

Total Organic Carbon Analyzer TOC-L

Application News

Evaluation of CO₂ Fixation by Microbial Metabolism

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User Benefits

- Quickly and easily measure the quantity of CO₂ 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 (CO₂) 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 CO₂ emissions, technologies for separating and capturing CO₂ 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 CO₂ 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 CO₂ absorbed by microbial metabolism by measuring the amount of dissolved CO₂ in medium with added microorganisms based on TOC-L analyzer measurements of inorganic carbon (IC).

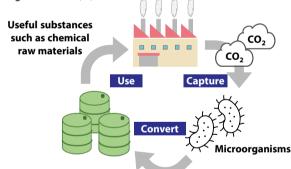


Fig. 1 Illustration of CO₂ Capturing and Conversion Using Microorganisms

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 CO₂ in an aqueous solution is in the form of hydrogen carbonate (HCO₃⁻) or carbonate (CO₃²⁻) ions. In IC measurements, the HCO₃⁻ and CO₃²⁻ in the sample are converted into the form of dissolved CO₂ by acidifying the sample, extracted with a CO₂-free gas, and quantified using an infrared CO₂ detector (Fig. 2). It is also possible to successively measure multiple samples using an autosampler (Fig. 3).

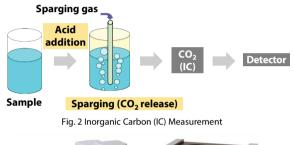




Fig. 3 TOC-L Analyzer and ASI-L Autosampler

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		
4.1 2.6 1.1	CO2 and 24 uurs Bacteria		

Bacteria added to medium with absorbed CO₂

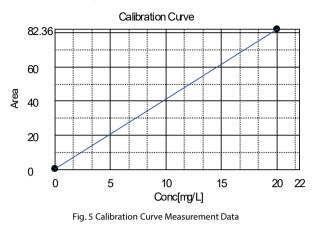
Bacteria

Bacteria absorb CO₂

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.

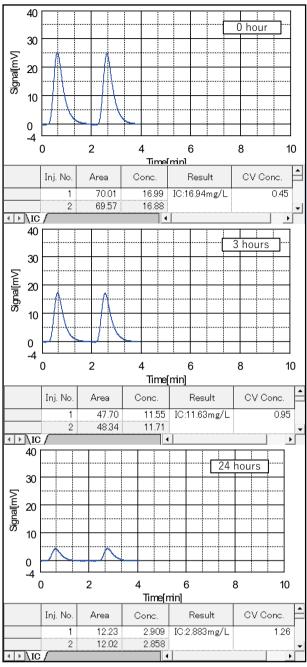


Measurement Results

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	0.45 About
3 hours	1163	83% 0.95 decrease
24 hours	288.3	1.26





Conclusion

In this paper, the amount of CO₂ absorbed by bacteria was evaluated by adding bacteria to a medium with absorbed CO₂, letting the bacteria and CO₂ react, and then measuring the IC in the supernatant. Information on the amount of CO₂ absorbed is useful for researching types of microorganisms that fix CO₂ and reaction conditions. The TOC-L analyzer enables the amount of dissolved CO₂ in solution to be determined easily and quickly. Try using it for your research of CO₂ fixation technology.

Acknowledgements

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