

TOC Measurements of Photosynthetic Bacteria

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User Benefits

- ◆ Measuring total organic carbon (TOC) is a simple and rapid method of evaluating the amount of microorganisms grown from CO₂ fixation.
- ◆ Use the "high suspension kit" with the TOC-L analyzer for good repeatability even with microorganism samples that have higher sedimentation rates.
- ◆ Use the ASI-L autosampler for consecutive analyses of a large numbers of samples.

Introduction

Technologies that separate, capture, and re-use CO₂ emissions are becoming increasingly important in the pursuit of a carbon-neutral society. Various approaches to carbon capture are being studied, one of which uses bioprocesses such as photosynthetic reactions. This approach involves using photosynthetic microorganisms to absorb CO₂ and synthesize organic substances and other useful materials, with research now aimed at improving the efficiency and increasing the scale of these types of processes. The Shimadzu TOC-L total organic carbon analyzer offers a simple and rapid means of measuring TOC to evaluate the amount of microorganisms grown from CO₂ capture. Because the amount of CO₂ dissolved in medium can be quantified by measuring inorganic carbon (IC), IC can also be used to determine the amount of CO₂ absorbed by microorganisms. These evaluations can be used to help screen and breed CO₂-fixing microorganisms and optimize cultivation and growth conditions.

This article describes an example of measuring TOC in a sample containing purple photosynthetic bacteria, and evaluating the amount of microorganisms in the sample.

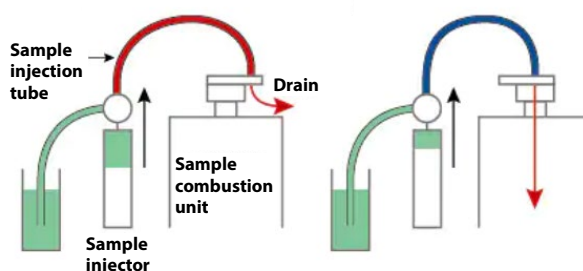
Measuring a High-Suspension sample with the TOC-L Analyzer

The extremely strong oxidizing power of Shimadzu TOC-L total organic carbon analyzer (Fig. 1) allows it to completely oxidize all organic material and detect TOC levels in a sample suspension.

Suspensions of microalgae and microorganisms can settle over time creating a sample with an uneven TOC concentration. Using a "high suspension kit" with the TOC-L analyzer allows it to measure these types of samples with good repeatability. The system using the sequence for measuring a high-suspension sample involves immediately feeding the sample into a sample injection tube (Fig. 2 (1)), then injecting the entire sample inside the sample injection tube into the combustion tube (Fig. 2 (2)). This process produces highly accurate measurements even with samples that have higher sedimentation rates. The ASI-L autosampler can also be equipped with an optional magnetic stirrer to perform consecutive measurements of many samples.



Fig. 1 TOC-L Analyzer



- (1) After sampling into sample injector, the sample is immediately fed into the sample injection tube.
- (2) The entire sample volume inside the sample injection tube is injected into the combustion tube.

Fig. 2 Schematic Diagram of Sample Collection and Injection by TOC-L and "High Suspension Kit" System

Analytical Method

For this analysis, purple photosynthetic bacteria were procured from a commercial source. The bacteria were isolated by centrifugal separation and then resuspended and diluted 1/3 and 2/3 in pure water (Fig. 3). The TOC concentration of these samples was then measured to examine the correlation between TOC concentration and amount of bacteria. The measurement conditions used are shown in Table 1.

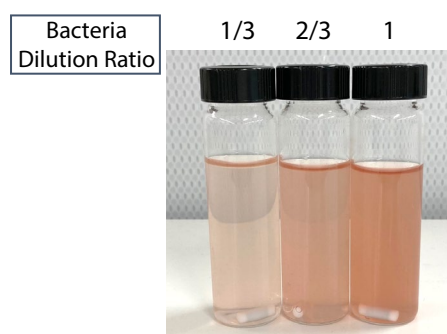


Fig. 3 Analyzed Purple Photosynthetic Bacteria Samples

Table 1 Measurement Conditions

Analyzer:	TOC-L _{CPH} Total Organic Carbon Analyzer + "High Suspension Kit" (Optional Accessory)
Catalyst:	TC standard catalyst
Measured Parameter:	TOC (based on TC-IC)
Calibration Curve:	TC: One-point calibration curve using 100 mgC/L aqueous solution of potassium hydrogen phthalate IC: Two-point calibration curve using 0 to 30 mgC/L aqueous solutions of sodium carbonate and sodium hydrogen carbonate
Injection Volume:	80 µL
Analyzed Sample:	Purple photosynthetic bacteria (commercial product)

■ Results of Measurement

The measurements collected from samples containing three different amounts of purple photosynthetic bacteria are shown in Fig. 4, and the results of measurement are shown in Table 2. Repeating each measurement revealed good repeatability with a coefficient of variation below 2 % for all analyses. Fig. 5 shows the correlation between the dilution ratio used to prepare each purple photosynthetic bacteria sample and the TOC concentration measured. The coefficient of correlation between the dilution ratio and TOC concentration is at least 0.999, indicating good correlation. This finding shows that TOC measurements can be used to accurately quantify amounts of microorganisms.

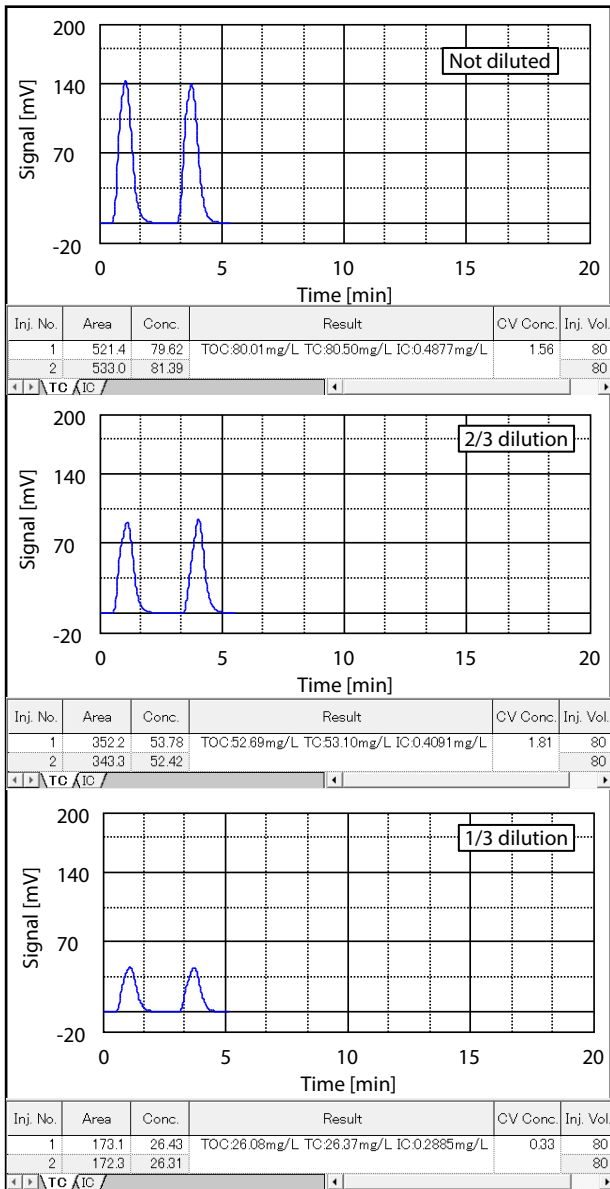


Fig. 4 TOC Measurements from Purple Photosynthetic Bacteria Samples

Table 2 Results of Measurement

Dilution	TOC (= TC - IC) Conc. (mgC/L)	Coefficient of Variation (%)
None	80.0	1.56
2/3 dilution	52.7	1.81
1/3 dilution	26.1	0.33

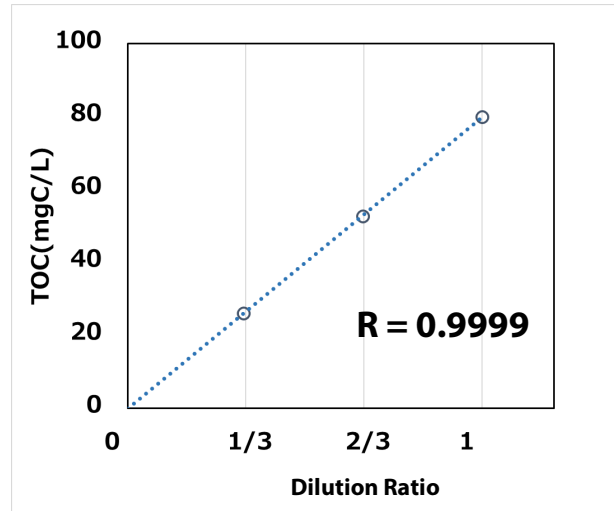


Fig. 5 Correlation between Purple Photosynthetic Bacteria Dilution Ratio and TOC Concentration

■ Conclusion

This article describes the use of the TOC-L analyzer to measure the TOC of purple photosynthetic bacteria and good correlation was observed between the amount of microorganisms in the sample and TOC measurements. The TOC-L analyzer can perform accurate quantitative analysis of suspensions of microorganisms such as photosynthetic bacteria. Because the amount of CO₂ dissolved in medium can also be determined based on IC, the TOC-L analyzer can also be used to simultaneously evaluate the amount of CO₂ absorbed by microorganisms.

Thus, the TOC-L analyzer can be used to help screen and breed CO₂-fixing microorganisms and optimize cultivation and growth conditions.