



13th bbe Webinar



SIGN
SINO GERMAN NETWORK
Assuring water quality
from the source to the tap

New Fluorometer Uses the Parameter 'Unbound Phycocyanin' as an Early Warning System for Cyanobacterial T&O Compounds and Cyanotoxins



13th Webinar

Welcome



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bbe Team



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Assuring water quality
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Goal:

Use of a selected parameter to minimize taste and odor problems and cyanotoxins in drinking water production

Monitoring targets:

Cyanobacterial taste & odor compounds (e.g. 2-MIB, Geosmin) and cyanotoxins indirectly by fluorescence patterns



Assumption:

If phycocyanin leaves the cell, other compounds such as cyanotoxins and T&O compounds also leave the cell.

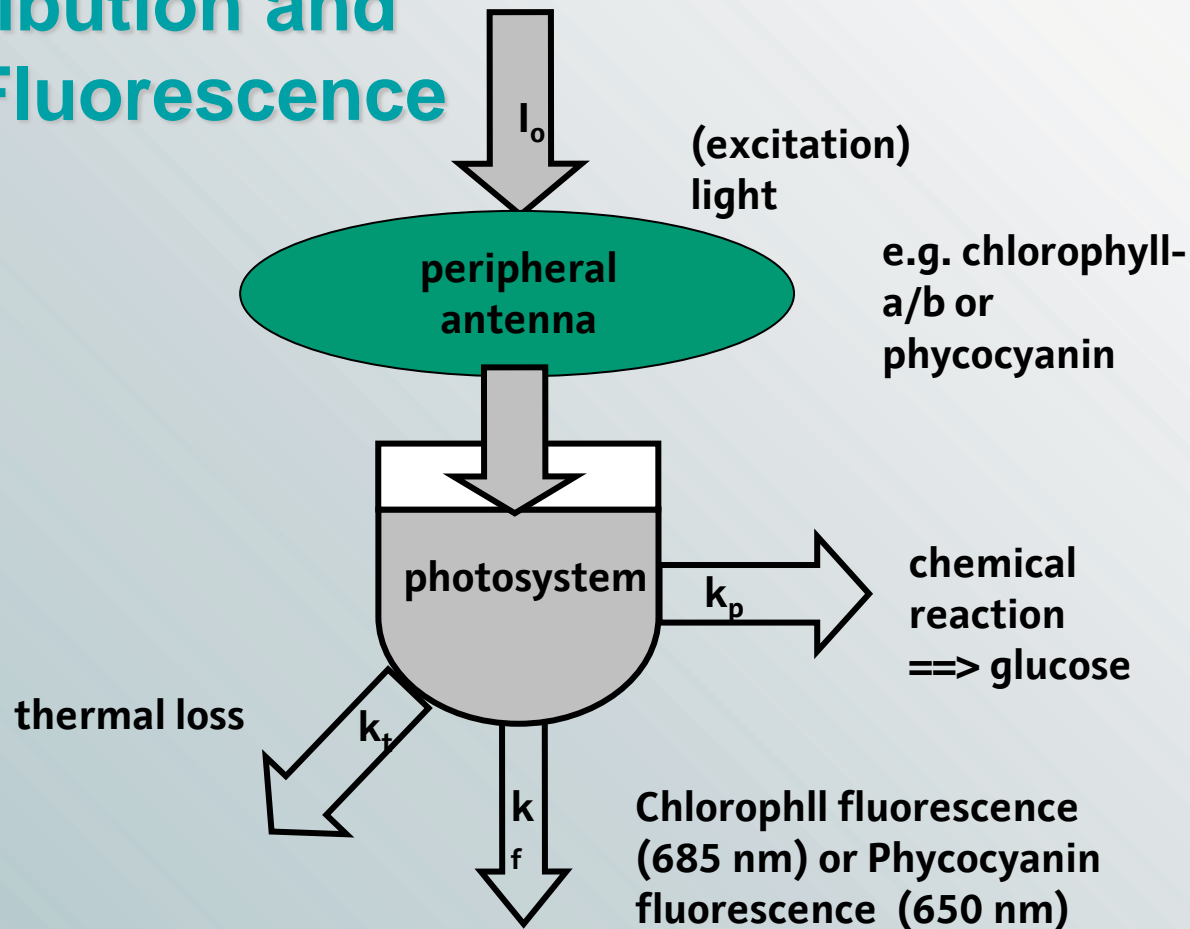
Method:

The pattern of fluorescence is investigated. The cyanobacteria pigment *phycocyanin* (PC) serves as an indicator for the release. We can discriminate between:

- PC, which has probably left the cell (free PC)
- PC, which is still bound to the photosystem

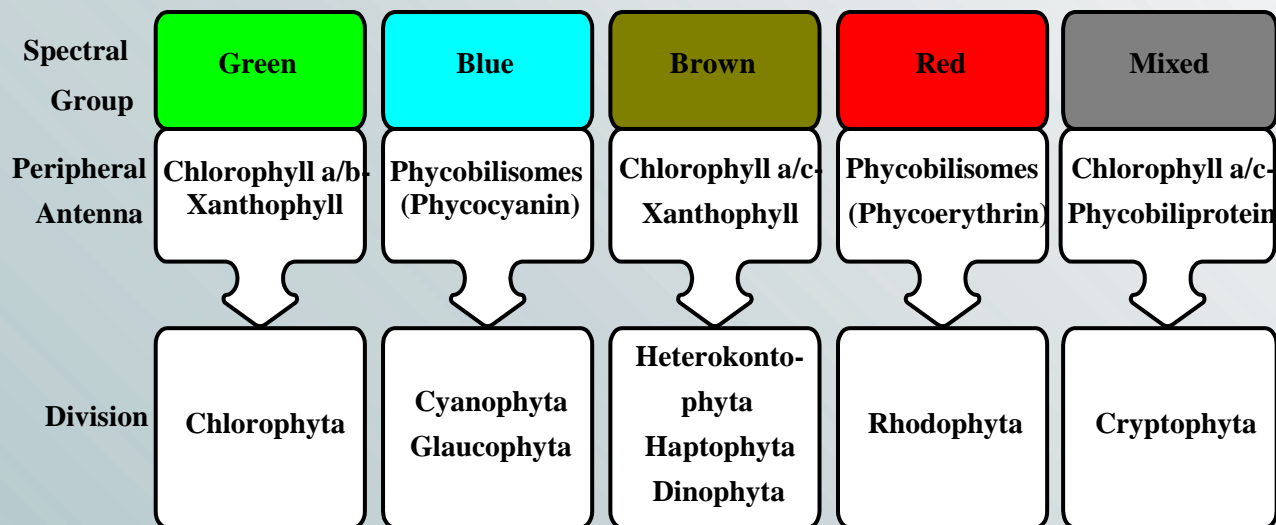


Energy Distribution and Chlorophyll Fluorescence





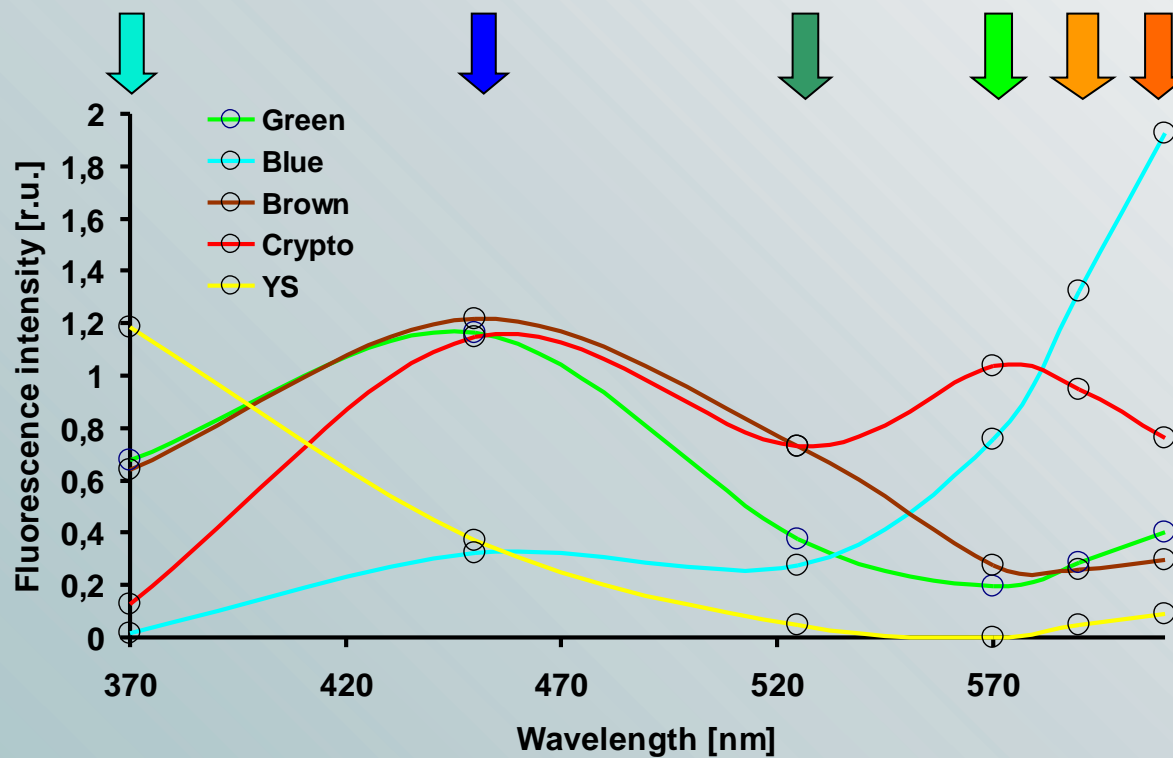
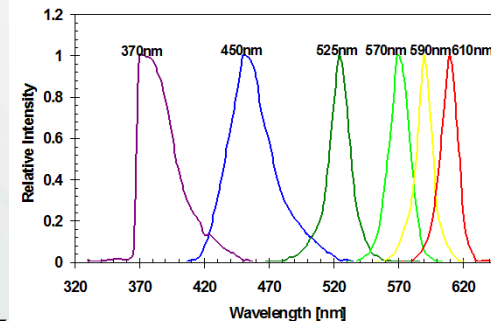
Spectral Groups of Phytoplankton



Algae pigments and their relation to taxomical algae classes

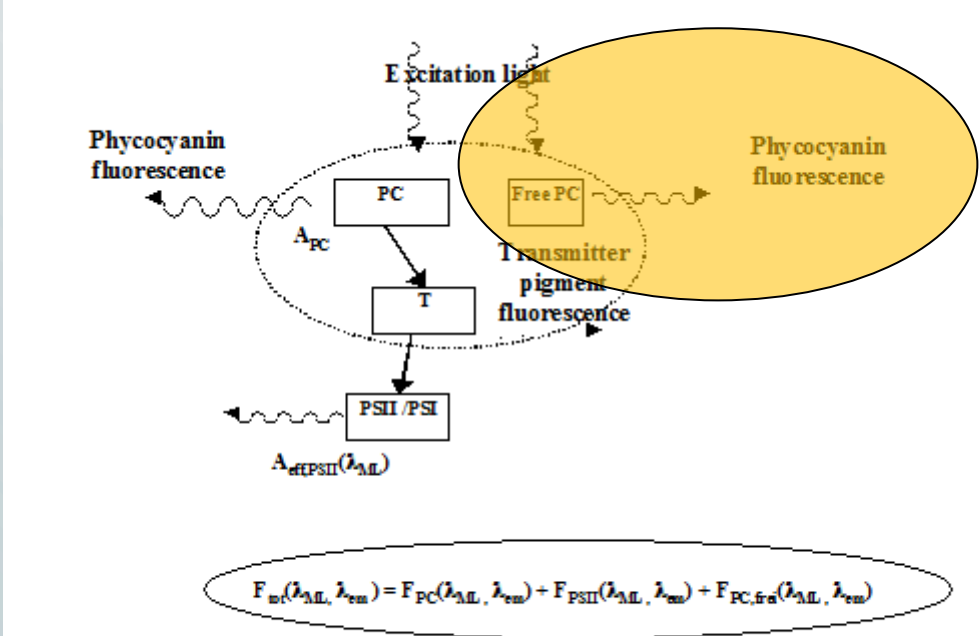
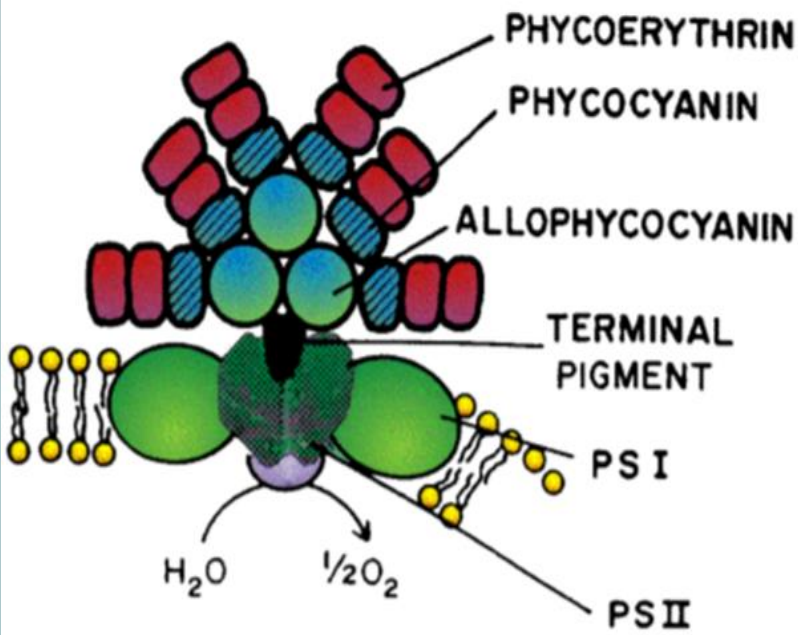


Normspectra (Fingerprints)





Unbound PC: The Fluorescence Spectra are Different



Unbound PC prefers to fluoresce at 650nm instead of at 700nm



The Toxin Release During Treatment is Recognized



United States
Environmental Protection Agency

Office of Water
Mail Code 4304T

EPA-810F11001
September 2014

Cyanobacteria and Cyanotoxins: Information for Drinking Water Systems

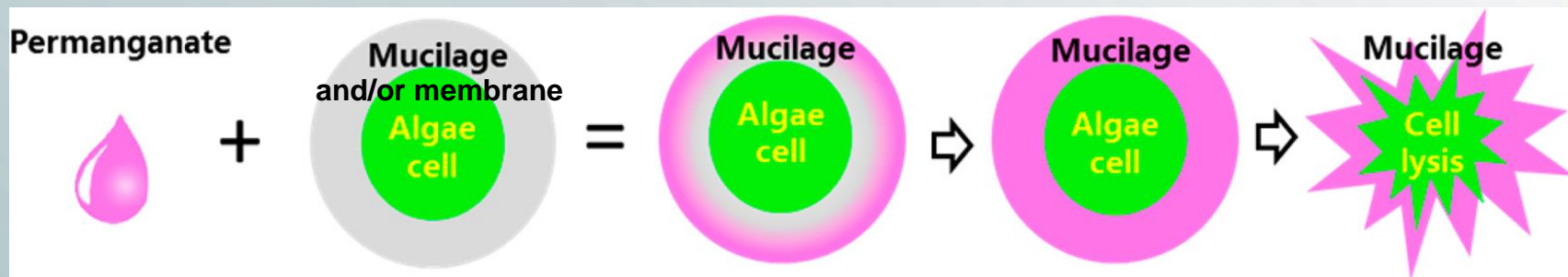
Intracellular Cyanotoxins Removal (Intact Cells)

Pre-treatment oxidation

Oxidation often lyses cyanobacteria cells releasing the cyanotoxin to the water column. If oxidation is required to meet other treatment objectives, consider using lower doses of an oxidant less likely to lyse cells (potassium permanganate). If oxidation at higher doses must be used, sufficiently high doses should be used to not only lyse cells but also destroy total toxins present (see extracellular cyanotoxin removal).



The Treatment of Cyanobacteria in Water Works

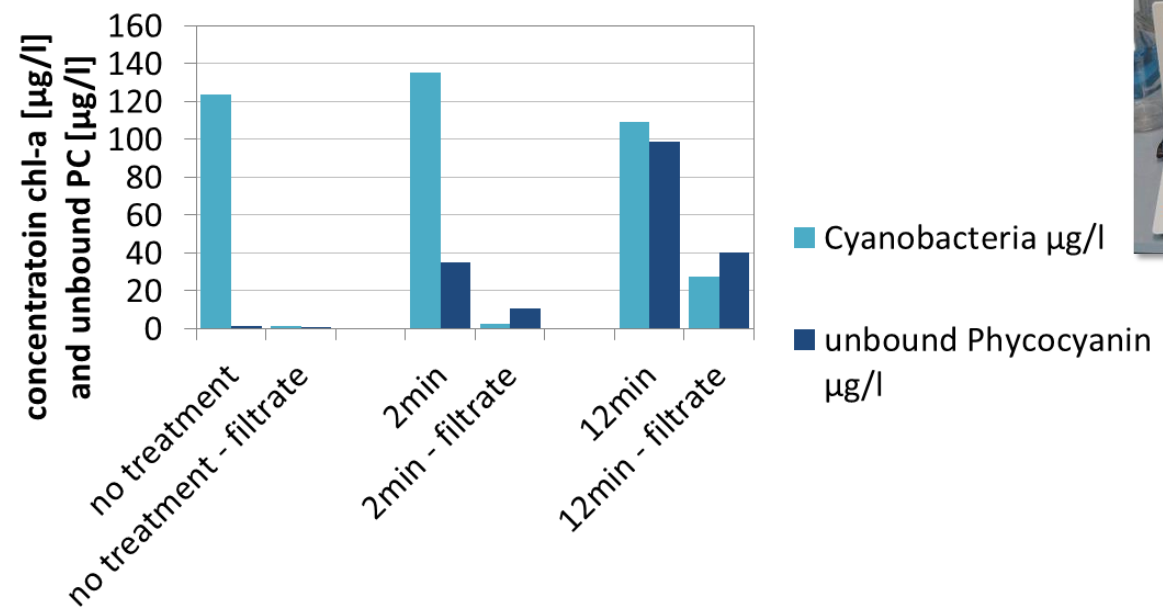


Pre-treatment affects cyanobacteria in water works (Li, Lei, 2013). The oxidation attacks the membrane structure and can lead to an increase of MIB/GSM/Toxins, for example, if the oxidant is consumed before the cell lysed.

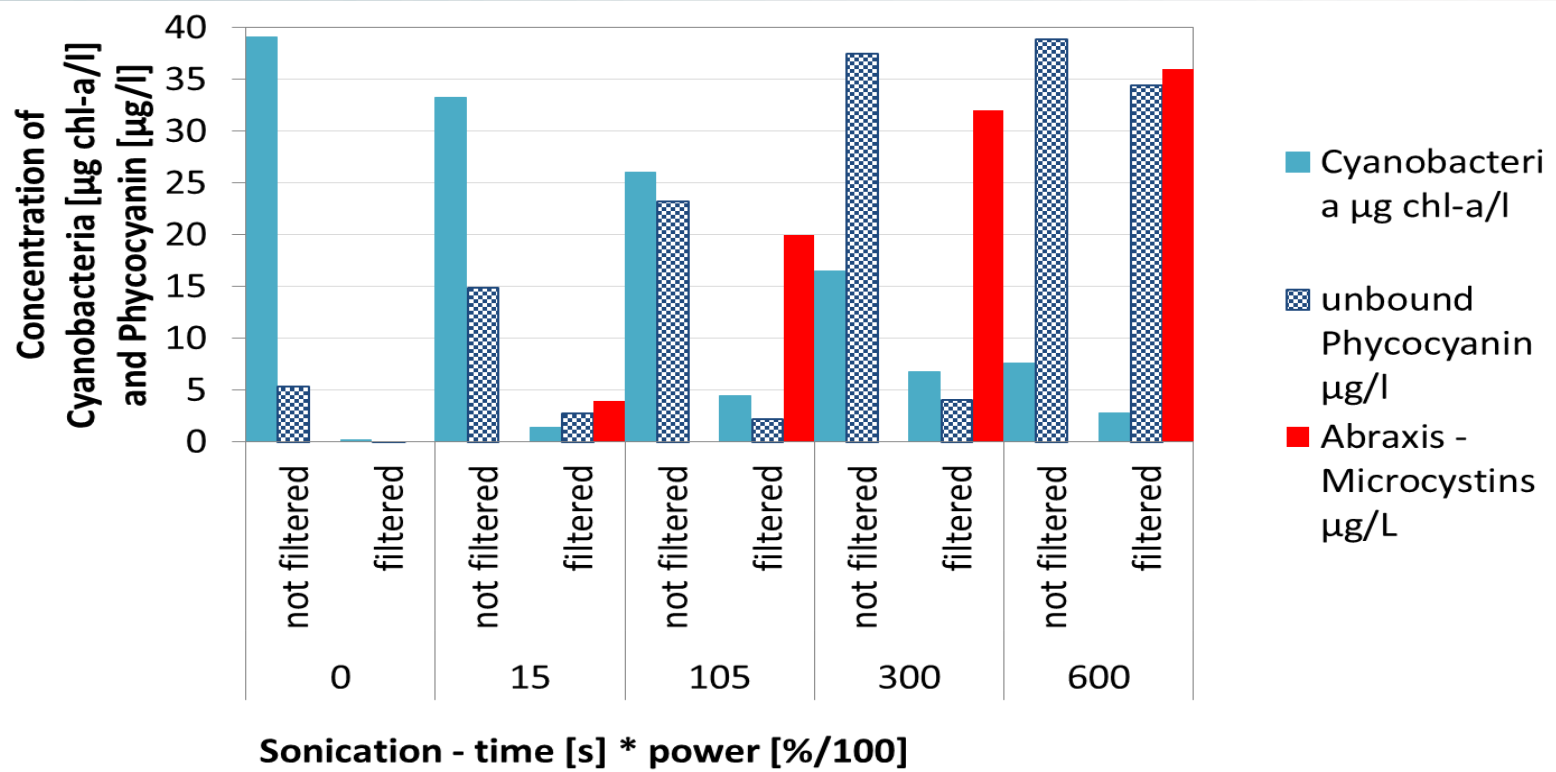


Cyanobacteria Treated by Ultrasound

Ultrasound treatment of *Microcystis a.* SAG sample measured unfiltered and 0,45µm filtrated



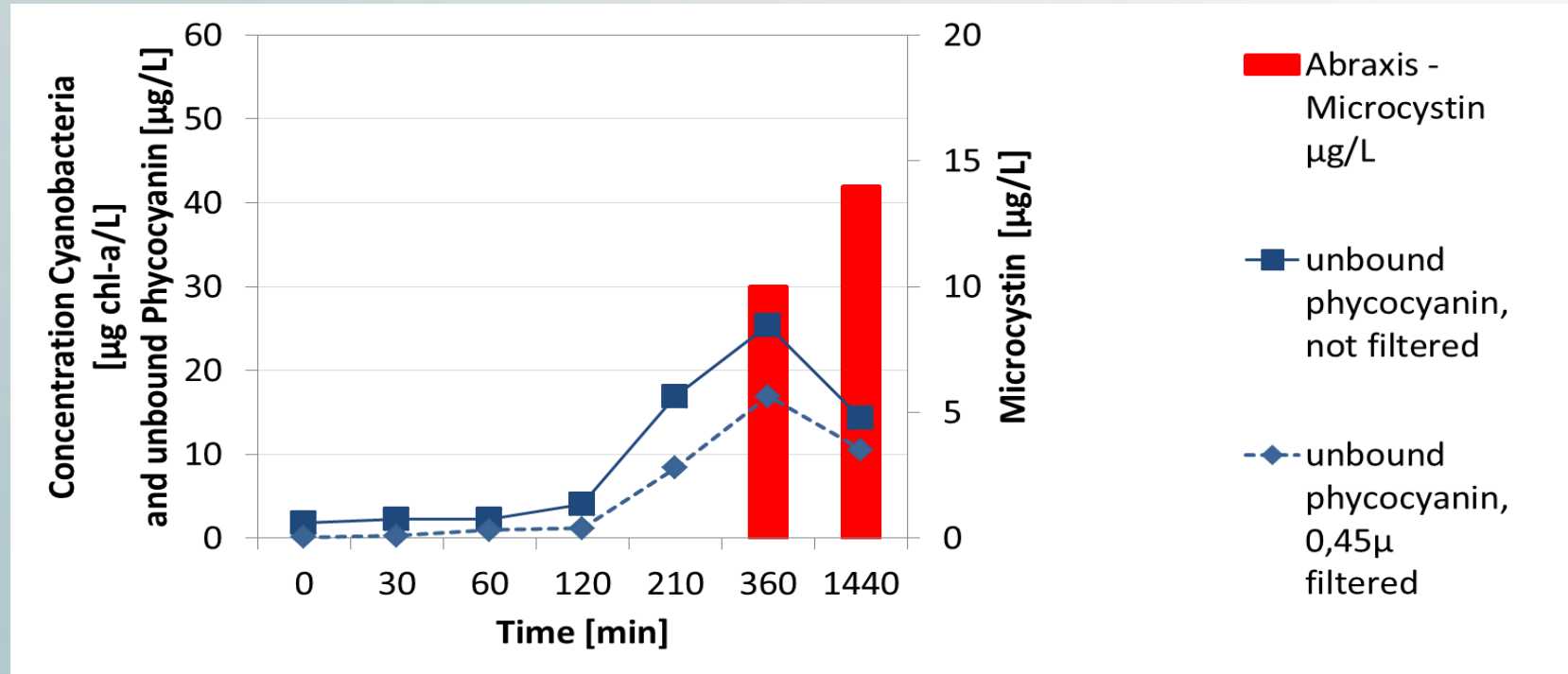
The graph shows the lysis of the cells and the development of unbound phycocyanin that can also partially pass a 0,45µm filter



Cyanobacteria treated with varying ultrasound power shows parallels of increasing free PC and microcystin concentrations. The overall microcystin content is stable over the recorded time span



Effect of the pre-oxidation chemical

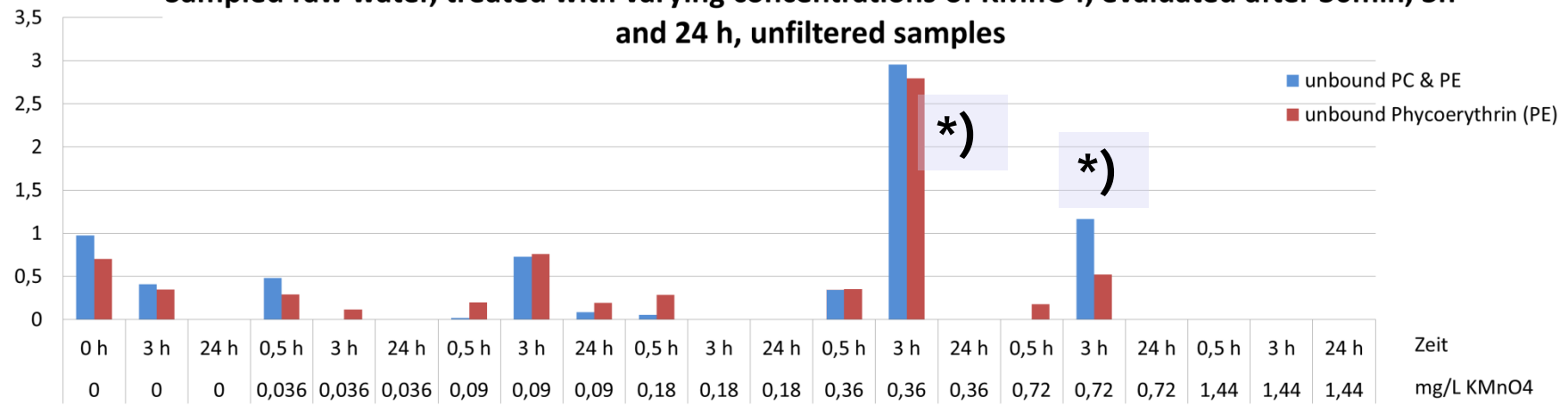


Application of 4mg/l KMnO_4 on a solution containing 50 $\mu\text{g/l}$ chlorophyll (*Microcystis*). Cell lysis allows the detection of unbound PC and extracellular microcystins



German Water Work (Altena, next to Dortmund) Suffering from Planktothrix rub.

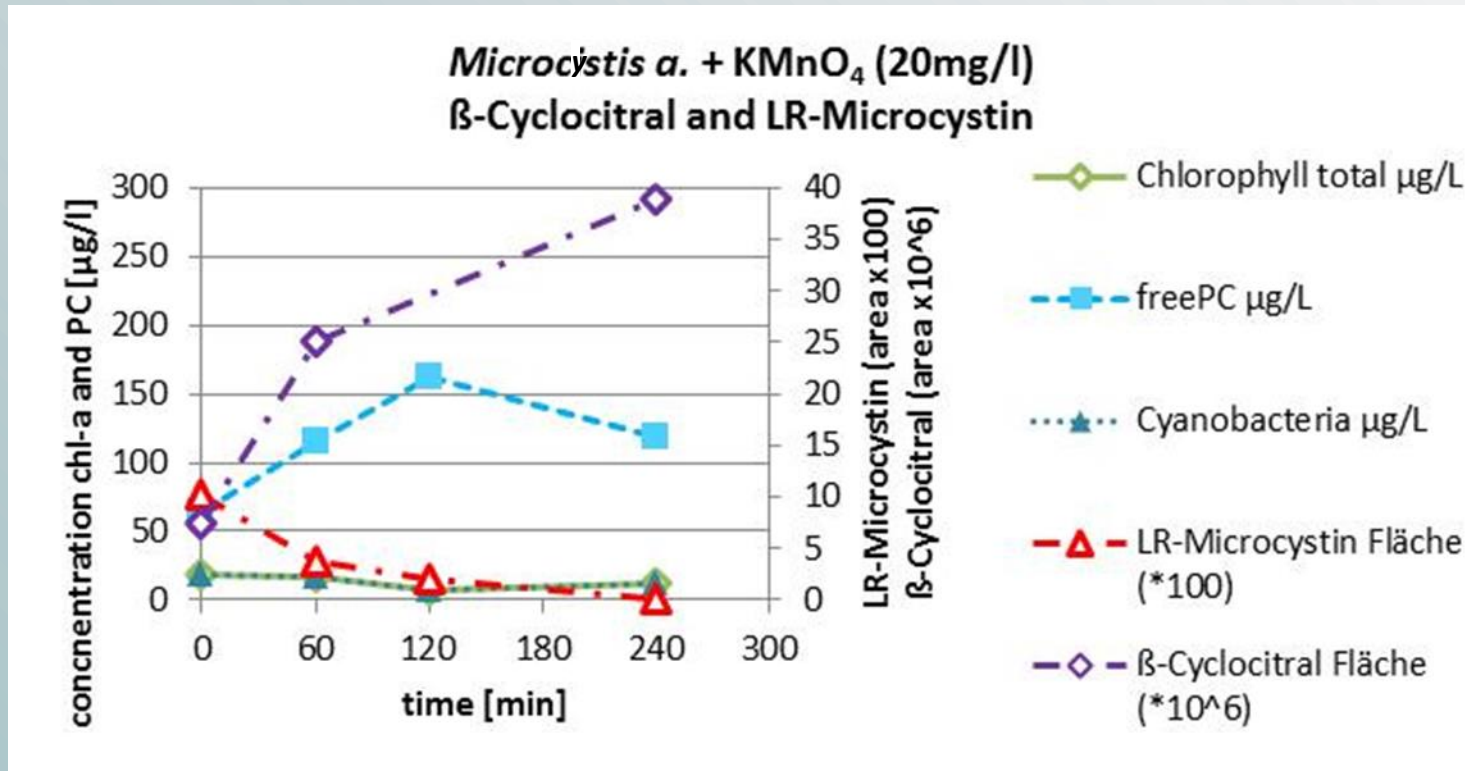
Sampled raw water, treated with varying concentrations of KMnO₄, evaluated after 30min, 3h and 24 h, unfiltered samples



***) = Data taken after pre-oxidation, Toxins found in the filtered samples**



The Release and Decay of Cyanobacterial Components





Possible Process Optimization in Drinking Water Works

PhycoSens
Cyanobacteria, lysing cells

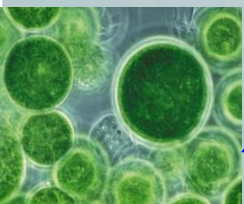


FluoSens

Biopolymers (amino acids, peptides, proteins), humic and fulvic acids



Raw water



Pre-ozonation

Co-agulation

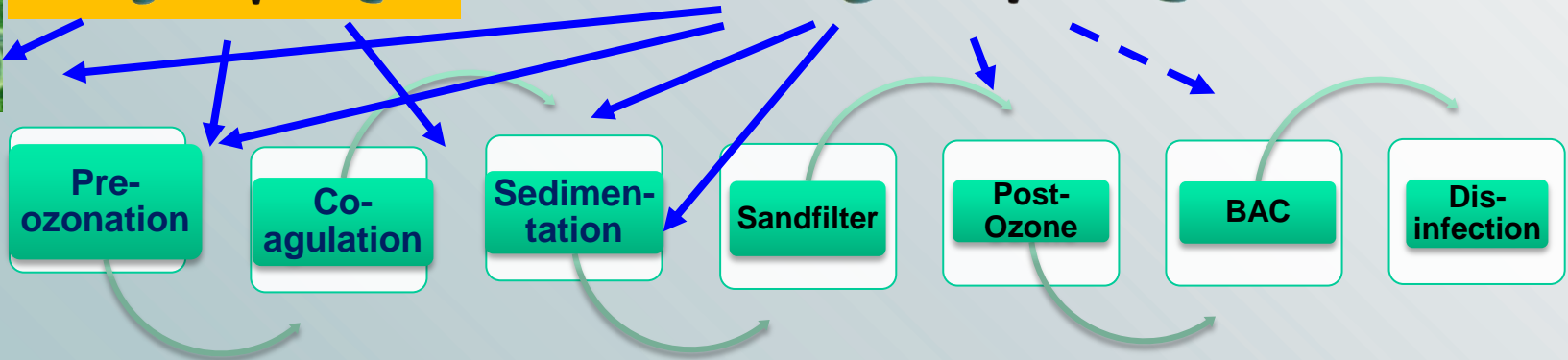
Sedimentation

Sandfilter

Post-Ozone

BAC

Disinfection





Why online ?

The efficiency of pre-oxidation chemicals depends on many factors, such as:-

- Algae density
- Algae age, health
- Competing organic compounds, such as humic substances
- Wind direction, which alters the algae concentration
- Temperature, pH,...etc.

The above conditions can change in minutes to hours



SUMMARY

- Most toxic T & O compounds stem from cyanobacteria. Cyanobacterial blooms are known to carry such compounds. The registration of lysing cells is helpful for management decisions in regard of health and economy.
- The analysis of the lysis of the cyanobacteria cells via unbound phycocyanin serves as a good early warning and control parameter for drinking water works.
- Unbound phycocyanin reflects the status of cyanobacteria and also describes clearly raw water quality.



Thank you