

Application News

No.052

Total Organic Carbon Analysis

Measurement of TOC and TN in Marine Water Algae Culture Solution

The culturing of microalgae in various types of non-edible biomass has been receiving considerable attention in recent years. In particular, microalgae that inhabit seawater are favored due to the low cost of the culture solution and the wide choice of culture locations. Various nutrients, such as nitrogen compounds, are added to these types of microalgae cultures. However, nutrient concentrations must be managed within an appropriate range depending on the type of microalgae and the culture conditions.

The Shimadzu TOC-L Series Combustion Type Total Organic Carbon Analyzer can directly measure the total organic carbon (TOC) and total nitrogen (TN) content in high-salt samples such as seawater, without requiring dilution of the samples.

Here, we introduce an example of simultaneous measurement of TOC and TN in seawater using the TOC and TN measurement system consisting of the TOC-L_{CPH} total organic carbon analyzer for microalgal biomass measurement and the TNM-L unit for total nitrogen (TN) measurement.

Analytical Method

Measurement samples were prepared by spiking seawater obtained from the Sea of Japan (coast of Fukui Prefecture) with potassium hydrogen phthalate as TOC and potassium nitrate as TN, to obtain equivalent concentrations of these measurement samples (1) to (5) at levels of 0 mg/L, 25 mg/L, 50 mg/L, 100 mg/L and 150 mg/L, respectively. Simultaneous TOC and TN measurement of these samples was then conducted using the TOC-L_{CPH} + TNM-L.

Table 1 Samples

Sample	Spiked Potassium Hydrogen Phthalate Concentration [mgC/L]	Spiked Potassium Nitrate Concentration [mgN/L]
Sample (1)	0	0
Sample (2)	25	25
Sample (3)	50	50
Sample (4)	100	100
Sample (5)	150	150

<Measurement Conditions>

Analyzer	: TOC-L _{CPH} for microalgal biomass measurement + TNM-L total nitrogen measurement unit
Catalyst	: TOC/TN catalyst
Measurement items	: Simultaneous measurement of TOC (= TOC due to acidification and sparging) and TN
Calibration curve	: 1-point calibration curve using 150 mgC/L potassium hydrogen phthalate solution, 1-point calibration curve using 150 mgN/L potassium nitrate aqueous solution
Sample	: Seawater sampled from the Sea of Japan (coast of Fukui Prefecture)
TOC spike substance	: Potassium hydrogen phthalate (produced by Wako Pure Chemical Industries, Ltd., JIS Special Grade)
TN spike substance	: Potassium nitrate (produced by Wako Pure Chemical Industries, Ltd., JIS Special Grade)

Measurement Results

The measurement results for samples (1) to (5) are shown in Table 2 and Fig. 1. Also, a chart of the measurement data is shown in Fig. 2.

As they consist of seawater, the samples include about 3 % NaCl, but as evident from the data, both TOC and TN have been accurately measured with no adverse influence due to coexisting substances such as salts.

Table 2 Measurement Results

Sample	TOC Measurement Value [mgC/L]	TN Measurement Value [mgN/L]
Sample (1) (seawater only)	1.05	0.21
Sample (2) (spiked at 25 mg/L)	25.8	24.7
Sample (3) (spiked at 50 mg/L)	51.7	49.1
Sample (4) (spiked at 100 mg/L)	102.1	101.2
Sample (5) (spiked at 150 mg/L)	151.4	152.8

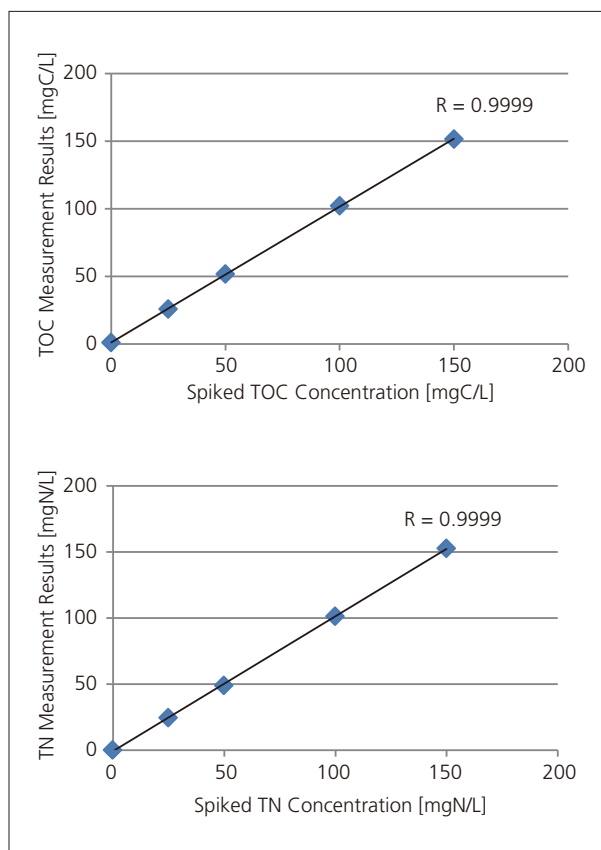
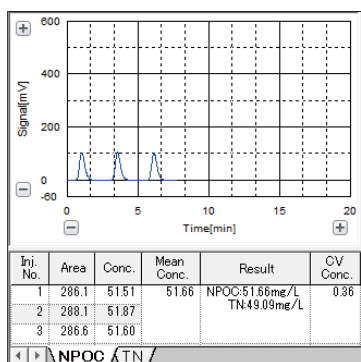
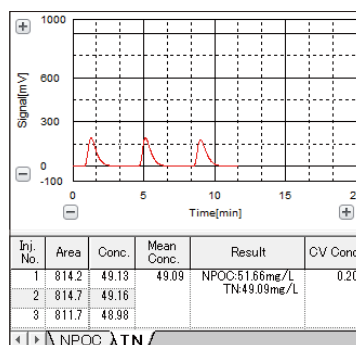


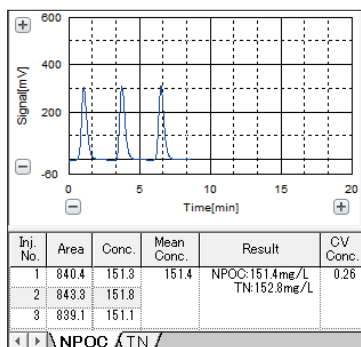
Fig. 1 Measurement Results



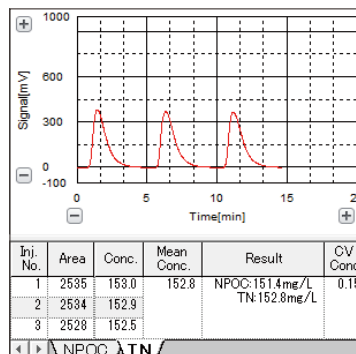
Sample (3) (spiked at 50 mg/L): TOC measurement



Sample (3) (spiked at 50 mg/L): TN measurement



Sample (5) (spiked at 150 mg/L): TOC measurement



Sample (5) (spiked at 150 mg/L): TN measurement

Fig. 2 Measurement Data

■ TOC-L for Microalgal Biomass Monitoring

The TOC-L for Microalgal biomass measurement is a total organic carbon analyzer that permits accurate measurement of total organic carbon even if the sample is in the form of a suspension, such as microalgae, and with minimal impact due to sedimentation. The following types of measurements can be conducted with the TOC-L for microalgal biomass measurement.

- Measurement of total carbon and nitrogen in water, and measurement of dissolved and suspended quantities of carbon and nitrogen^{*)}
- Measurement of total carbon, organic carbon, and inorganic carbon in water
- Measurement of dissolved CO₂ content in water

Therefore, the TOC-L for microalgal biomass measurement can be utilized for the following purposes in microalgae research.

- Obtaining information related to the nature and physiological state of microalgae
- Grasping the time-course changes in the culture, and the material changes in cells in a light and dark environment
- Grasping the time-course changes in the carbon / nitrogen ratio in the culture system quantitatively

As the TOC-L supports measurements using small sample volumes of 10 to 20 mL, it is also suitable for laboratory-scale research.

(*) The TNM-L total nitrogen (TN) unit is required for TN (nitrogen) measurement. In addition, separate measurement of these in the suspended state and dissolved state requires pretreatment operations, including filtration and centrifugal separation, etc.



Fig. 3 TOC-L for Monitoring a Microscopic Algae Biomass