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# Application News

## No.O49

Total Organic Carbon Analysis

# Monitoring of Algae Growth by TOC Measurement

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 Shimadzu TOC-L Series combustion-type total organic carbon analyzer, with its powerful organic substance oxidation features, permits the complete oxidization and measurement of samples such as microalgae cell culture suspensions.

Here, we introduce an example of a unique application in which the TOC-L$_{CPH}$ 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.

The data presented here was provided by the University of Tsukuba Shiraiwa laboratory.

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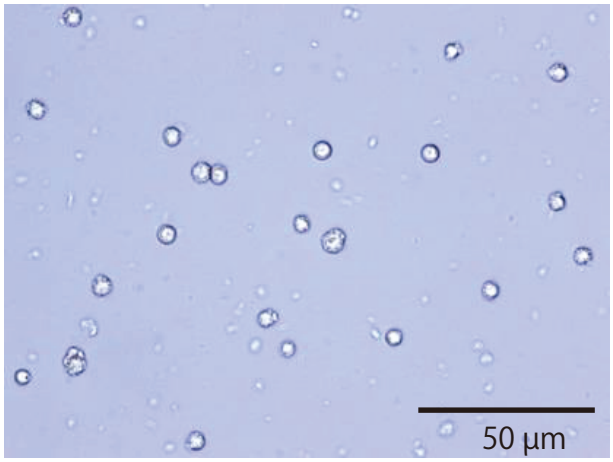


**Fig. 1 Algae**

## 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.

## 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.

<Measurement Conditions>

| | |
|---|---|
| Analyzer | : Shimadzu TOC-L$_{CPH}$ 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 |
| Water sampling method | : Sample 1 water was sampled while stirring with a magnetic stirrer |

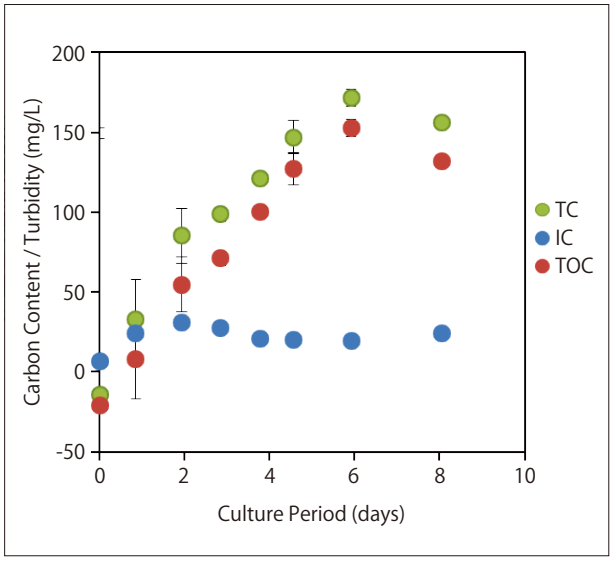


**Fig. 2 Changes in TC, IC, TOC Quantity in Microalgae Cells (Conversion value per turbidity unit)**

## Shimadzu TOC-L Series Total Organic Carbon Analyzer

The Shimadzu TOC-L Series Total Organic Carbon Analyzer can be used to conduct the following types of measurements.

- Measurement of total carbon and nitrogen content in water, quantity dissolved, quantity suspended*
- Measurement of total carbon, organic carbon, inorganic carbon in water
- Measurement of dissolved $CO_2$ in water

Thus, the TOC-L series can be utilized for such applications as the following types of microalgae research.

- Obtain information related to the physiological state and the properties of microalgae.
- 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.

The TOC-L Series instruments can be used to conduct measurements using very small volumes of sample in the range of 10 to 20 mL, making it suitable for laboratory-scale studies.

* The TNM-L Total Nitrogen Unit option is required for nitrogen (TN) measurement. In addition, filtering and centrifugal separation, etc. are required for separate measurement of samples in the dissolved state and suspended state.

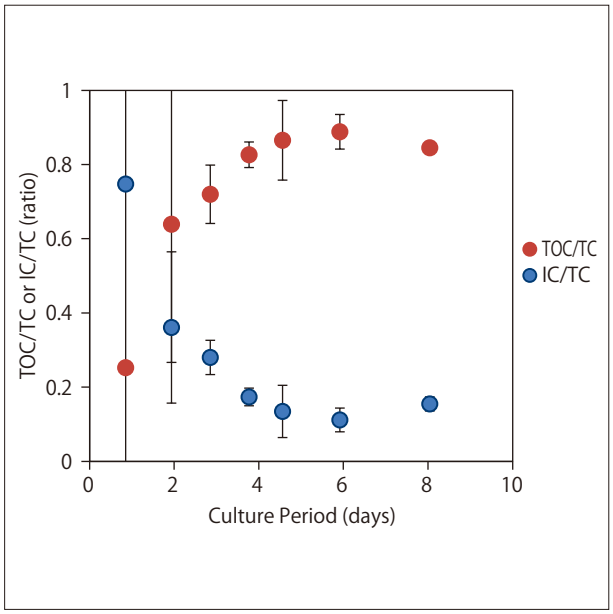


**Fig. 3 Changes in TOC/TC and IC/TC in Microalgae Cells**

**Fig. 4 TOC-L Total Organic Carbon Analyzer + TNM-L Total Nitrogen Unit**

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