



OPUS

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OPUS is a spectral probe for the online measurement of nitrogen and carbon compounds. By analyzing a complete spectrum, OPUS is able to provide reliable measurement values for $\text{NO}_3\text{-N}$, $\text{NO}_2\text{-N}$, organic constituents (COD_{eq} , BOD_{eq} , DOC_{eq} , TOC_{eq}) and a number of other parameters.

OPUS aero is a variant of OPUS for the online measurement of nitrate and nitrite in wastewater aeration tanks. By analyzing a complete spectrum, OPUS aero is able to provide reliable measurement values for either $\text{NO}_3\text{-N}$ only or $\text{NO}_3\text{-N}$ and $\text{NO}_2\text{-N}$, depending on the calibration.

OPUS is equipped with the TriOS G2 interface and thus allows simple and fast sensor configuration using a web browser. This makes integration into existing process control systems and external data loggers uncomplicated.

Mobile applications can also be realized with the optionally available battery pack. A laptop, tablet or smartphone can be used for control via WLAN without the need to install special application software or an app.

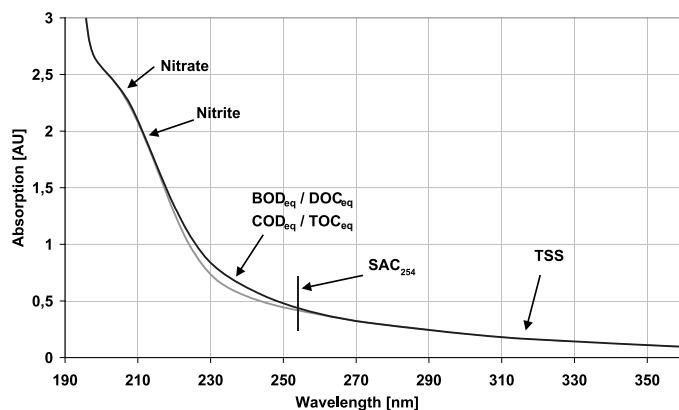
Advantages

- Without sampling and sample preparation
- Delay-free
- Without reagents
- Optical windows with nano-coating
- Pre-installed application calibration

Applications

- Waste water
- Environmental monitoring
- Drinking water monitoring
- Industrial applications
- Aeration in clarifiers (OPUS aero)
- Use on Argo floats
- Versions for DeepSea applications up to 2,000 m and 6,000 m available

Absorption spectrum with/without CSB_{eq}



Technical specifications

Measurement technology	Light source	Xenon flash lamp
	Detector	High-end miniature spectrometer
		256 channels
		200 to 360 nm
		0.8 nm/pixel
Optical path	OPUS	0.3 mm, 1 mm, 2 mm, 5 mm, 10 mm, 20 mm, 50 mm
	OPUS aero	0.3 mm, 1 mm, 2 mm, 5 mm
Parameters	OPUS	See paragraph "Measurement ranges and detection limits OPUS"
	OPUS aero	Nitrate NO ₃ -N or nitrate NO ₃ -N + nitrite NO ₂ -N
Measurement range	OPUS	See paragraph "OPUS measuring ranges dep. on the path length"
	OPUS aero	See paragraph "OPUS aero measuring ranges"
Measurement accuracy	OPUS	See paragraph "Measurement ranges and detection limits OPUS"
	OPUS aero	± (5 % + 0,1)
Turbidity compensation		Yes
Data logger		~ 2 GB
Response time T100		2 min
Measurement interval		≥ 1 min

Housing material		Stainless steel (1.4571/1.4404) or titanium (3.7035)	
Dimensions (L x Ø)		470 mm x 48 mm*	~ 18.5" x 1.9"
Weight	VA	~ 3 kg*	~ 6.6 lbs
	Ti	~ 2 kg*	~ 4.4 lbs

*with 10 mm path

Interface	digital	Ethernet (TCP/IP)
		RS-232 or RS-485 (Modbus RTU)
Power consumption		≤ 8 W
Power supply		12-24 VDC (± 10 %)

Maintenance effort		≤ 0.5 h/month typical	
Calibration/ maintenance interval		24 months	
System compatibility		Modbus RTU	
Warranty period		1 year (EU: 2 years)	

Sample temperature		0...+55 °C* +2...+40 °C for specified measurement accuracy	~ +32 to +131 °F* ~ +36 to +104 °F
Ambient temperature		0...+55 °C* +2...+40 °C for specified measurement accuracy	~ +32 to +131 °F* ~ +36 to +104 °F
Storage temperature		-20...+80 °C	~ -4 to +176 °F
Approach velocity		0.1...10 m/s	~ 0.33 to 33 fps

* No ice crystals in the sample water

Max. pressure	with Sub-conn*	30 bar	~ 435 psi
	with fixed cable	3 bar	~ 43.5 psi
	in flow unit	1 bar, 2...4 L/min	~ 14.5 psi at 0.5 to 1.0 gpm
Degree of protection		IP68	

*Not OPUS aero

Measurement ranges and detection limits OPUS

The following tables provide an overview of the measurement ranges and detection limits of the various parameters, using path lengths of 1 mm and 10 mm as examples.

These values apply to individual substances in ultrapure water under laboratory conditions.

Path length 1 mm

Path (mm)	Parameters	Measurement principle	Measurement unit	Measurement range	Detection limit	Limit of quantification	Precision	Accuracy*
1	Nitrate N-NO ₃	spectral	mg/L	0...100	0.3	0.5	0.05	± (5 % + 0.1)
	Nitrite N-NO ₂	spectral	mg/L	0...150	0.5	1.2	0.12	± (5 % + 0.1)
	COD _{eq}	spectral	mg/L	0...2200***	30	100	10	
	BOD _{eq}	spectral	mg/L	0...2200***	30	100	10	
	DOC _{eq}	spectral	mg/L	0...1000	5	10	1	
	TOC _{eq}	spectral	mg/L	0...1000	5	10	1	
	TSS _{eq}	spectral	mg/L	0...1500	60	200	20	
	KHP	spectral	mg/L	0...4000	5	10	1	± (5 % + 2)
	SAC ₂₅₄	Single wavelength	1/m	0...2200	15	50	5	
	COD-SAC _{eq} **	Single wavelength	mg/L	0...3200	22	73	7.3	
	BOD-SAC _{eq} **	Single wavelength	mg/L	0...1050	7.2	24	2.4	

* Based on a standard calibration solution

** Based on KHP (100 mg COD standard solution corresponds to 85 mg/L KHP)

*** Dependent on the composition of the COD and BOD (sum parameter)

1 mg/L N-NO₃ corresponds to 4.43 mg/L NO₃

1 mg/L N-NO₂ corresponds to 3.29 mg/L NO₂

Path length 10 mm

Path (mm)	Parameters	Measurement principle	Measurement unit	Measurement range	Detection limit	Limit of quantification	Precision	Accuracy*
10	Nitrate N-NO ₃	spectral	mg/L	0...10	0.03	0.05	0.005	± (5 % + 0.1)
	Nitrite N-NO ₂	spectral	mg/L	0...15	0.05	0.12	0.012	± (5 % + 0.1)
	COD _{eq}	spectral	mg/L	0...220***	3	10	1	
	BOD _{eq}	spectral	mg/L	0...220***	3	10	1	
	DOC _{eq}	spectral	mg/L	0...100	0.5	1	0.1	
	TOC _{eq}	spectral	mg/L	0...100	0.5	1	0.1	
	TSS _{eq}	spectral	mg/L	0...150	6	20	2	
	KHP	spectral	mg/L	0...400	0.5	1	0.1	± (5 % + 2)
	SAC ₂₅₄	Single wavelength	1/m	0...220	1.5	5	0.5	
	COD-SAC _{eq} **	Single wavelength	mg/L	0...320	2.2	7.3	0.73	
	BOD-SAC _{eq} **	Single wavelength	mg/L	0...105	0.72	2.4	0.24	

* Based on a standard calibration solution

** Based on KHP (100 mg COD standard solution corresponds to 85 mg/L KHP)

*** Dependent on the composition of the COD and BOD (sum parameter)

1 mg/L N-NO₃ corresponds to 4.43 mg/L NO₃

1 mg/L N-NO₂ corresponds to 3.29 mg/L NO₂

OPUS measuring ranges depending on the path length*

The following tables provide an overview of the measurement ranges of the various parameters depending on the path length.

Parameter (spectral)	Unit	Factor	Path length (mm)						
			0.3	1	2	5	10	20	50
Absorption dimension (AU)	AU**	-	0.01...2.2	0.01...2.2	0.01...2.2	0.01...2.2	0.01...2.2	0.01...2.2	0.01...2.2
Absorption coefficient (1/m)	1/m	-	50...7300	15...2200	7.5...1100	3...440	1.5...220	0.75...110	0.3 - 44
Nitrate N-NO ₃	mg/L	-	1.0...330	0.3...100	0.15...50	0.06...20	0.03...10	0.015...5	0.006...2
Nitrate NO ₃	mg/L	-	4.43...1460	1.33...440	0.67...220	0.27...88	0.13...44	0.067...22	0.030...9
Nitrite N-NO ₂	mg/L	-	1.7...500	0.5...150	0.25...75	0.1...30	0.05...15	0.025...7.5	0.01...3
Nitrite NO ₂	mg/L	-	5.6...1650	1.65...500	0.82...250	0.33...100	0.17...50	0.083...25	0.033...10
DOC _{eq}	mg/L	-	17...3300	5.0...1000	2.5...500	1.0...200	0.5...100	0.25...50	0.1...20
TOC _{eq}	mg/L	-	17...3300	5.0...1000	2.5...500	1.0...200	0.5...100	0.25...50	0.1...20
COD _{eq} ***	mg/L	-	100...7300	30...2200	15...1100	6.0...440	3.0...220	1.5...110	0.6...44
BOD _{eq} ***	mg/L	-	100...7300	30...2200	15...1100	6.0...440	3.0...220	1.5...110	0.6...44
KHP	mg/L	-	17...13300	5.0...4000	2.5...2000	1.0...800	0.5...400	0.25...200	0.1...80

Parameter (Single wave-lengths)	Unit	Factor	Path length (mm)						
			0.3	1	2	5	10	20	50
SAC ₂₅₄	1/m	-	50...7300	15...2200	7.5...1100	3...440	1.5...220	0.75...110	0.3...44
COD-SAC _{eq} ****	mg/L	1.46	75...10600	22...3200	11...1600	4.4...640	2.2...320	1.1...160	0.44...64
BOD-SAC _{eq} *****	mg/L	0.48	24...3500	7.2...1050	3.6...525	1.44...210	0.72...105	0.36...52.5	0.15...21
TSS _{eq} *****	mg/L	2.6	130...4300	40...1300	20...650	8.0...260	4...130	2...65	0.8...26

* under laboratory conditions

** unit of absorption measure

*** depending on the composition of the COD or BOD (sum parameter)

**** based on KHP (note: 100 mg COD standard solution corresponds to 85 mg/L KHP)

***** based on SiO₂ note: 1 mg/L N-NO₃ corresponds to 4.43 mg/L NO₃ 1 mg/L N-NO₂ corresponds to 3.29 mg/L NO₂

OPUS aero measuring ranges

Path (mm)	Nitrate N-NO ₃	Nitrite N-NO ₂
0.3	2.4...120	4.4...220
1	0.7...36	1.3...67
2	0.35...18	0.65...33.5
5	0.15...7	0.25...13.5