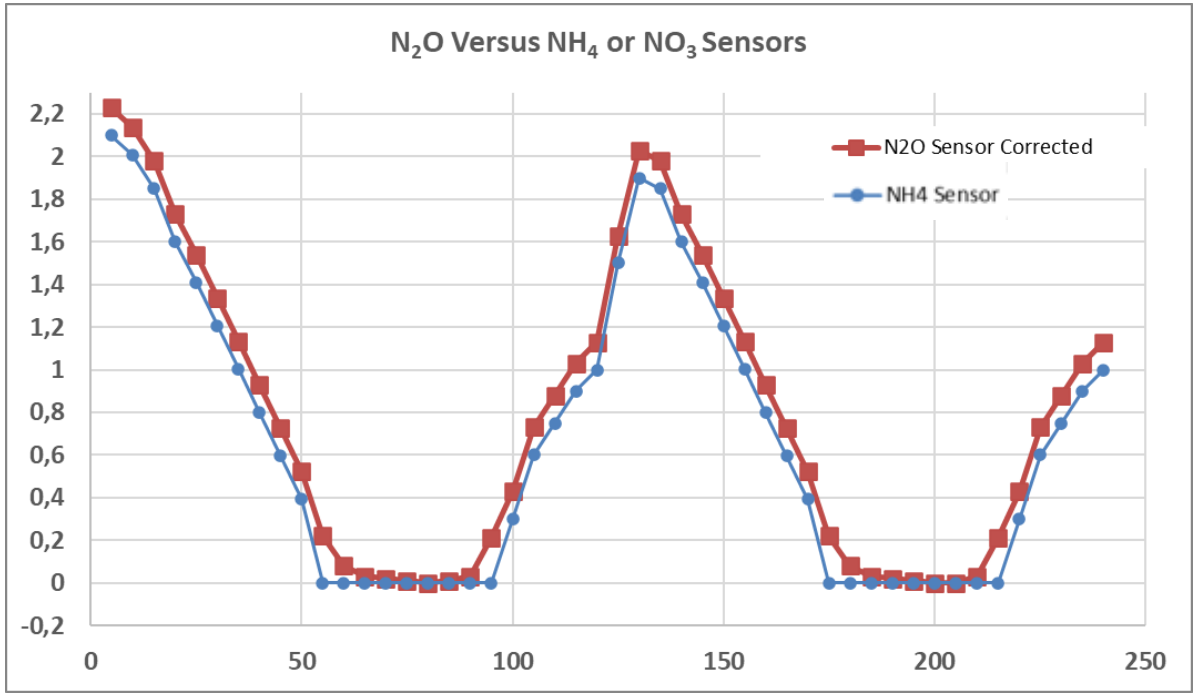
Why can negatives occur?

- Sensor signal not clipped off
- Only relevant close to zero

Practical reasons

- Calibrated before fully polarized
- Temperature changes affect signal

N_2O Wastewater System – Negative concentrations



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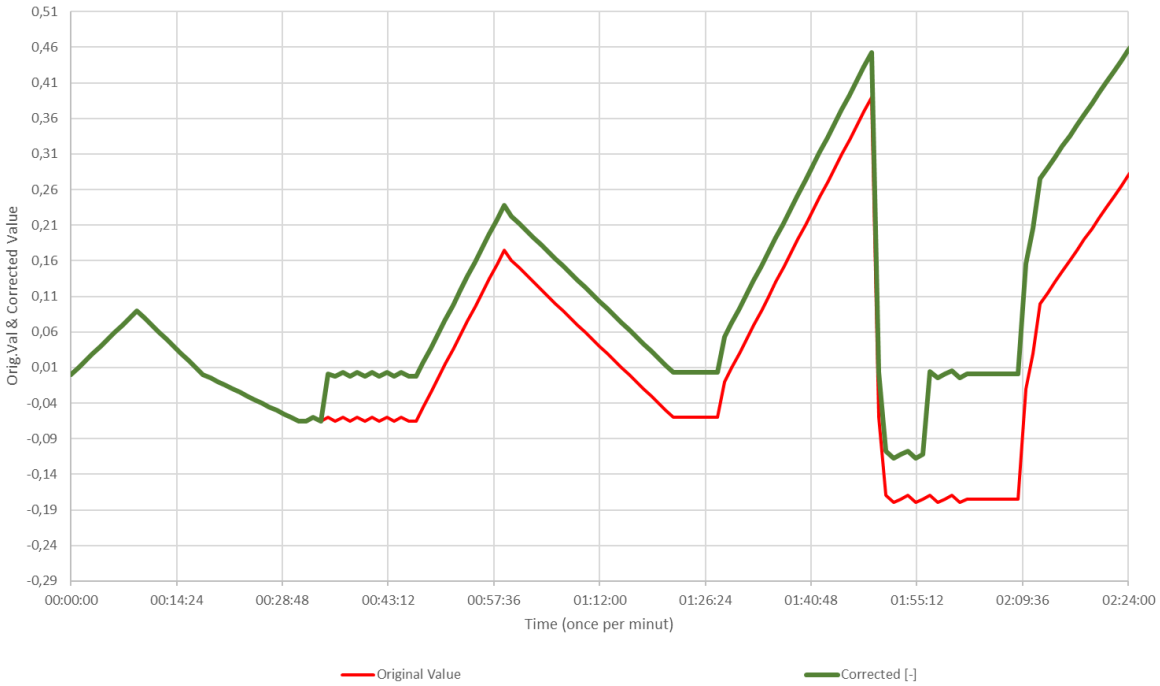
N_2O Wastewater System – Negative concentrations



How to remove negatives?

- Manual Zero calibration
- Data Offset manual
- **Autozero addon**

- if stable negative measured 15 min

→ new zero point defined

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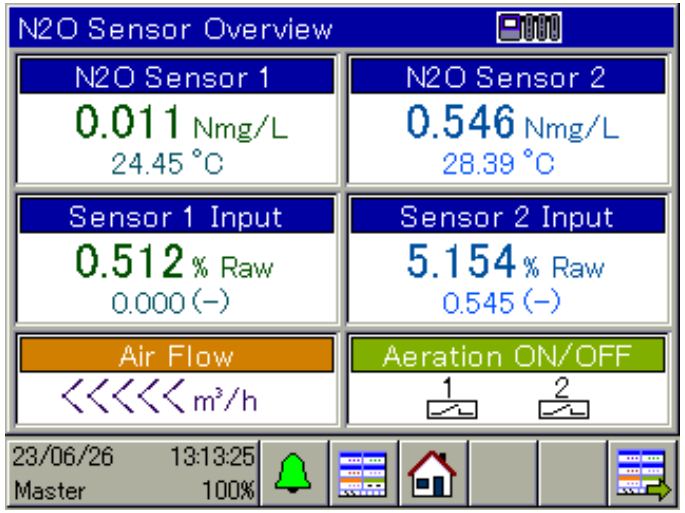
N_2O Wastewater System – Update (Oct '23)

Available for older systems



Key features in all new Systems

- Auto Zero to correct for negative values
- Algorithms advanced – lower effect of temperature on concentration
- Controller screen "cleaned up"
- Alarm if calibration temperature out of range (digital)

New MODBUS/ Profibus addresses

MANUALS
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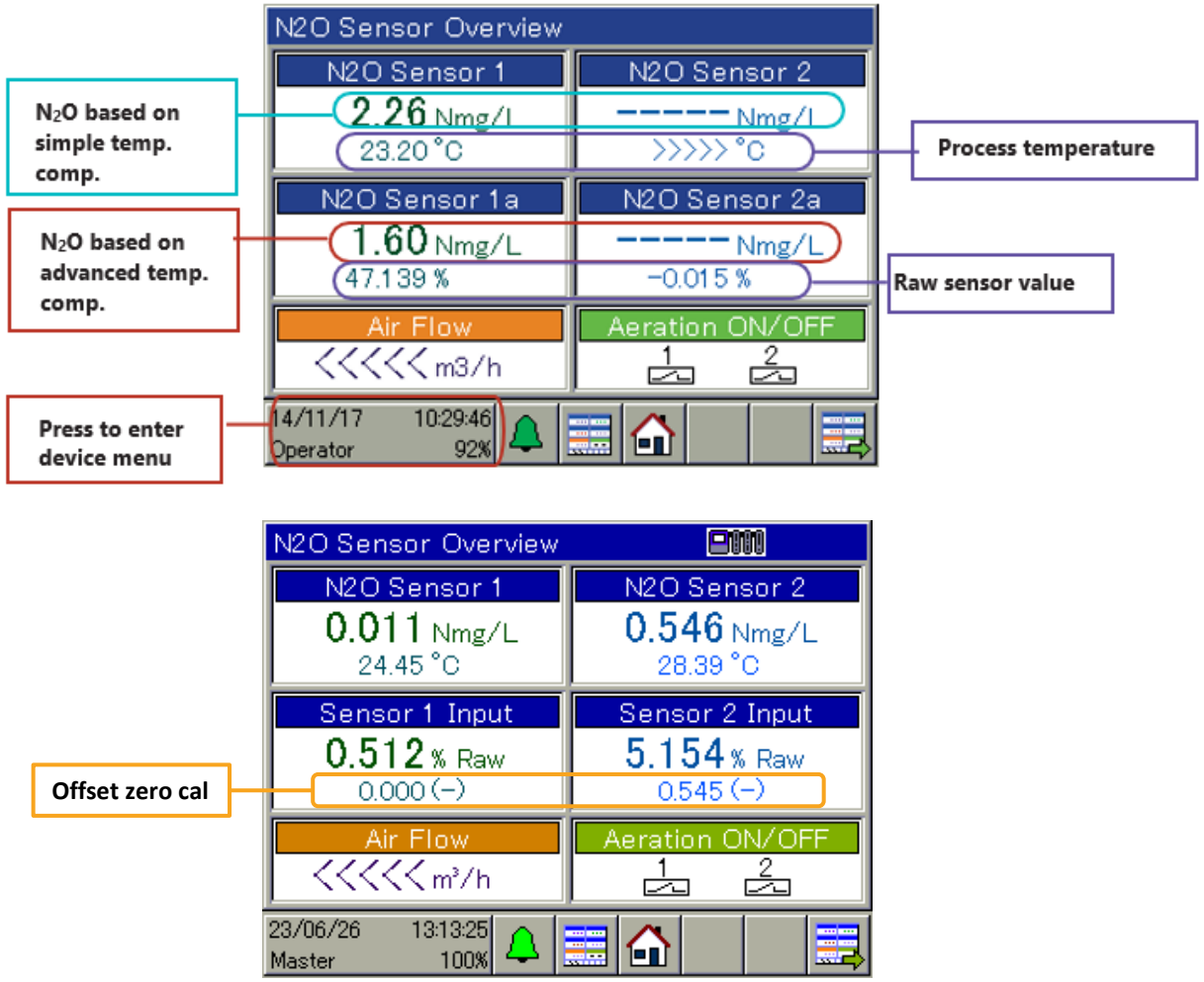
Old vs new Controller screen



Differences

- Only 1 concentration value
- Raw % changed position
- Offset zero calibration added

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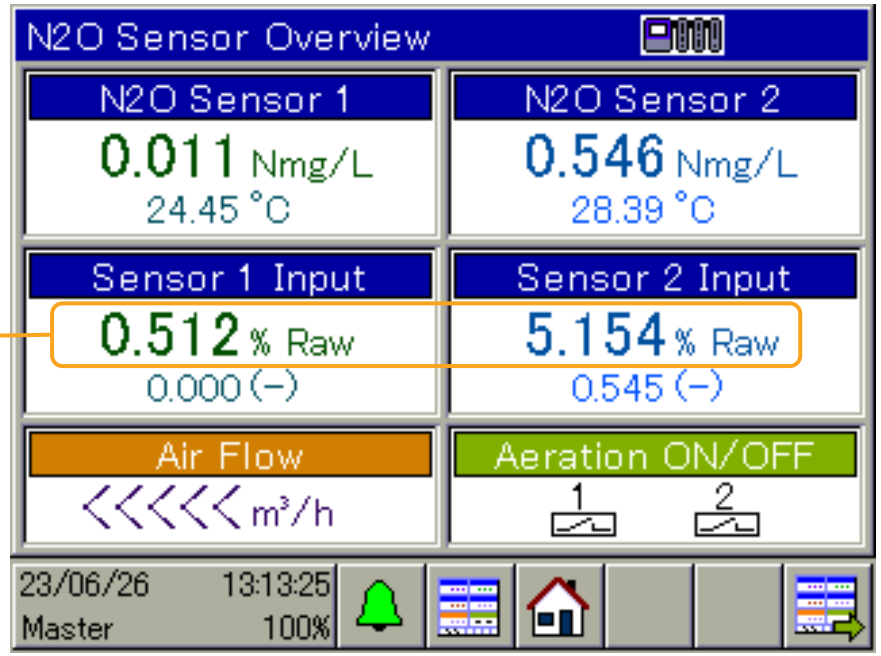
Using the Raw % Value



Signal without calibration

Raw value meaning

- Signal unaffected by calibration
- Is input to concentration
- Used to check sensor head ”health” & functionality

→Polarization procedure

→Baseline before calibration

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Sensor head installation

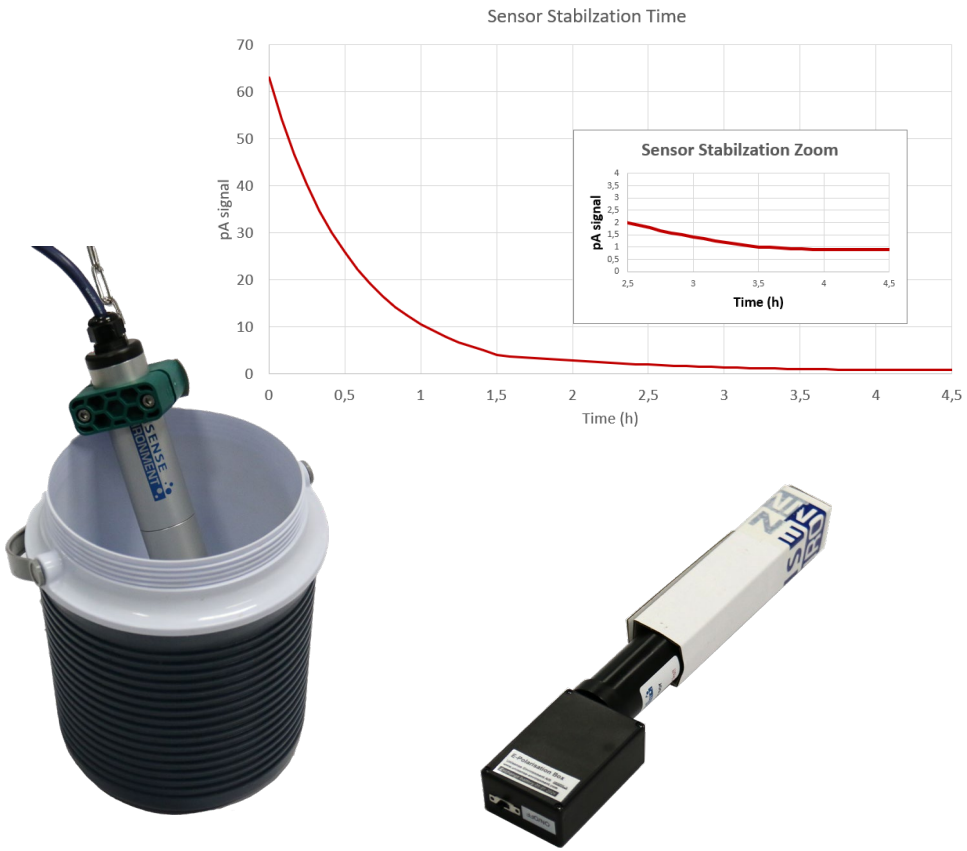
Polarization starts when

- A connection to sensor is established
  - Sensor (re-)connected
  - Sensor cable plugged in

Polarization procedure

- 30 min duration
  - Rapid increase (90-100%)
  - Wavering signal
  - Decrease (<2%) → up to 12h for new sensor

Sensor head installation



Polarization procedure

- Keep sensor in bucket of water (unless freezing)
- Goal – stable below 2% raw value
- Up to 12h for stable value to be reached

Pre-polarization

Pre-polarization box used to

- Prepare sensor head for installation
- Shorten waiting time on site to 30 min
- Enable same-day calibration
- Take care of packing!

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Time for questions

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Troubleshooting

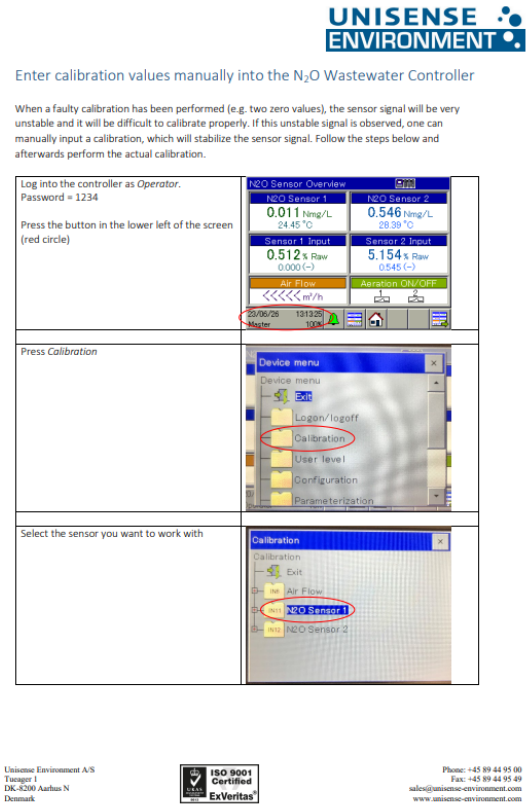
To diagnose

1. Place sensor in tap water
2. Check Raw value

Problem symptom

- Fluctuating signal
- Maxed out signal (99%)
- Not responding to N_2O
- High baseline (above 2%)

Troubleshooting



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Enter calibration values manually into the N_2O Wastewater Controller

When a faulty calibration has been performed (e.g. two zero values), the sensor signal will be very unstable and it will be difficult to calibrate properly. If this unstable signal is observed, one can manually input a calibration, which will stabilize the sensor signal. Follow the steps below and afterwards perform the actual calibration.

Log into the controller as *Operator*. Password = 1234 Press the button in the lower left of the screen (red circle)	
Press *Calibration*	
Select the sensor you want to work with	

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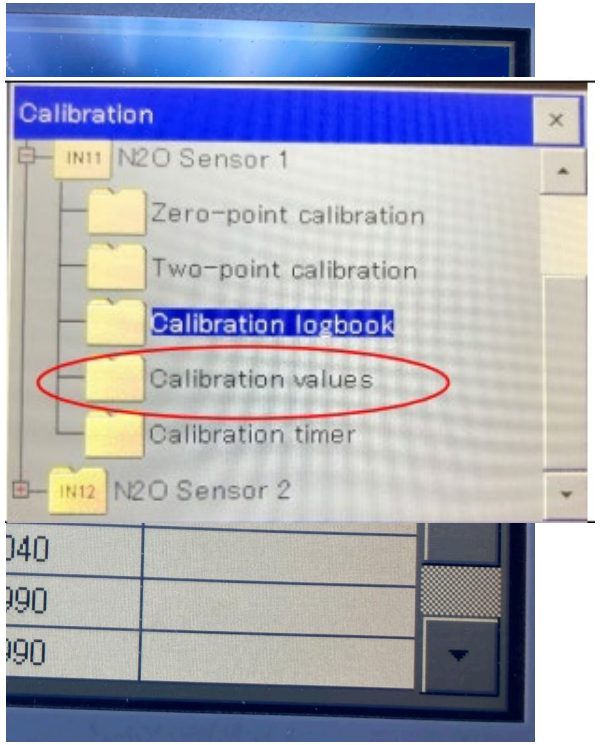

- Fluctuating signal, not stabilizing
  - Faulty calibration

  → input manually (**zero point: 0; slope 30%**)
- Maxed out signal (99%)
- Not responding to N_2O
- High baseline (above 2%)

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Troubleshooting

- Fluctuating signal
- Maxed out signal (99%)
  - Airbubble in tip
  - Polarization not successful
  - Sensor head damaged
- Not responding to N_2O
- High baseline (above 2%)

Troubleshooting

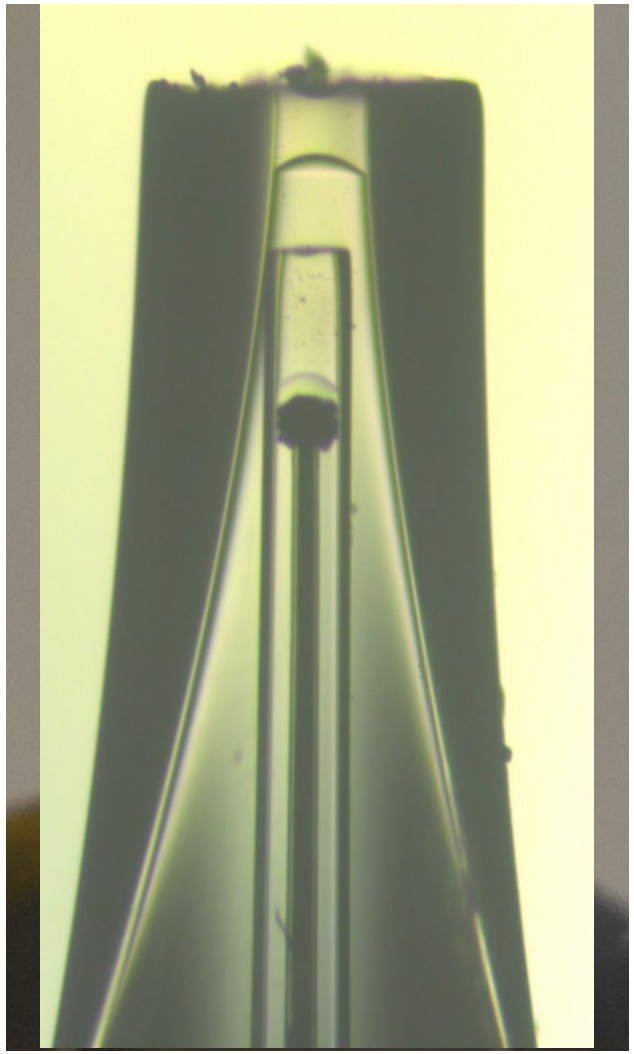
- Fluctuating signal
- Maxed out signal (99%)
  - Airbubble in tip (invisible)
  - Polarization not successful
  - Sensor head damaged
- Not responding to N_2O
- High baseline (above 2%)

Troubleshooting

1. Disconnect head, check raw % value
   - Close to 0% → OK
   - Stays high → sensor body fault
2. Reconnect, check polarization procedure
   - OK → recalibrate
   - Stays high → sensor head fault

- Fluctuating signal
- Maxed out signal (99%)
  - Airbubble in tip (invisible)
  - Polarization not successful → test sensor body & restart polarization
  - Sensor head damaged
- Not responding to N_2O
- High baseline (above 2%)

Troubleshooting



- Fluctuating signal
- Maxed out signal (99%)
  - Airbubble in tip (invisible)
  - Polarization not successful
  - Sensor head damaged
    - Visible or invisible
- Not responding to N_2O
- High baseline (above 2%)

Troubleshooting

- Fluctuating signal
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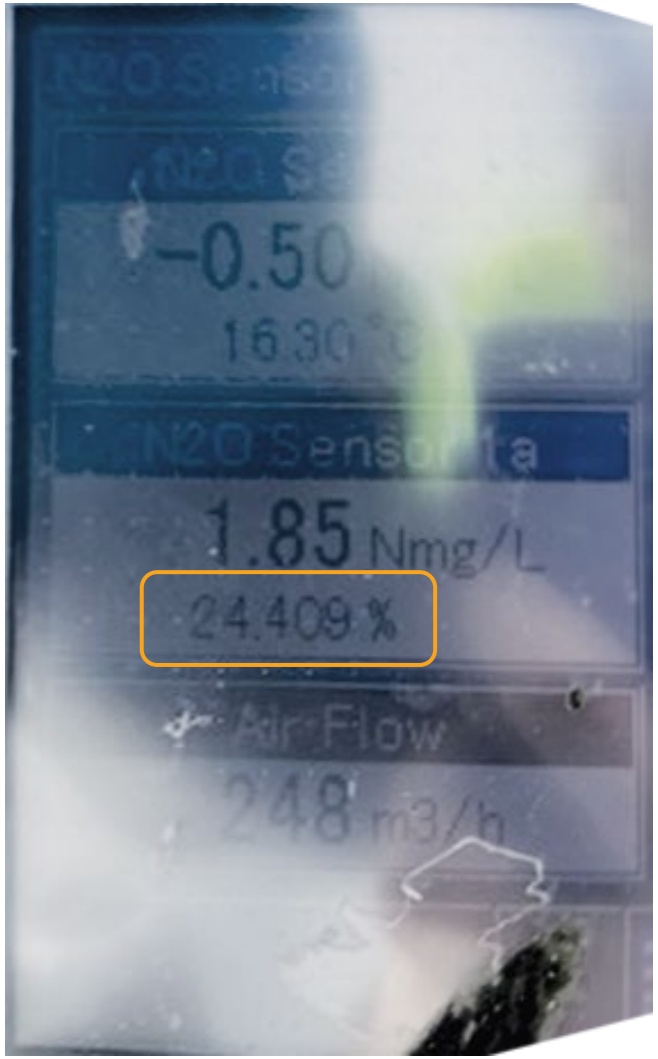
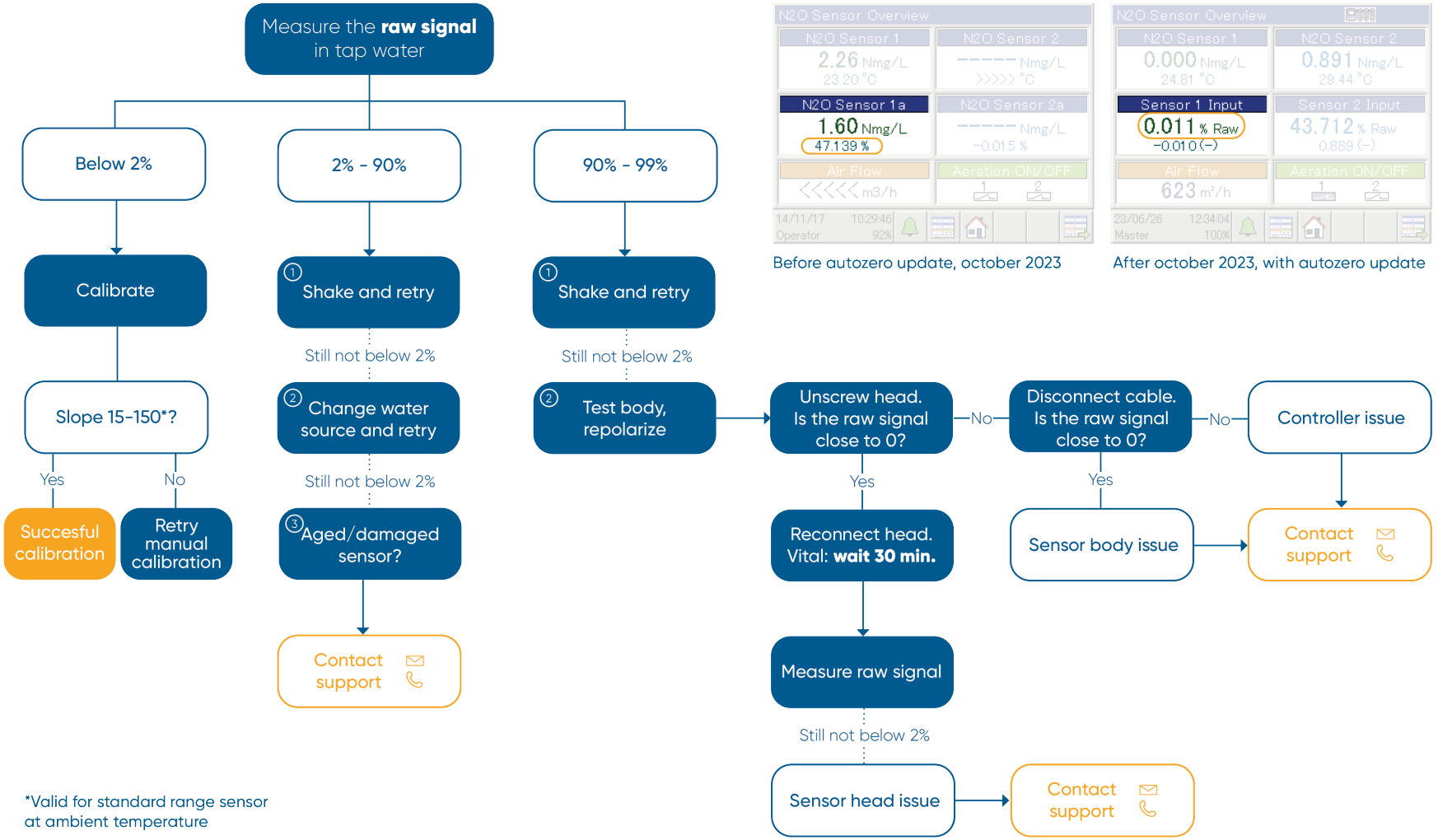


- Fluctuating signal
- Maxed out signal (99%)
- Not responding to N_2O
- High baseline (above 2%)
  - Airbubble in tip
  - Sensor aging (temperature)
  - N_2O in calibration water

Troubleshooting - Sensor health check



Before autozero update, october 2023

After october 2023, with autozero update

*Valid for standard range sensor at ambient temperature

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Time for questions

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Frequenly Asked Questions

- Cable lenghts
- Out of range measurements
- Recalibration after power off
- Sensor dimensions

FAQ

- Extension cable is available, max total length 100m
- Connection may not be underwater and should be protected from rain

- Cable lenghts
- Out of range measurements
- Recalibration after power off
- Sensor dimensions

FAQ

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- Sensor can measure above its range, but will age faster
- Signal will not be logged or transferred (analogue) unless rescaled

- Cable lenghts
- Out of range measurements
- Recalibration after power off
- Sensor dimensions

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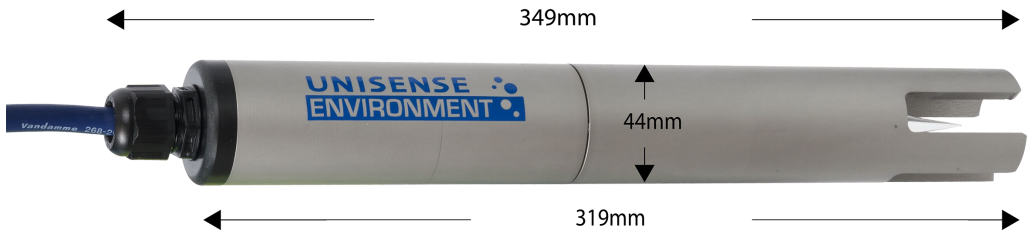
FAQ

- Calibrations saved on controller
- Controller power off >1h
  → recalibrate
- Sensor position changed
  →recalibrate
- Cable lenghts
- Overrange measurement
- Recalibrate after power off / moving
- Sensor dimensions

FAQ



Sensor must not point upwards

- Cable lenghts
- Overrange measurement
- Recalibrate after power off / moving
- Sensor dimensions

Pitfalls when mounting

- Banging on tank wall / other objects (day to day & when calibrating)

→ Consider changes of flow direction!

Pitfalls when mounting

- Grinding of cable

→ Consider changes of flow direction!

Pitfalls when mounting

- Corrosion (metal / metal contact)
- Grinding of sensor

Pitfalls when mounting

- Controller screen
- Remove the protective film!

Thanks for acting on N_2O

measure to kN_2Ow

bp@unisense.com

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