High-Resolution Analysis of Greenhouse Gases

[Introduction]

Real-time monitoring of nitrous oxide (N_2O) is required to elucidate the generating mechanism and investigate its trend of spread. N_2O is known as a greenhouse gas, and the warming effect is about 310 times larger than carbon dioxide (CO_2).1 Furthermore, N_2O is one of the ozone-depleting substances. If we try to carry out real-time monitoring of N_2O using mass spectrometry, a mass spectrometer with high mass resolution is required, because the nominal mass of N_2O is the same as that of CO_2. If we would like to separate CO_2 and N_2O doublet completely, the required mass resolution is about 10,000. Conventional portable field instruments are incapable of this measurement because of low mass resolution.

The infiTOF system is compact, portable, and capable of achieving a resolving power of 30,000. Here, we demonstrate the feasibility of using the InfiTOF for high-resolution N_2O analysis using N_2O standard gas.2

[1] Ravishankara, A. R.; Daniel, J. S; Portmann, R. W. Science 2009, 326, 123-125.
[2] Shimma, S.; Nagao, H.; Aoki, J.; Takahashi, K.; Miki, S.; Toyoda, M.
Anal. Chem. 2010, 82, 8456-8463.

[Material]

CO_2 and N_2O mixture gas (49.4%:50.6%).
N2 and N_2O mixture gas (concentration of N_2O was 30 ppm).
These gases were purchased from DAIHO SANGYO Inc. (Minato-ku, Tokyo, Japan).

[Methods]

Measurement mode of MS: Multi segment
Analyte gases were introduced into the EI ion source via the needle valve.
For low molecular weight analysis (m/z < 50), applied voltages were specialized as follows.

Acceleration voltage: 2000 V (push), 3190 V (float),
Einzel lens: 2160 V,
Ionization voltage: 80 V,
Injection sector: 1502.5 V (D -77.0 V),
Ejection sector: 1406.5 V (D -272.0 V),
Multi-turn sector: 1518.0 V (D -309.0 V),
Matsuda plate: 939 V
NOTE:
For better mass resolution, applied voltage for Matsuda plate keep less than 1000 V

[Separation of CO_2 and N_2O doublet]

In the short flight length (10 cycles Fig. 1A), the doublet was still unified.

After 20 cycles, the doublet began to separate, but not still completely (Fig. 1B).

After 50 cycles, CO_2 and N_2O were clearly separated, and the obtained mass resolution was 11,000 (Fig. 1C). After 100 cycles, the mass resolution of 22,000 was achieved (Fig. 1D).

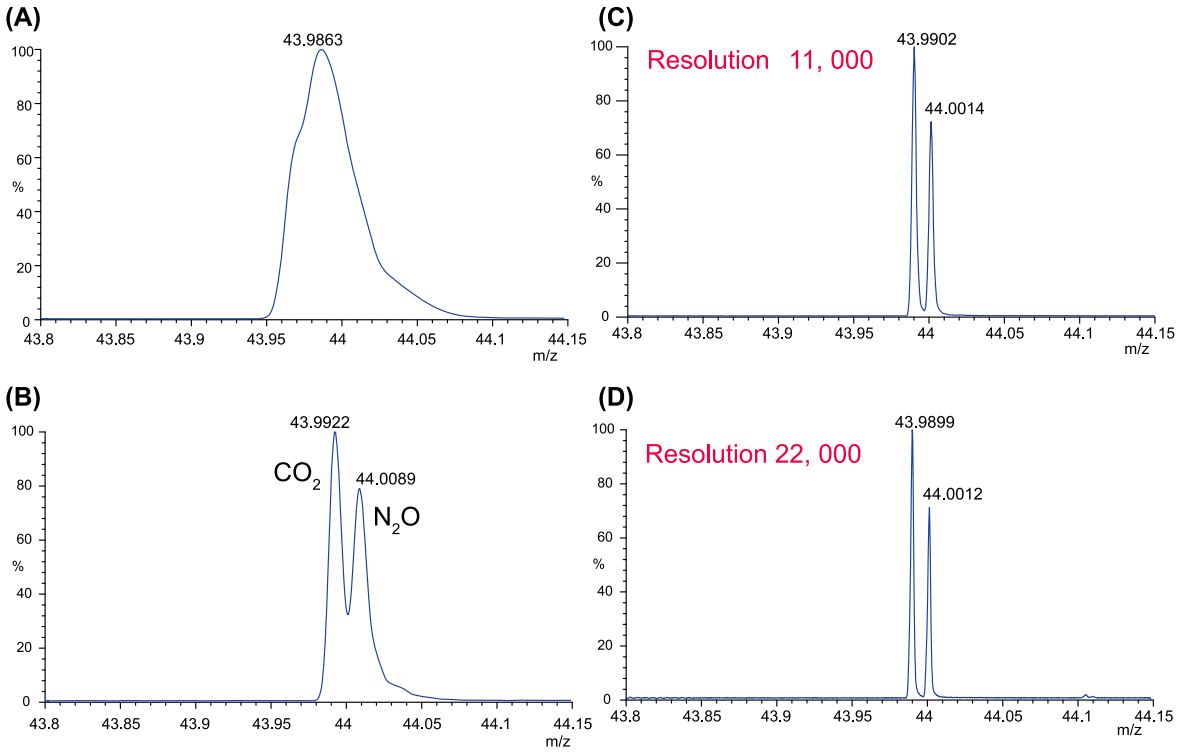

Fig.1 Separation of CO2 and N2O doublet. (A)10 cycles, (B) 20 cycles, (C) 50 cycles and (D) 100 cycles. At 100 cycles, mass resolution of 22,000 was achieved.

[Simultaneous measurement of N2+N2O (30 ppm) mixture gas]

We found CO_2 and N_2O were completely separated after 50 cycles. As a next experiment, simultaneous measurement of N_2 and N_2O was performed. The concentration of N_2O was 30 ppm to N_2. In this experiment, air was also introduced intentionally into EI ionization source to detect CO_2 in the air.

The obtained spectrum at 50 cycles was shown in Fig. 2

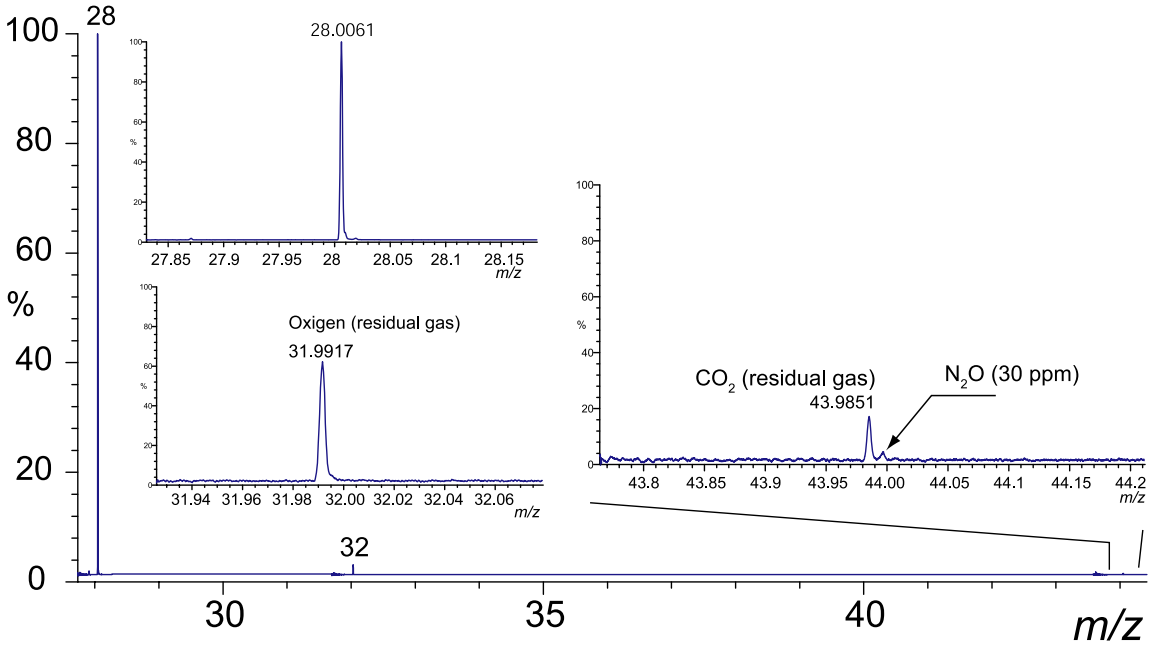

Fig. 2 Simultaneous measurement of N_2 and N_2O. All peaks were detected at the same time with the same detector condition. Furthermore, separated N_2O was able to be separated from CO_2 in the air.

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