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Total Organic Carbon Analyzer TOC-L

Application News

Evaluation of CO_2 Fixation by Microbial Metabolism

Akari Goto

User Benefits

- Quickly and easily measure the quantity of CO_2 absorbed by microorganisms using a TOC-L analyzer to measure inorganic carbon (IC).
- ASI-L autosampler enables automatic continuous measurement of multiple samples simply by loading vials.

■ Introduction

Reducing carbon dioxide (CO_2) emissions, which cause global warming, is a global issue, and various efforts are being made in various countries. In recent years, in addition to methods for directly reducing CO_2 emissions, technologies for separating and capturing CO_2 emitted into the atmosphere, converting it into useful substances, such as chemical raw materials, have become important for realizing a carbon-neutral society. Various methods are being considered for CO_2 capturing and conversion. Among them, biological approaches have been studied using artificial photosynthesis, algae, and microbial metabolism (Fig. 1). These methods are attracting attention because they can be used for environmentally friendly products, such as biofuels, and the processes also have a low impact on the environment. This article describes evaluating the amount of CO_2 absorbed by microbial metabolism by measuring the amount of dissolved CO_2 in medium with added microorganisms based on TOC-L analyzer measurements of inorganic carbon (IC).

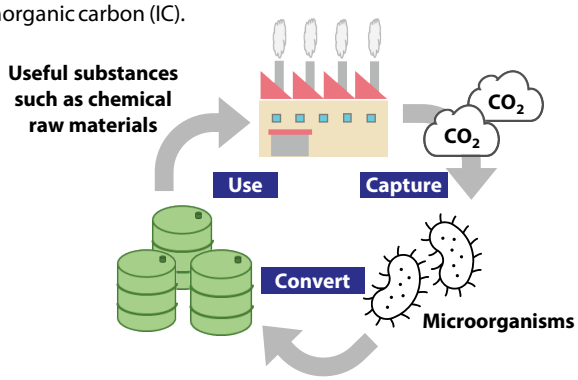

Fig. 1 Illustration of CO_2 Capturing and Conversion Using Microorganisms

■ Inorganic Carbon (IC) Measurement by TOC-L Analyzer

The TOC-L analyzer has functionality for determining both total organic carbon (TOC) and inorganic carbon (IC) in samples. Most of the CO_2 in an aqueous solution is in the form of hydrogen carbonate (HCO_3^-) or carbonate (CO_3^{2-}) ions. In IC measurements, the HCO_3^- and CO_3^{2-} in the sample are converted into the form of dissolved CO_2 by acidifying the sample, extracted with a CO_2-free gas, and quantified using an infrared CO_2 detector (Fig. 2). It is also possible to successively measure multiple samples using an autosampler (Fig. 3).

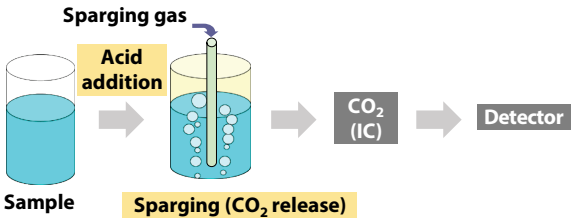

Fig. 2 Inorganic Carbon (IC) Measurement

Fig. 3 TOC-L Analyzer and ASI-L Autosampler

■ Analysis Method

For this example, the bacteria were added to the medium in which a certain amount of CO_2 had been absorbed, and allowed to react for 0, 3, and 24 hours. Bacteria were removed by centrifugation, and the IC concentration of the supernatant was measured (Fig. 4). Table 1 shows the measurement conditions.

Table 1 Measurement Conditions

Analyzer:	TOC-L_{CPH} total organic carbon analyzer
Measurement Items:	Inorganic carbon (IC)
IC Measurement Method:	Extraction of carbon dioxide by phosphoric acid acidification
Calibration Curve:	2-point calibration curve for 0-20 mgC/L sodium carbonate and sodium hydrogen carbonate (aq)
Injection Volume:	50 µL
Dilution Ratio:	100 times

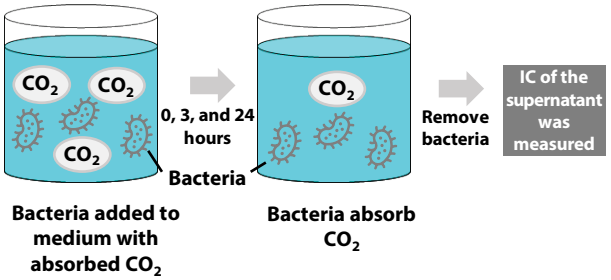

Fig. 4 Analysis Method

■ Calibration Curve

The analyzer was calibrated by measuring 0-20 mgC/L sodium carbonate and sodium hydrogen carbonate (aq). Measurement data is shown in Fig. 5.

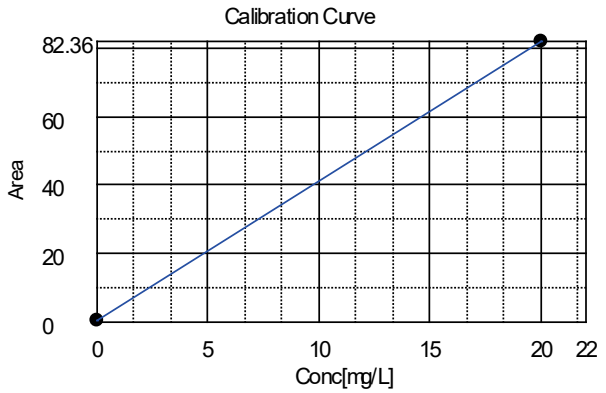

Fig. 5 Calibration Curve Measurement Data

■ Measurement Results

The measurement data for three samples with different reaction times with bacteria are shown in Fig. 6, and the measurement results corrected by the dilution ratio are shown in Table 2. As the reaction time increased, the IC concentration of the supernatant solution decreased markedly, allowing the amount of CO_2 absorbed by the bacteria to be quantitatively evaluated. The coefficient of variation for repeated measurements was less than 2 % in all cases, indicating good reproducibility.

Table 2 Supernatant Measurement Results (Corrected with Dilution Ratio)

Reaction Time	IC Conc. (mgC/L)		Coefficient of Variation (%)
0 hour	1694	About 83% decrease	0.45
3 hours	1163		0.95
24 hours	288.3		1.26

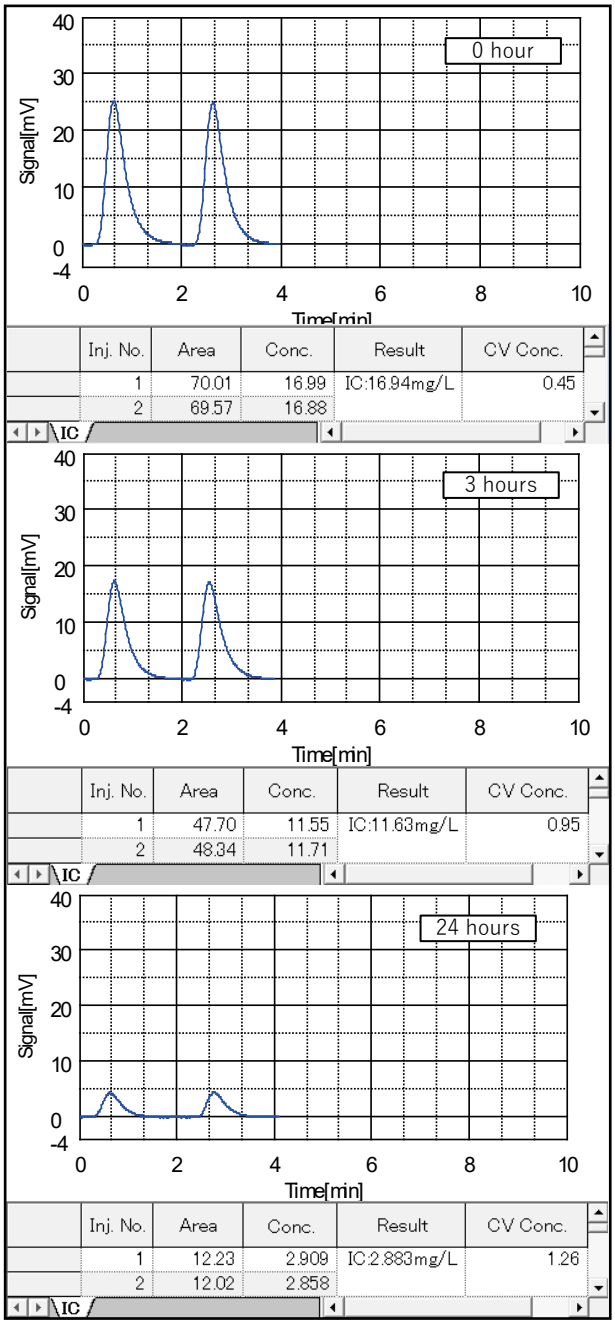

Fig. 6 Sample Measurement Data

■ Conclusion

In this paper, the amount of CO_2 absorbed by bacteria was evaluated by adding bacteria to a medium with absorbed CO_2, letting the bacteria and CO_2 react, and then measuring the IC in the supernatant. Information on the amount of CO_2 absorbed is useful for researching types of microorganisms that fix CO_2 and reaction conditions. The TOC-L analyzer enables the amount of dissolved CO_2 in solution to be determined easily and quickly. Try using it for your research of CO_2 fixation technology.

Acknowledgements

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