

Application News

No.044

Total Organic Carbon Analysis

USP-Specified TOC System Suitability Test by TOC-LCPH

The United States Pharmacopeia (USP) specifies the use of Total Organic Carbon (TOC) for management of organic impurities in purified water (PW) and water for injection (WFI). According to the USP, the TOC analyzer to be used for these analyses must satisfy the TOC system suitability testing requirement, and must be capable of detecting TOC at concentrations below 0.05 mg/L.

Here, using the Shimadzu TOC-LCPH combustion catalytic oxidation type analyzer, we introduce examples of TOC system suitability testing and measurement of TOC at a concentration below 0.05 mg/L.

TOC System Suitability Test Specified in USP

The TOC system suitability test indicated in the USP specifies the use of two types of USP reference standards (sucrose and 1,4-benzoquinone). Sucrose is used as a test solution standard, and 1,4-benzoquinone is used as the system suitability test solution.

In addition, calibration of the TOC analyzer is specified to be conducted using a method that is suitable for that instrument. The test procedure is shown in Table 1.

TOC System Suitability Test Data by USP Method

The TOC system suitability test was conducted using the Shimadzu TOC-LCPH combustion catalytic oxidation type analyzer by the procedure outlined in Table 1. The instrument was calibrated beforehand using aqueous solutions of potassium hydrogen phthalate with carbon concentrations of 0 and 0.5 mgC/L, respectively. The TOC system suitability test data are shown in Fig. 1. According to the USP, the detection rate is to be evaluated using the analyzer response values, but here, the measured concentrations were used instead. The result indicated a 100.1 % detection rate with respect to the system suitability test solution (1,4-benzoquinone aqueous solution), thereby satisfying the system suitability test requirement. (Table 2)

Measurement Conditions

Analyzer	: Shimadzu TOC-LCPH Combustion Catalytic Oxidation Type Analyzer
Catalyst	: High-sensitivity catalyst
Injection Volume	: 816 µL
Measurement Item	: TOC (= NPOC: TOC by acidification/sparging)
Calibration Curve	: 2-point calibration curve using 0 – 0.5 mgC/L potassium hydrogen phthalate aqueous solution

Table 1 TOC System Suitability Test Procedure Specified in USP

TOC System Suitability Test Procedure				
(1) Measure the TOC in distilled water (distilled water used for preparing test solution). This value is indicated as r_w .				
(2) Measure the TOC in the sucrose standard solution (0.50 mg/L carbon concentration). This value is indicated as r_s .				
(3) Measure the TOC by the system suitability test (1,4-benzoquinone solution with 0.50 mg/L carbon concentration). This value is indicated as r_{ss} .				
(4) The system suitability test requirement is satisfied if: detection rate = $100 (r_{ss} - r_w) / (r_s - r_w)$ is 85 % - 115 %				

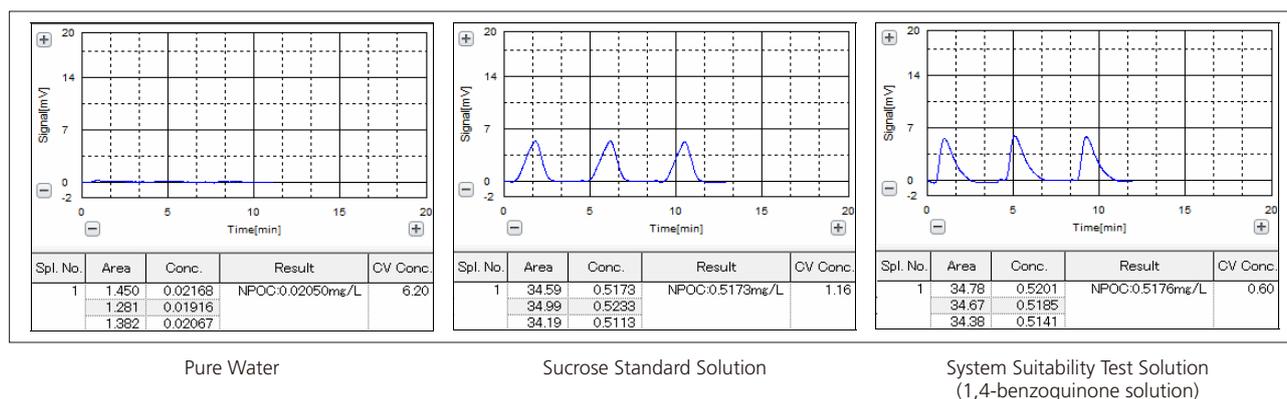


Fig. 1 TOC System Suitability Test Data

Table 2 Results of TOC System Suitability Test

(1) Distilled water TOC value $r_w = 0.0205$ mg/L
(2) Sucrose standard solution TOC value $r_s = 0.5173$ mg/L
(3) System suitability test solution (1,4-benzoquinone aqueous solution) TOC value $r_{ss} = 0.5176$ mg/L
(4) System suitability test solution detection rate
$= 100 (r_{ss} - r_w) / (r_s - r_w)$
$= 100 (0.5176 - 0.0205) / (0.5173 - 0.0205)$
$= 100.1 \%$

Table 3 Measurement Data for TOC Concentrations Below 0.05 mg/L (50 µg/L)

Sample Name	TOC Value [mgC/L]	Coefficient of Variation (CV) [%]
Potassium hydrogen phthalate aqueous solution	0.047	2.66

■ TOC Measurement Below 0.05 mg/L

The USP specifies that TOC analyzers to be used must be able to detect TOC at a concentration below 0.05 mg/L.

To verify this, we measured a potassium hydrogen phthalate aqueous solution with a TOC concentration of 0.025 mgC/L. The results are shown in Fig. 2 and Table 3. Because the distilled water used to prepare the sample contained TOC components as impurities, the measurement resulted in a higher concentration of 0.047 mgC/L, with a resulting coefficient of variation (CV) of 2.66 %. Since the coefficient was within 10 %, a CV value commonly associated with a concentration close to the lower limit of quantitation, the Shimadzu TOC-L_{CPH} combustion catalytic oxidation type analyzer clearly satisfied the USP requirement for TOC measurement of concentrations below 0.05 mg/L.

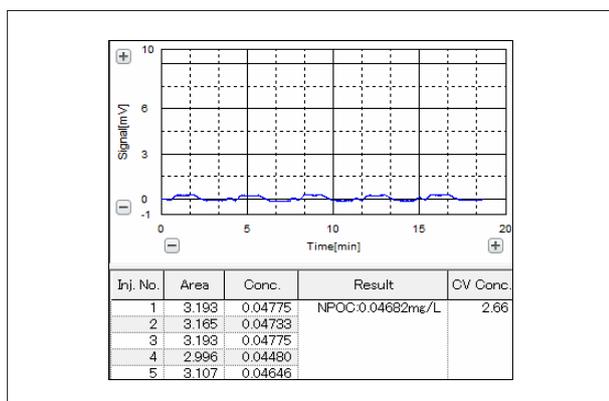


Fig. 2 Measurement Data for TOC Concentrations Below 0.05 mg/L (50 µg/L)

Measurement Conditions

Analyzer	: Shimadzu TOC-L _{CPH} Combustion Catalytic Oxidation Type Analyzer
Catalyst	: High-sensitivity catalyst
Injection Volume	: 816 µL
Measurement Item	: TOC (= NPOC: TOC by acidification/sparging)
Calibration Curve	: 2-point calibration curve using 0 – 0.5 mgC/L potassium hydrogen phthalate aqueous solution
Sample	: 0.025 mgC/L potassium hydrogen phthalate aqueous solution