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
The AlgaeOnlineAnalyser offers the following:

- **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.

**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
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.

What else can the AlgaeOnlineAnalyser do?

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 have 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.

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.

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
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 (finger-print) 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^{11}.

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 \( f_b \) 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 \( f_{\text{m}} \), within milliseconds. The difference between \( f_{\text{m}} \) and \( f_b \), is called variable fluorescence and reflects the maximum range of the use of light for photosynthesis.

The photosynthetic activity is calculated by \( f_{\text{m}} - f_b / f_{\text{m}}, \) also known in the literature as the Genty factor \( a \) (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^{12}.


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

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurements</td>
<td>Total chlorophyll-a [μg Chl-a/l], concentration green algae [μg Chl-a/l], concentration cyanobacteria [μg Chl-a/l], concentration brown class algae [μg Chl-a/l], concentration cryptophytes [μg Chl-a/l], yellow substances (relative units), photosynthetic activity (Genty factor), transmission at 5 wavelengths, water temperature</td>
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<tr>
<td>Chlorophyll</td>
<td>0 - 500 μg chlorophyll-a/l</td>
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<tr>
<td>Measurement principle</td>
<td>Spectral fluorometry</td>
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<tr>
<td>Resolution</td>
<td>0.01 μg chlorophyll-a/l</td>
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<tr>
<td>Transmission</td>
<td>0 - 100%, photometry</td>
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<tr>
<td>Photosynthetic activity</td>
<td>0-1 for &gt; 3 μg chlorophyll-a/l</td>
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<tr>
<td>Cleaning function</td>
<td>Cleaning piston</td>
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<tr>
<td>Housing</td>
<td>V4A steel/aluminium/coated steel plate</td>
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<td>Weight</td>
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<td>Dimensions (H x W x D)</td>
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<tr>
<td>Voltage</td>
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<td>Performance</td>
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<td>Sample temperature / environment</td>
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<td>Sample volume</td>
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<td>Maintenance interval</td>
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<td>Sample feed</td>
<td>Free pressureless inlet / peristaltic pump</td>
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<tr>
<td>PC</td>
<td>Touchscreen PC 12” with Windows, bbe++ software</td>
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<tr>
<td>Outputs</td>
<td>USB, LAN, R232</td>
</tr>
<tr>
<td>Outputs (optional)</td>
<td>Modem, analogue outputs 4-20 mA up to 16, relay outputs up to 8, SDI-12 converter, Modbus TCP/IP</td>
</tr>
</tbody>
</table>

Do you have any questions? Please contact us!

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