

bbe

biological · biophysical · engineering

moldaenke



www.bbe-moldaenke.de

AlgaeOnlineAnalyser

The best solution for the
Online Monitoring of Algae



Harmful Algae monitoring 24/7



Online, flow-through
measurement of microalgal
concentrations in rivers,
lakes and reservoirs

What does the Algae-OnlineAnalyser offer?

The AlgaeOnlineAnalyser is an instrument for the rapid measurement of microalgae using a flow-through chamber.



✓ TASKS

- ▶ online algae analysis
- ▶ regulatory control and monitoring
- ▶ environmental monitoring
- ▶ limnological questions
- ▶ *Planktothrix* detection

The AlgaeOnlineAnalyser is used in measuring stations and laboratories, in fact wherever the **online assessment of water quality** of flowing waters, reservoirs and drinking water extraction is needed.

On board ships and integrated into complex analytical systems, the AlgaeOnlineAnalyser determines biologically relevant data of commonly travelled shipping routes. Further applications include the detection of the early stages of **algal blooms**, **ecological changes** in diverse phytoplankton, as well as in **limnological** and **oceanographic** studies.

The purpose of algal class determination is the qualitative and quantitative detection and evaluation of the occurrence of particular types of algae, particularly those which can be classified as potentially harmful. This includes the cyanobacteria *Planktothrix rubescens*, which increasingly occur in reservoirs used for drinking water extraction.

The measurement principle

The AlgaeOnlineAnalyser continuously determines the algal content of water based on chlorophyll fluorescence in real time and without the need for sample preparation. The chlorophyll-a measurement is used as an approximation of the biomass of the micro-phytoplankton in the water. The measurement is based on the natural fluorescence of the photosynthetic apparatus of chlorophyll using excitation by light sources. Comprehensive excitation of all microalgae is made possible by **six different LEDs** at particular wavelengths.

The presence of characteristic pigments in the algae influences chlorophyll-a fluorescence. A complex spectral analysis leads to the allocation of the fluorescence signal to particular algal classes. Up to five different algal classes can be determined simultaneously.

In contrast to other commercially available chlorophyll measurement instruments, the AlgaeOnlineAnalyser is calibrated using **real algal cultures**.

The fluorescence measurement corresponds to the time-intensive, wet-chemical chlorophyll analysis according to **ISO 10260** and **DIN 38412/16**. However, in contrast to wet-chemical analysis, the AlgaeOnlineAnalyser needs no sample preparation and can even replace the laborious method of cell counting with a microscope.

Fluorometric determination using the AlgaeOnlineAnalyser is highly sensitive due to the use of a low-noise photomultiplier.



MEASUREMENT

- ▶ *in vivo* determination in real time
- ▶ multi-spectral excitation
- ▶ measurement of up to five algal classes
- ▶ calibration at factory
- ▶ method comparison
- ▶ highest sensitivity

The AlgaeOnlineAnalyser measures 42 cm high by 60 cm wide and 20 cm deep

”

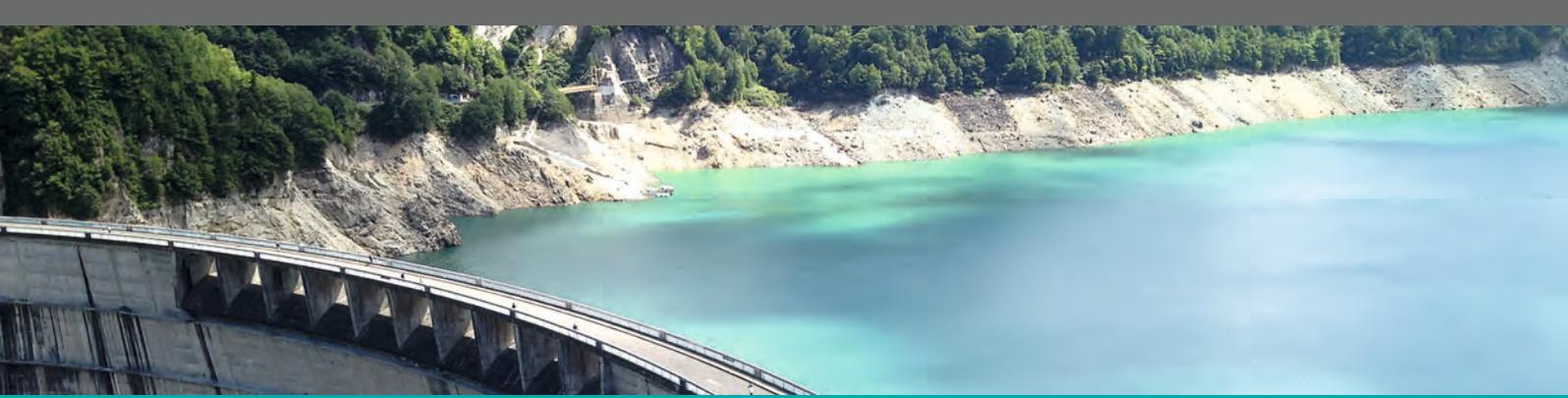
With the AlgaeOnlineAnalyser we always have the algal content of our waterworks intake under control and can react immediately if it becomes too high.

“

Norbert Kellner

Department Head of Glüder Waterworks, Germany





What else can the AlgaeOnlineAnalyser do?

✓ FEATURES

- ▶ yellow substances measurement and correction
- ▶ transmission measurement
- ▶ touchscreen
- ▶ integrated PC database
- ▶ alarm threshold values
- ▶ measurement of photosynthetic activity

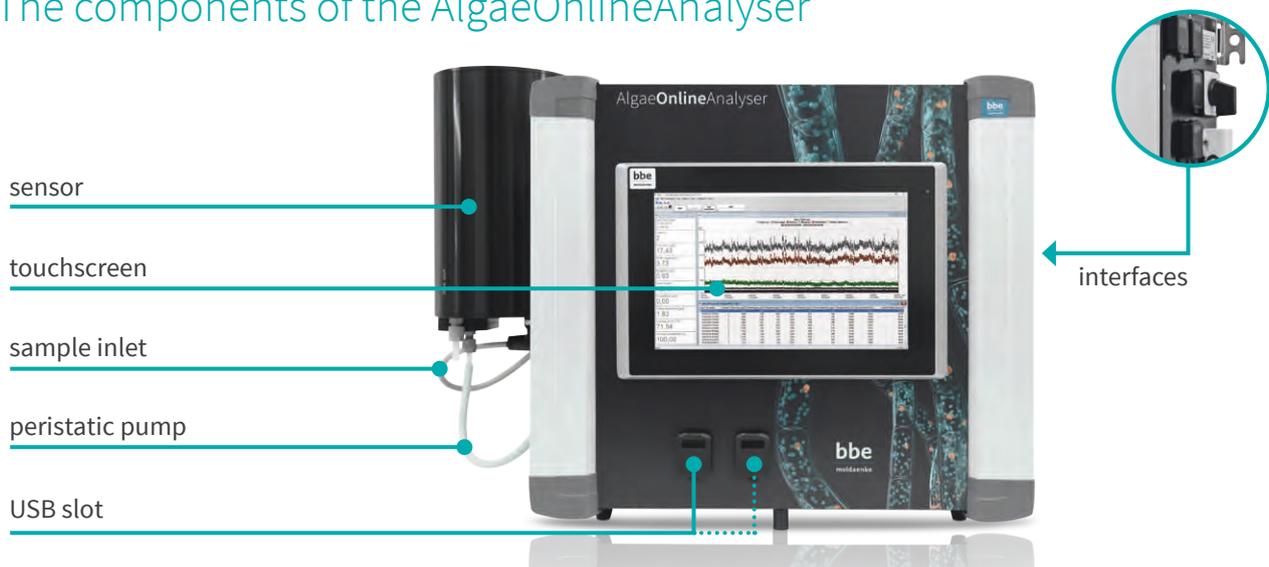
Unique Features

The integrated detection and correction of **yellow substances** eliminates the interference of fluorescent humic substances on the chlorophyll measurement and improves the quality of the measurement. Additional information on turbid matter is provided by the **transmission measurement**, which is also used for the compensation of turbidity.

All relevant data and measurement results are displayed on the touchscreen in the form of tables or graphs and stored in the database. The parameter settings and the measurement process can be controlled by using the integrated PC. Alarm values can be freely chosen by the user or adapted to WHO guidelines. An optional conversion of algal concentrations to cells/L is available.

Extensive fluorescence measurements allow analysis of the **photosynthetic activity** of the available algae. The resulting numeric values indicate the health of the algae and their photosynthetic performance.

The components of the AlgaeOnlineAnalyser



Valve Control: the AlgaeOnlineAnalyser can analyse several water samples in sequence using valves attached to [several different inlet tubes](#). The results allow direct measures to be taken to reduce undesired algae in, e.g., sample water, cooling water and aquaculture plants.

Remote control and operation of the AlgaeOnlineAnalyser is feasible from a central computer system via the Modbus TCP/IP protocol.

The instrument is calibrated using pre-installed algal classes before delivery. The algal cultures and the corresponding reference instrument are subject to continual [quality control](#).

The AlgaeOnlineAnalyser needs very little maintenance and uses a cleaning mechanism in the measuring chamber. This ensures the removal of particles and biofilms inside the chamber. Biofilms can reduce the excitation light and lead to continually worsening measurement results.

Interfaces

The AlgaeOnlineAnalyser is equipped with a serial RS232 interface for data export and for connection to an external computer. In addition to the serial connections, the instruments can be integrated into a LAN network via Ethernet and also has a USB (2.0) interface. Optionally, additional analogue outputs (in pairs, up to a maximum of 16) and relay outputs for alarms (up to a maximum of 8) can be installed. A SDI 12 converter is available on request.



FEATURES

- ▶ alternating channel measurements in sequence
- ▶ remote data access
- ▶ algae breeding experiments
- ▶ reduced maintenance due to cleaning mechanism



INTERFACES

- ▶ RS232
- ▶ Ethernet, USB
- ▶ analogue outputs
- ▶ relay outputs

A look inside the bbe AlgaeOnlineAnalyser

Details of AlgaeOnlineAnalyser measurements

Algae of a given taxonomic class possess a similar composition of photosynthetic pigments and thus have a typical *in vivo* fluorescence-excitation spectrum, whereby the emission wavelengths of the measured fluorescent light are between 680 and 700 nm. It is thus possible to allocate an algal species to a [spectral algal class](#) based on its fluorescence spectrum. In order to obtain a meaningful fluorescence excitation spectrum, six LEDs are used at frequencies of 370nm, 430nm, 470nm, 525nm, 590nm and 610nm, respectively. The excitation wavelengths of the LEDs are adapted to the absorption wavelengths of the light-harvesting pigments of different algal classes: phycocyanin, phycoerythrin, fucoxanthin, peridinin and chlorophyll. The excitation of the algal pigments is performed after a dark adaptation by [switching on the LEDs](#) one after the other at high frequency. In the phases between these pulses, the fluorescence emission of the



MEASUREMENT PROCEDURE

- ▶ chlorophyll determination of algal classes
- ▶ unique pigment analysis via multispectral excitation



chlorophyll chlorophyll resulting from the excitation is measured. Spectra of different algal classes of an algal sample consisting of cyanobacteria, chlorophytes, diatoms, dinoflagellates and cryptophytes are recorded. A mean excitation spectrum normalized by **chlorophyll-a content** (fingerprint) of an algal class is determined. Using these “fingerprints” and a **mathematical operation** (best-fit procedure) enables to calculate the chlorophyll-a concentration from a complex mixture and the distribution of up to 4 different algal classes in a water sample. A fifth preinstalled class is reserved for the detection of fluorescent yellow substances (humic substances) and their is used in the chlorophyll correction. Additional algal classes can be added and customized. The chlorophyll determination is quantitatively based on an established HPLC separation method of algal pigments⁽¹⁾.

- 1 Wiltshire, K. H., Harsdorf, S., Smidt, B., Blöcker, G., Reuter, R. and Schroeder, F.; *The determination of algal biomass (as chlorophyll) in suspended matter from the Elbe estuary and the German Bight: A comparison of HPLC, delayed fluorescence and prompt fluorescence methods.* *J. Exp. M. Biol. Ecol.* 222, 113-131 (1998).
- 2 Bernard Genty, Jean-Marie Briantais and Neil R. Baker; *The relationship between the quantum yield of photo synthetic electron transport and quenching of chlorophyll fluorescence, Biochimica et Biophysica Acta* 990, 87-92, (1989).

Principle of the activity measurement

The light energy (photons) absorbed by the chlorophyll of the algal cell is used either for photosynthesis or dissipated as heat or **fluorescence**. The processes are linked in such a way that information on the photosynthetic performance of the algae can be derived from the fluorescence.

The capacity of the photosynthetic activity is characterised by **maximal quantum yield** (energy input / maximum energy used in photosynthesis). After a dark adaptation, the base fluorescence f_0 is determined, which represents low energy input when the photosystem receives minimal photons, i.e. when no more photosynthetic products are made. If the system then

becomes saturated with intense light, the photosynthetic process is limited and the fluorescence reaches the maximum f_{\max} within milliseconds. The difference between f_{\max} and f_0 is called variable fluorescence and reflects the maximum range of the use of light for photosynthesis.

The photosynthetic activity is calculated by $f_{\max} - f_0 / f_{\max}$, also known in the literature as the Genty factor (a number between 0 and 1), which correlates to oxygen release of photosynthesis. This factor is not dependent on the chlorophyll concentration. When algae are damaged by external factors, photosynthesis is reduced and so is the Genty factor ⁽²⁾.

Software, specifications and scope of delivery

The software of the AlgaeOnlineAnalyser

The AlgaeOnlineAnalyser uses the supplied bbe++ software. The main functions of the software are the operation, parameterisation and control of the instrument, data observation and the evaluation in the form of tables or graphs, as well as the export of data and parameters in different formats (e.g. Excel).

All parameters and data are stored in a **database**. The database can store the data from different instruments and types. The raw data measured using the AlgaeOnlineAnalyser can be subjected to recalculation using a changed parameter set. This recalculation (refit) leads to better results when the basic algal class better fits the algae in the sample. Using the bbe++ software new, different algal classes can be calibrated. The offset (zero value, blank) is also determined using the calibration function.

In batch mode, **individual samples** can be analysed. To do this, the AlgaeOnlineAnalyser is completely filled with a sample and the measurement is started manually.



Screenshot of the AlgaeOnlineAnalyser

The macro function contains **pre-installed settings** for a combination of graphs and tables. This function allows the user to easily select commonly used windows for display.

Alarm thresholds can be configured for the individual algal classes or total chlorophyll levels. Alarms are shown on the display and can trigger an alarm (optional relay) or send a signal to the serial interface.

A test mode to check the functions of the hardware components of the AlgaeOnlineAnalyser is also integrated.

The bbe software runs on all present-day Windows PCs. The touchscreen PC of the AlgaeOnlineAnalyser uses a current Windows operating system.



SOFTWARE

- ▶ graphic display
- ▶ table view
- ▶ parameterisation
- ▶ database function
- ▶ data export
- ▶ recalculation (refit)
- ▶ calibration function
- ▶ batch mode
- ▶ macro function
- ▶ alarms and alarm thresholds
- ▶ test function
- ▶ operating system



SCOPE OF DELIVERY

- ▶ Instrument: AlgaeOnlineAnalyser
- ▶ manual
- ▶ software
- ▶ network cable
- ▶ replacement tubes
- ▶ replacement fuse
- ▶ plugs for analogue output / relay output

+ BENEFITS

- ▶ Immediate analysis of chlorophyll content
- ▶ Covers all algae classes with six excitation wavelengths
- ▶ Adjustable alarm thresholds
- ▶ prompt, on-site information on cyanobacteria
- ▶ long-term operation with minimal maintenance due to self-cleaning and anti-fouling
- ▶ calibrated using real algal cultures
- ▶ evaluation of the algal condition of the flow-through sample
- ▶ simple operation with touchscreen PC



Technical Details

DESCRIPTION	VALUE
Measurements	total chlorophyll-a [$\mu\text{g Chl -a/l}$], concentration green algae [$\mu\text{g Chl -a/l}$], concentration cyanobacteria [$\mu\text{g Chl -a/l}$], concentration brown class algae [$\mu\text{g Chl -a/l}$], concentration cryptophytes [$\mu\text{g Chl -a/l}$], yellow substances (relative units), photosynthetic activity (Genty factor), transmission at 5 wavelengths, water temperature
Chlorophyll	0 - 200 $\mu\text{g chlorophyll-a/l}$
Measurement principle	spectral fluorometry
Resolution	0.01 $\mu\text{g chlorophyll-a/l}$
Transmission	0 - 100%, photometry
Photosynthetic activity	0-1 for > 3 $\mu\text{g chlorophyll-a/l}$
Cleaning function	cleaning piston
Housing	V4A steel/aluminium/coated steel plate
Weight	19 kg
Dimensions (H x W x D)	420 x 600 x 200 mm
Protection class	IP 54
Voltage	110/240 V 50/60 Hz
Performance	100 W
Sample temperature / environment	0 - 35 °C / 0 - 40 °C
Sample volume	30 ml
Maintenance interval	> 7 days
Sample feed	free pressureless inlet / peristaltic pump
PC	touchscreen PC 12" with Windows, bbe++ software
Outputs	USB, LAN, R232
Outputs (optional)	modem, analogue outputs 4-20 mA up to 16, relay outputs up to 8, SDI-12 converter, Modbus TCP/IP

Do you have any questions? Please contact us!

Your local representative

bbe

biological · biophysical · engineering

moldaenke

bbe Moldaenke GmbH

Preetzer Chaussee 177
24222 Schwentinental
Germany

Tel.: +49 (0) 431 - 380 40-0
Fax: +49 (0) 431 - 380 40-10
bbe@bbe-moldaenke.de

