

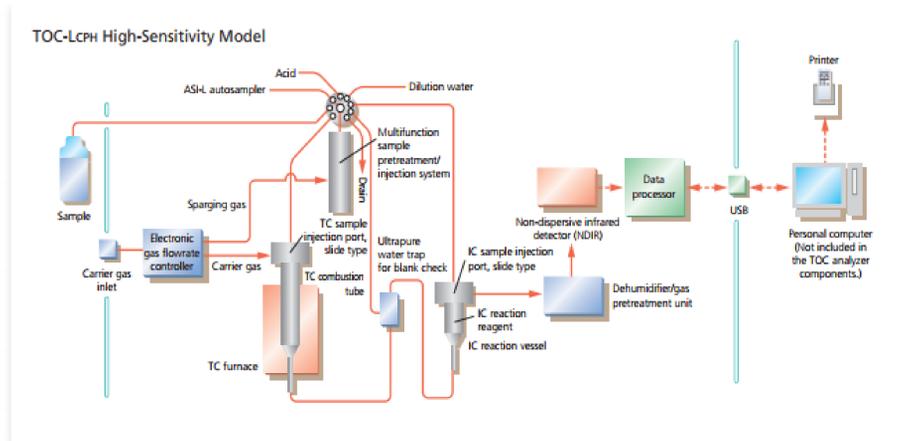
Monitoring of Algae Growth by TOC Measurement

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Introduction

Global warming, due to the excessive use of fossil fuels is becoming a problem which has prompted and accelerated the search for alternative fuels. Among the more attractive alternatives is biomass fuel, which is attracting considerable attention. Microalgae can be used for the production of oil without competing with food production, and to a greater extent than other biofuels, its productivity per unit time and area is high, while arable land selection possibilities are great. As for the practical use of microalgal biomass, various studies have been conducted at each stage of its production, including stock selection and breeding, cultivation, harvesting, oil extraction, and purification. The carbon content of the biomass is often one of the primary measurements to determine the energetic value of the biomass and to provide information on the efficiency of carbon conversion in a cultivation system¹. Here, we introduce an example of a unique application in which the TOC-LCPH total organic carbon analyzer is used to track the growth process of microalgae by directly measuring, without conducting any pretreatment, the TOC content in a suspended culture of microalgae cells.

Total Organic Carbon (TOC) Analyzer Operation



TOC Three Main Stages of Operation:

- 1) Acidification-Addition of acid and inert-gas sparging allows all bicarbonate and carbonate ions to be converted to carbon dioxide.
- 2) Oxidation- High Temperature Combustion. Prepared samples are combusted at 1,200°C in an oxygen-rich atmosphere. All carbon present converts to carbon dioxide, flows through scrubber tubes to remove interferences such as chlorine gas, and water vapor and the carbon dioxide is measured either by absorption into a strong base then weighed, or using an Infrared Detector. Most modern analyzers use non-dispersive infrared (NDIR) for detection of the carbon dioxide.
- 3) Detection and Quantification- The non-dispersive infrared analysis (NDIR) method offers the only practical interference-free method for detecting CO₂ in TOC analysis. The principal advantage of using NDIR is that it directly and specifically measures the CO₂ generated by oxidation of the organic carbon in the oxidation reactor. Data is collected and processed via a PC or as a standalone unit.

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Analytical Method

The microalgae was cultured for 8 days, and from the starting day, TOC measurement was conducted once per day for both Sample 1, which consisted of culture along with suspended microalgae cells, and Sample 2, which consisted of culture only obtained by removing the microalga cells from Sample 1 through centrifugal sedimentation. Then, from the difference in organic carbon (TOC) between Sample 1 and Sample 2, we obtained the value of TOC present in the organic matter of the microalgae cells. Further, we measured the turbidity of Sample 1, and that value was taken as an index of cell mass. A microscopic image of the microalgae cells of Sample 1 is shown in Fig. 1.

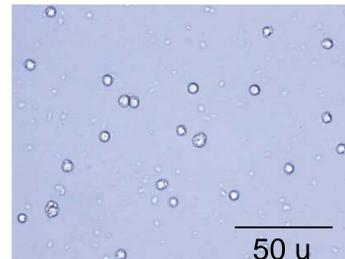


Fig. 1 Algae

Measurement Conditions>

Analyzer	: Shimadzu TOC-LCPH total organic carbon analyzer
Catalyst	: Standard catalyst
Measurement item: TOC (TC-IC)	
Calibration curve	: 1-point calibration curve using 1000 mg/L potassium hydrogen phthalate aqueous solution
Sample 1	: Culture solution containing suspended microalgae cells
Sample 2	: Culture solution with microalgae cells removed using centrifugal sedimentation
Sampling method	: Sample 1 water was sampled while stirring with a magnetic stirrer.

Measurement Results

Fig. 2 shows the measurement results for the total carbon (TC), total organic carbon (TOC) and inorganic carbon (IC) associated with the cell mass during the culture period. Also, the ratios of TOC to IC in the microalgae cells are shown in Fig. 3. From these results, it was possible to obtain information regarding the increase and decrease of TC, IC and TOC values associated with the microalgae cells throughout the culture process. One essential element in the practical realization of microalgal biomass is establishment of the culture conditions, and it is clear from this study that information regarding the carbon balance can be obtained using a TOC analyzer.

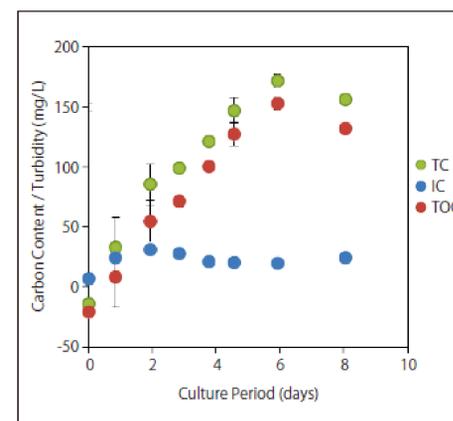


Fig. 2 Changes in TC, IC, TOC Quantity in Microalgae Cells (Conversion value per turbidity unit)

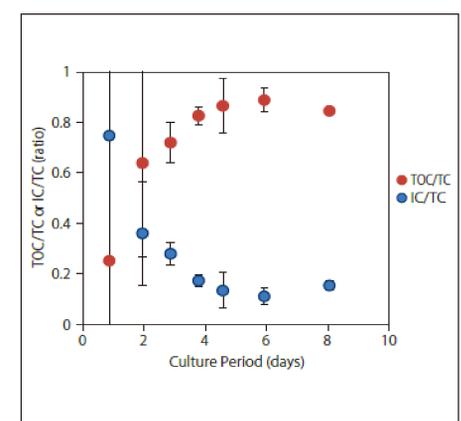


Fig. 3 Changes in TOC/TC and IC/TC in Microalgae Cells

Conclusions

Further research can include:

- Measurement of total carbon and nitrogen content in water, quantity dissolved, and quantity suspended.
- Measurement of dissolved CO₂ in water.
- Understand the changes in cell material with respect to changes over time in the culture and changes due to light and dark environment.
- Understand quantitatively the carbon and nitrogen balance in the culture system.