

Application News

No.050

Total Organic Carbon Analysis

Characterization of Algae 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 oxidation 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 characterize 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.

T. Iharada, M. Tanaka

■ Analytical Method

Five types of microalgae A – E were cultured for 3 to 14 days, and at the start, after several days, and at the end of culturing, TOC measurement was conducted for sample 1, consisting of the various types of microalgae cells suspended in culture medium, and for sample 2, consisting of culture obtained by removing the microalga cells through filtration of sample 1. Then, from the difference in organic carbon content (TOC) in samples 1 and 2, we determined the TOC in the organic material of the various types of microalgae cells. Also, the turbidity of sample 1 was measured, and that value was taken as an index of cell mass.

<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 by filtration
Water sampling method	: Sample 1 water was sampled while stirring with a magnetic stirrer.

■ Measurement Results

The increase in total carbon (TC), total organic carbon (TOC) and inorganic carbon (IC) in five types of microalgae culture and cells are shown in Fig. 1 and Fig. 2, respectively.

It became apparent from the results that organic material take-up and release by the cells varied depending on the type of microalgae and the duration of the culture period. Further, in regard to the microalgae that form the shells of calcium carbonate, the results suggested that such shell formation information can be obtained using IC measurement.

To express these pieces of information that include the type, nature and growth state of microalgae, a TOC analyzer can be utilized for screening of the microalgae and investigation of culture conditions.

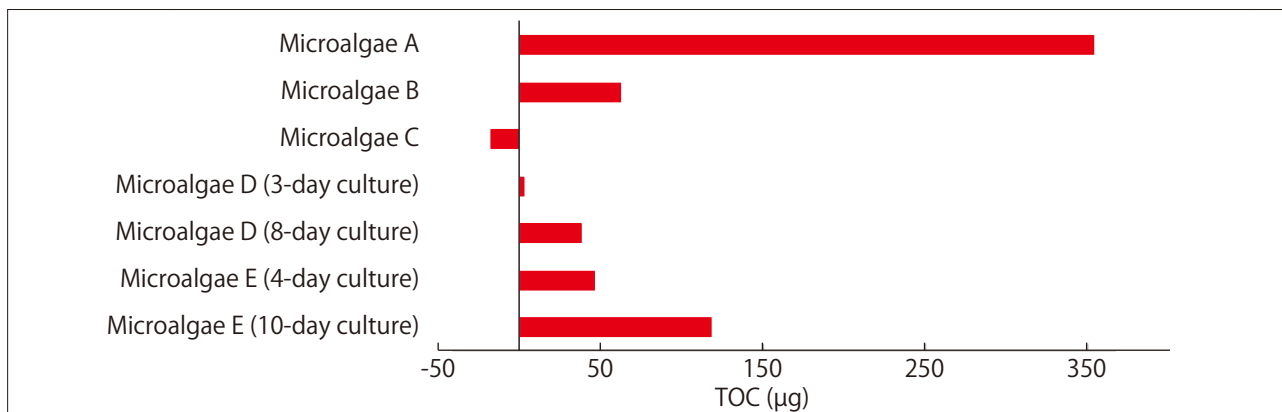


Fig. 1 TOC/OD in Culture (Conversion value per turbidity unit)

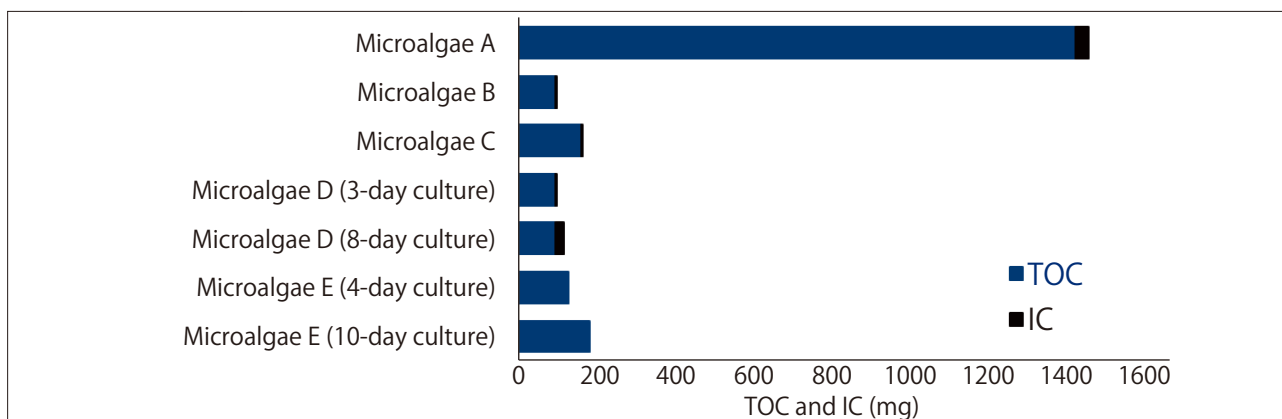


Fig. 2 TOC and IC/OD in Cell (Conversion value per turbidity unit)

■ 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 CO₂ 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 measurement 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 TOC-L Total Organic Carbon Analyzer + TNM-L Total Nitrogen Unit