A novel membrane-based spectrophotometric method for quantifying of transparent exopolymer particles

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Introduction

What is TEP?

- ❑ Transparent, sticky and gel like substances, excreted by phytoplankton and bacterioplankton.
- ❑ Comprised mainly of acidic polysaccharides.
- ❑ Associated with algal growth, abundant during algal bloom events.
- ❑ Adverse impacts to water treatment systems such as membrane fouling.

Existing detection method

- ❑ Dead-end filtration with MF membrane e.g 0.4µm membrane.
- ❑ Visible when stained by Alcian Blue (AB).
- ❑ Using strong acid to elute TEP and AB complexes from the membrane and quantifiable using UV spectrometer.
- ❑ Time consuming (> 2 hours), tedious, offsite measurement.

To develop a TEP sensor with following properties:

- ❑ Simple, sensitive and shorter detection time
- ❑ Able to use for onsite measurement
- ❑ Reusable

Methodology

A TEP sensor consists of:

- ❑ A fibre optic spectrophotometer and crossflow filtration system.
- ❑ TEP is collected on the membrane surface and stained using AB.
- ❑ Quantified directly through the amount of light that is reflected from the surface using the reflection probe, represented by the CIE L*a*b colour space.
- ❑ Colour space value of b* appears to be more negative with the presence of TEP i.e. more TEP, more blue.

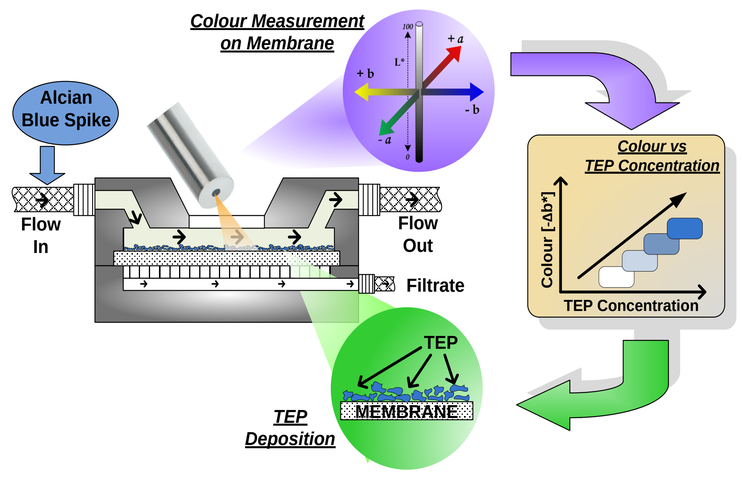

Figure 1: Schematic diagram of TEP sensor

Results & Discussion

Correlation of colour measurement and model foulant for TEP

- ❑ The visual blueness of the membranes increased with increasing XG concentration and can be quantified through the b* value of L*a*b colour space.

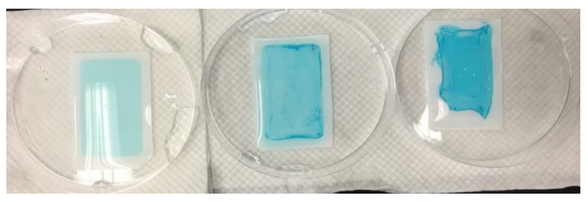

Figure 2: Different concentrations of XG fouled on 30kDa membrane surface, stained with AB.

- ❑ The b* value is linearly related to XG concentration.

Regeneration of TEP sensor

- ❑ After each TEP measurement, the membrane was regenerated using NaOCl (0.05%wt/v) for about 30 minutes.
- ❑ After regeneration of membrane, the membrane was challenged with another concentration of XG. This process is repeated for 9 cycles.
- ❑ The results shows that it is possible to regenerate and reuse the same membrane for at least 9 cycles. The Δb* values lie within the calibration curve.

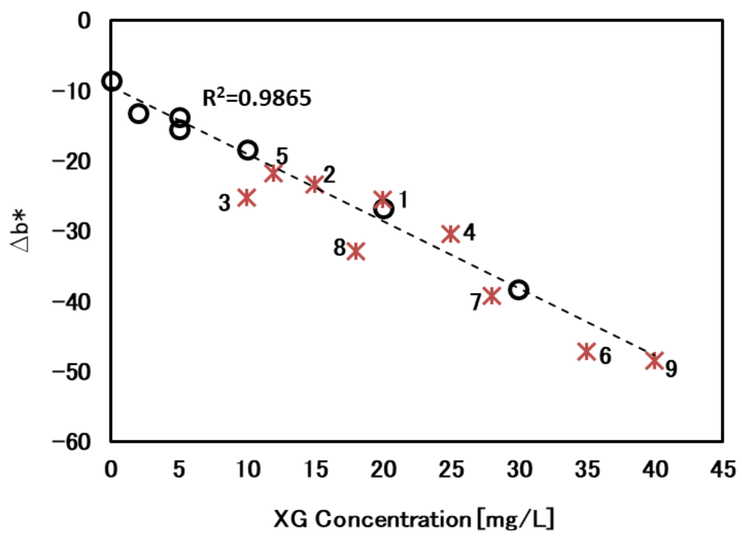

Figure 3: Calibration between Δb* and XG concentration (○). The red stars (*) are the values obtained after each cycle of regeneration. The number beside the star indicates the sequence of the test. Conditions: Flux = 180L/m².h; crossflow velocity = 0.15m/s, filtration duration 30 minutes

TEP production during algae growth

- ❑ To investigate the TEP production during the algae growth, a single species of algae was batch cultured.

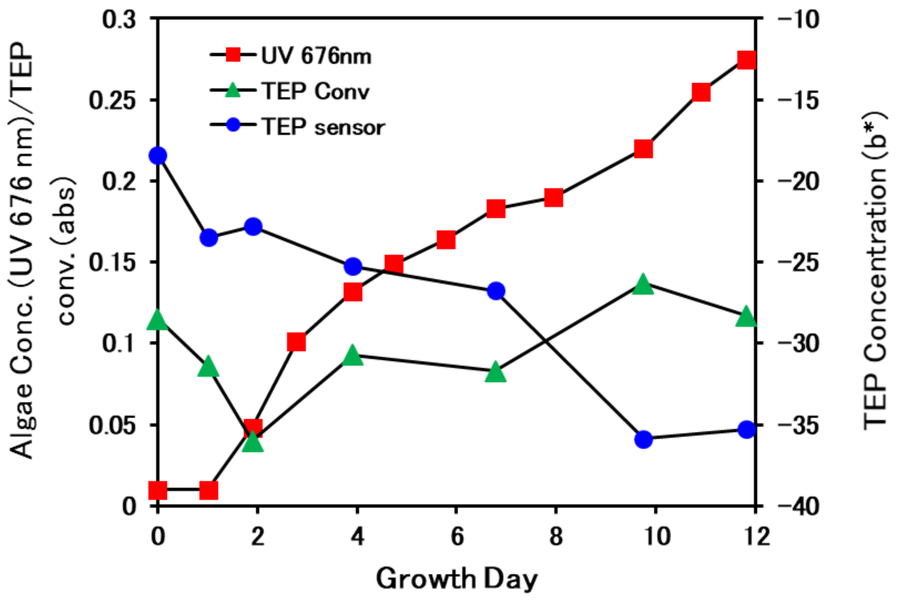

Figure 4: Changes in cell density, conventional TEP (TEP>0.1µm) and TEP sensor (TEP>30kDa) measurements during the incubation period of batch culture of *Thalasiorra Pseudonana*. Note the TEP sensor was performed at lower flux of 90L/m2.h, filtration duration of 2 hours.

- ❑ The increase in UV 676nm intensity indicates algae growth.
- ❑ TEP sensor shows an obvious TEP release (more negative b*) during the growth of algae, whilst conventional TEP method only have slight variation throughout the monitoring period.
- ❑ TEP sensor is more sensitive than the conventional method.
- ❑ The TEP precursor (<0.1µm) is likely the dominant fraction among algal-released TEP.

Proposed TEP sensor equipped with

- ❑ Shorter measurement duration of 30minutes.
- ❑ Choice of tighter membranes (e.g. 30kDa UF membrane) for higher sensitivity.
- ❑ Membrane is regenerable and hence do not require frequent membrane replacement.

Conclusions

This work focused on the development of a novel TEP monitoring method which enables online measurement with a shorter analysis duration. The membrane of the sensor can be regenerated without comprising the accuracy of the measurement. TEP sensor is more sensitive compared to conventional method.

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