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Application News

No. 067

Total Organic Carbon Analysis

TN Measurement of Urea Solution

Diesel engines have mainly been used in large-sized trucks and buses, but advances in technology have enabled its use in passenger cars as well. Diesel engines feature good fuel efficiency (combustion efficiency), low carbon dioxide emissions, and great durability. However, there are also drawbacks such as the occurrence of noise and vibrations, and higher emissions of black smoke, particulate matter (PM), and nitrogen oxides (NOx). The PM and NOx contained in the exhaust of diesel engines are considered to be causes of atmosphere pollution, and technologies for preventing release such harmful substances into the atmosphere have been developed.

A urea selective catalytic reduction (SCR) system can reduce atmosphere pollution by converting NOx into nitrogen and water. This system uses urea adjusted to an optimum concentration in order to efficiently convert emitted NOx. However, if the urea concentration is low, conversion of NOx may be insufficient. On the other hand, if the concentration is too high, an ammonia slip may occur, resulting in the leak of harmful ammonia outside of the system.

Shimadzu's combustion method total organic carbon analyzers (TOC-L: laboratory analyzer; TOC-4200: on-line analyzer) can be combined with a total nitrogen (TN) measurement option to easily measure TN. If using the Kjeldahl method, which is widely used to measure nitrogen content, multiple reagents such as acids and alkalis are required and the measurement takes several hours for digestion and distillation. On the other hand, the TN measurement conducted with these analyzers is thermal-decomposition - chemiluminescence method. Therefore, reagents are not necessary and a measurement result can be obtained rapidly in approxi. 5 minutes.

This article introduces example measurements of aqueous urea solutions (urea solution) adjusted to constant concentrations using a system comprising Shimadzu's TOC-L and TNM-L total nitrogen unit.

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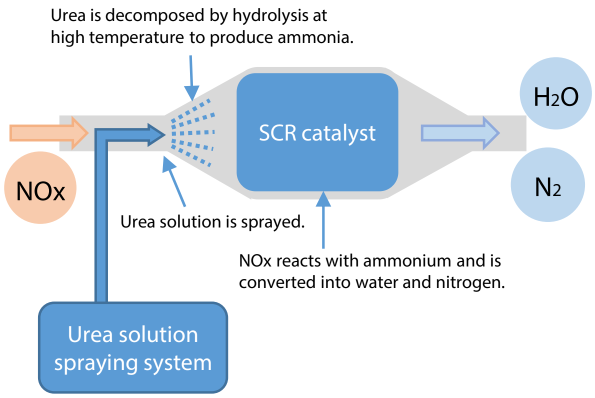


Fig. 1 Schematic of Urea SCR System

Analysis Method

Powdered urea was dissolved in pure water to create 10 %, 20 %, 30 %, 40 %, and 50 % urea solution. Since the nitrogen concentration of these solutions is too high, they were diluted and then measured.

The calibration curve for TN measurement was created using 0 and 30 mgN/L aqueous solutions of potassium nitrate.

Table 1 Measurement Conditions

Analyzer	: TOC-L_{CPH} + TNM-L total nitrogen unit
Catalyst	: TOC/TN catalyst
Measurement Item	: TN measurement
Calibration Curve	: Two-point calibration curve using 0 and 30 mgN/L aqueous solutions of potassium nitrate

Measurement Results

Table 2 indicates the results obtained from measuring the urea solution of each concentration. Fig. 2 shows the correlation between the theoretical values and the measured values, and Fig. 3 shows each of the obtained measurement data. Based on the recovery rate results and the linear correlation between theoretical values and measured values, we can see that each urea solution was measured accurately.

Table 2 Measurement Results

Sample	Logical TN (mgN/L)	Measured TN (mgN/L)	Recovery Rate (%)
10 % Urea Solution	4.67	4.63	99
20 % Urea Solution	9.33	9.69	104
30 % Urea Solution	14.0	14.2	101
40 % Urea Solution	18.7	19.6	105
50 % Urea Solution	23.3	24.4	105

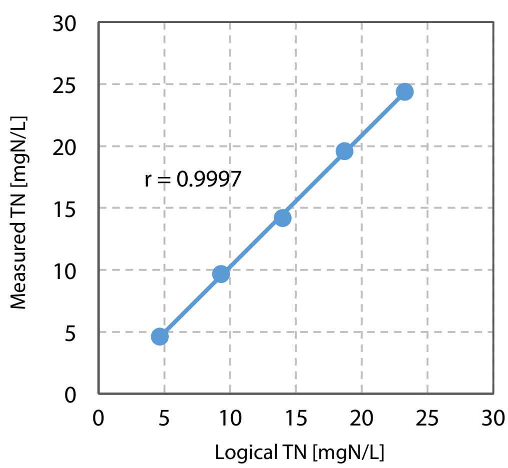
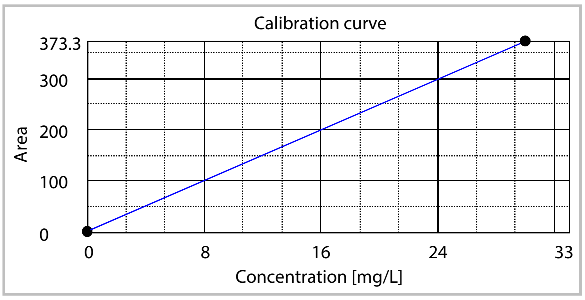
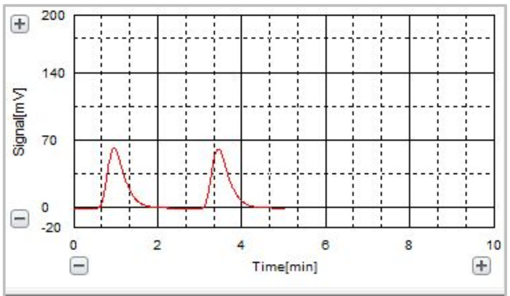


Fig. 2 Relationship of Logical and Measured TN Values

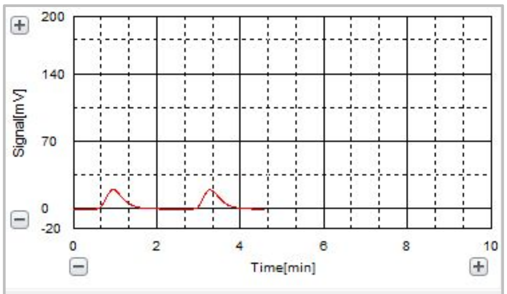


TN calibration curve



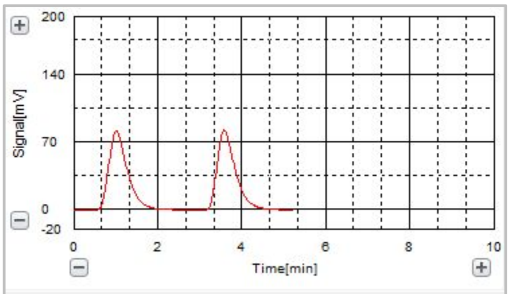
Inj. No.	Area	Conc.	Mean Conc.	Result	CV Conc.
1	177.0	14.22	14.22	TN:14.22mg/L	0.08
2	176.8	14.21			

30 % urea solution



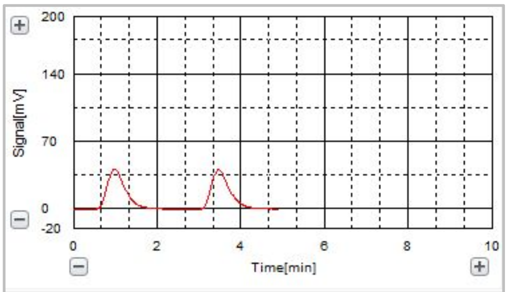
Inj. No.	Area	Conc.	Mean Conc.	Result	CV Conc.
1	58.16	4.674	4.627	TN:4.627mg/L	1.45
2	56.98	4.579			

10 % urea solution



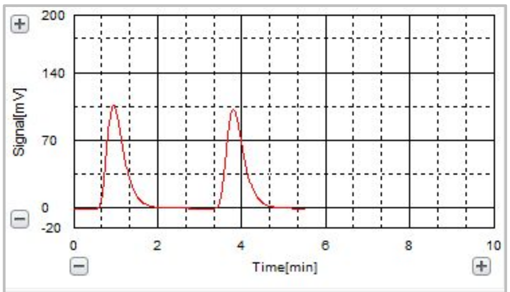
Inj. No.	Area	Conc.	Mean Conc.	Result	CV Conc.
1	244.1	19.62	19.55	TN:19.55mg/L	0.47
2	242.5	19.49			

40 % urea solution



Inj. No.	Area	Conc.	Mean Conc.	Result	CV Conc.
1	120.8	9.708	9.692	TN:9.692mg/L	0.23
2	120.4	9.676			

20 % urea solution



Inj. No.	Area	Conc.	Mean Conc.	Result	CV Conc.
1	305.3	24.54	24.36	TN:24.36mg/L	1.00
2	301.0	24.19			

50 % urea solution

Fig. 3 Measurement Data

Fig. 4 TOC-LCPH Laboratory TOC Analyzer and TN Option

Fig. 5 TOC-4200 On-Line TOC Analyzer and TN Option

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