

## Application News

Total Organic Carbon Analyzers  
Combustion Catalytic Oxidation TOC-L / Wet Chemical Oxidation TOC-V

### TOC Measurement of Pharmaceutical Water

A. Goto

#### User Benefits

- ◆ Quick and easy control of organic impurities in pharmaceutical water is possible by using a Shimadzu TOC analyzer.
- ◆ Highly accurate measurement of pharmaceutical water with TOC concentrations of several 10 µgC/L is possible with both the combustion catalytic oxidation type TOC-L and the wet chemical oxidation type TOC-V.

#### ■ Introduction

Pharmaceutical water used in drug manufacturing processes must have a high level of safety and minimal impurities. Total organic carbon (TOC) is used in control of organic impurities in pharmaceutical water, and control standards corresponding to the application are provided in the pharmacopoeias used in various countries. For example, the Japanese Pharmacopoeia (JP) sets a limit of "not more than 0.500 mg/L" for TOC in purified water and water for injection (bulk). Quick and easy control of organic impurities is possible with Shimadzu TOC analyzers, even in cases where measurement with this high sensitivity/high accuracy is required.

Application News No. O81 introduced online measurement of ultrapure water with the TOC-1000e. This article introduces an example of measurement of pharmaceutical water with the combustion catalytic oxidation type TOC-L and the wet chemical oxidation type TOC-V, which enable batch measurement in the laboratory.

#### ■ Measurement Principle: Oxidation Methods

TOC analyzers generally decompose organic substances in a sample by oxidation and measure the generated carbon dioxide. Methods of oxidative decomposition are broadly divided into the combustion catalytic oxidation method and the wet chemical oxidation method. Table 1 shows their respective features and main applications.

Combustion catalytic oxidation has high oxidizability and enables oxidative decomposition regardless of the type and state of existence of organic substances. For this reason, it is the optimum method for measurements of environmental water and waste water, but since this method also realizes high sensitivity, which a limit of detection of 4 µg/L, it amply satisfies the requirements for measurement of pure water. The wet chemical oxidation method provides higher sensitivity measurement performance and is the optimum method for measurements of ultrapure water.

Table 1 Oxidation Methods

	Wet chemical oxidation	Combustion catalytic oxidation
Features	<ul style="list-style-type: none"> <li>High sensitivity</li> <li>• Optimum for measurement of ultrapure water</li> <li>• Limit of detection &lt; 1 µg/L</li> </ul>	<ul style="list-style-type: none"> <li>High oxidizability</li> <li>• Enables oxidative decomposition regardless of type and state of existence of organic substances</li> <li>• Limit of detection &lt; 4 µg/L</li> </ul>
Main applications	Ultrapure water, pure water (pharmaceutical water), tap water	Pure water (pharmaceutical water), tap water, environmental water, waste water

#### ■ Analysis Method

Pure water samples were measured under the conditions in Tables 2 and 3 using a combustion catalytic oxidation type TOC-L and a wet chemical oxidation type TOC-V.

Table 2 Measurement Conditions of Combustion Catalytic Oxidation Type TOC-L

Instrument	: Total organic carbon analyzer TOC-L <sub>CPH</sub>
Oxidation method	: 680 °C combustion catalytic oxidation
Catalyst	: High sensitivity catalyst
Measurement items	: NPOC (non-purgeable organic carbon; TOC measurement by acidification and sparging)
Calibration curve	: 2-point calibration curve by 0-500 µgC/L KHP (aq)
Injection volume	: 2000 µL

Table 3 Measurement Conditions of Wet Chemical Oxidation Type TOC-V

Instrument	: Total organic carbon analyzer TOC-V <sub>WP</sub>
Oxidation method	: Oxidation by oxidant, UV irradiation, and heating
Oxidant	: Sodium peroxodisulfate
Measurement items	: NPOC (TOC measurement by acidification and sparging)
Calibration curve	: 2-point calibration curve by 0-500 µgC/L KHP (aq)
Injection volume	: 3000 µL



Fig. 1 Shimadzu TOC Analyzers: TOC-L<sub>CPH</sub> and TOC-V<sub>WP</sub>

## ■ Calibration Curve

Fig. 2 shows the 2-point calibration curve prepared using 0 and 500 µgC/L (=ppb) potassium hydrogen phthalate (KHP). In order to eliminate the effect of carbon impurities in the ultrapure water used to prepare the standard solutions, the calibration curve was shifted in parallel so as to pass through the coordinate origin.

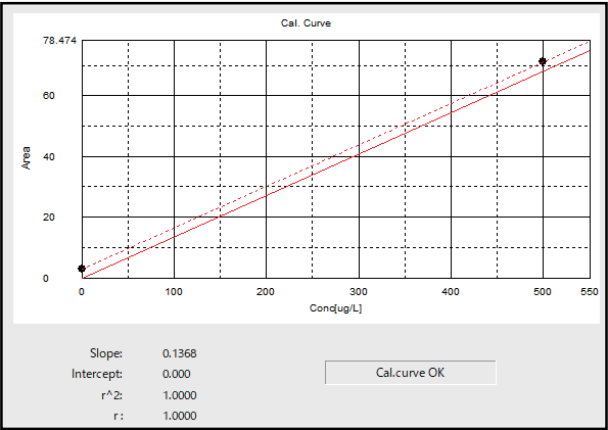


Fig. 2 Calibration Curve Measurement Data  
(Combustion Catalytic Oxidation Type TOC-L)

## ■ Measurement Results

Table 4 shows the results of measurements of pure water with the combustion catalytic oxidation type TOC-L and the wet chemical oxidation type TOC-V, and Figs.3 and 4 show the measurement charts. Similar TOC concentration values of 23.33 µgC/L and 22.54 µgC/L were obtained by the combustion catalytic oxidation method and the wet chemical oxidation method, respectively. In both cases, measurement with good repeatability was possible, as the coefficient of variation (CV) was approximately 3 % or less.

Table 4 Measurement Results

Oxidation method	Combustion catalytic oxidation type TOC-L	Wet chemical oxidation type TOC-V
Result (µgC/L)	23.33	22.54
Coefficient of variation (%)	3.09	2.60

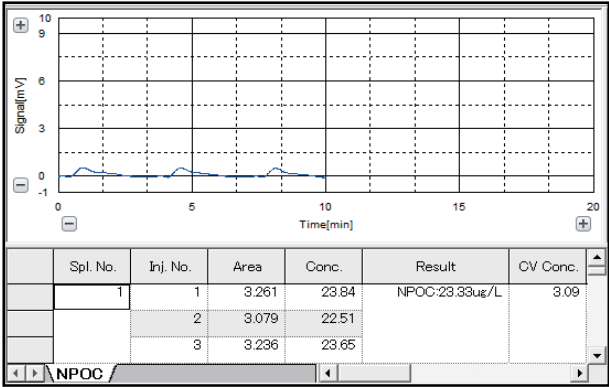


Fig. 3 Measurement Data Obtained with  
Combustion Catalytic Oxidation Type TOC-L

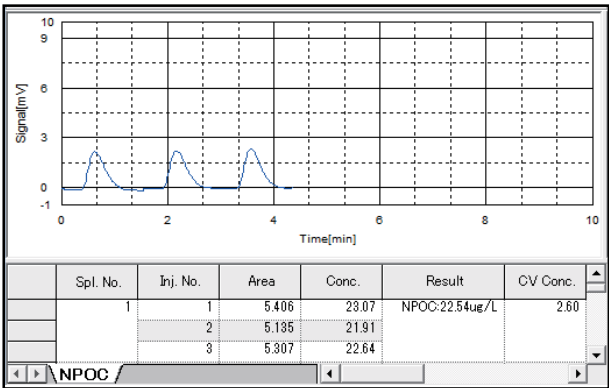


Fig. 4 Measurement Data Obtained with Wet Chemical Oxidation Type TOC-V

## ■ Conclusion

In this article, TOC measurements of pure water were carried out with a combustion catalytic oxidation type TOC-L and a wet chemical oxidation type TOC-V. As the measurement results, similar TOC concentration values were obtained with both instruments, and the repeatability of the measurements was also good, as the coefficient of variation (CV) was approximately 3 % or less. These results show that it is possible to measure pure water with a low TOC concentration, such as pharmaceutical water, with high accuracy and high sensitivity with both the combustion catalytic oxidation type TOC-L and the wet chemical oxidation type TOC-V.