Application News

Gas Chromatograph GC-2030

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Greenhouse Gas Analyzer

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User Benefits

- Simultaneously measures the 3 main greenhouse gases: CH_4, CO_2, and N_2O.
- Offers short analysis cycle times and is equipped with an AOC-6000 Plus syringe injection system to analyze large numbers of samples.
- Uses nitrogen as a carrier gas for lower running costs.

■ Introduction

Greenhouse gases are a major cause of climate change, and carbon dioxide, (CO_2), methane (CH_4), and nitrous oxide (N_2O) are considered the 3 primary greenhouse gases. Although CO_2 accounts for the majority of greenhouse gas emissions followed by CH_4, reducing CH_4 emissions is considered important because CH_4 has a warming effect that is more than twenty times greater than CO_2. At the United Nations Climate Change Conference (COP26) in November 2021, over 100 countries joined the Global Methane Pledge, which pledges by 2030 to reduce global CH_4 emissions by 30 % compared to 2020 levels.

The Greenhouse Gas Analyzer is a gas chromatography system that has been developed by Shimadzu in collaboration with the National Agriculture and Food Research Organization (NARO) (Fig. 1). Measuring levels of CH_4, CO_2, and N_2O simultaneously in a single sample is difficult, but the Greenhouse Gas Analyzer has been designed to do this simultaneously, which reduces analytical errors and improves the sampling speed, giving researchers a valuable tool in reducing greenhouse gas emissions.

This Application News describes using the Greenhouse Gas Analyzer to simultaneously measure CO_2, CH_4, and N_2O levels.

Fig. 1 Greenhouse Gas Analyzer

■ System Configuration

The Greenhouse Gas Analyzer measures gases using a valve system that is combined with 3 detectors. Different detectors are used for specific analytes. CH_4 is measured using a flame ionization detector (FID). CO_2 is measured using a thermal conductivity detector (TCD), and N_2O is measured using an electron capture detector (ECD). A schematic flow diagram of the system is shown in Fig. 2, and the conditions used in the analysis are shown in Table 1. Although helium is a popular choice as a carrier gas, recent supply chain disruptions have led to helium shortages. Nitrogen is easier to procure and can be used as a carrier gas by the Greenhouse Gas Analyzer. The Greenhouse Gas Analyzer is also compatible with gas bags and glass vial sampling containers. Investigating changes over time in large areas, such as fields, requires large numbers of samples. In these situations, glass vials can offer shorter sample collection times and easier transportation because they are smaller than gas bags (Fig. 3). The AOC-6000 Plus syringe injection system used by the Greenhouse Gas Analyzer can hold up to 108 glass vial samples for high-throughput analysis.

■ Analysis Flow

The AOC-6000 Plus syringe injection system uses a syringe to inject samples from the vials, which are arranged in trays, into a packed column injection port (Fig. 2). When performing manual analysis of a sample in a gas bag, the gas bag is connected to the system, and the sample is passed from the bag through the sample loop and into the gas chromatograph. The accumulation of sample gas moisture in one part of an analysis column can cause issues in the chromatogram. However, the Greenhouse Gas Analyzer uses a precolumn to separate moisture and other unwanted impurities from the sample and vent them from the system (the pre-cut). After the pre-cut, each target gas (CH_4, CO_2, and N_2O) is isolated by a different column, and CH_4 is measured by an FID, CO_2 by a TCD, and N_2O by an ECD.

Fig. 3 Comparison of a Gas Bag and a Glass Vial

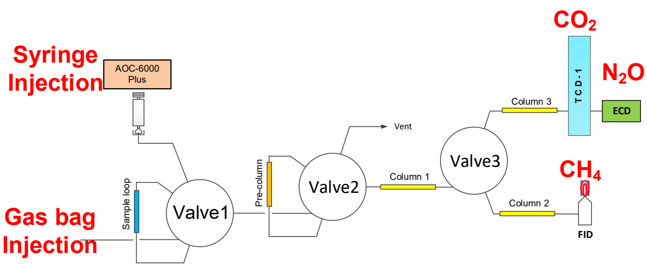

Fig. 2 Schematic Flow Diagram of CH_4, CO_2, and N_2O Greenhouse Gas Analyzer

Table 1 Analytical Conditions

Model:	GC-2030 FID + TCD + ECD + Valve option box
Auto Sampler:	AOC-6000 Plus
Injection Volume:	1 mL
Valve. Temp.:	110 °C
Inj. Temp.:	110 °C
Carrier Gas:	N_2
Column Temp.:	110 °C
FID. Temp.:	250 °C
FID Gas:	Air, H_2, N_2
TCD Temp.:	120 °C
TCD Current:	70 mA
TCD Gas:	N_2
ECD Temp.:	340 °C
ECD Current:	2 nA
ECD Gas:	CH_4 5 %/Ar

■ Analysis of Standard Samples

Fig. 4 shows the chromatograms obtained from standard samples.

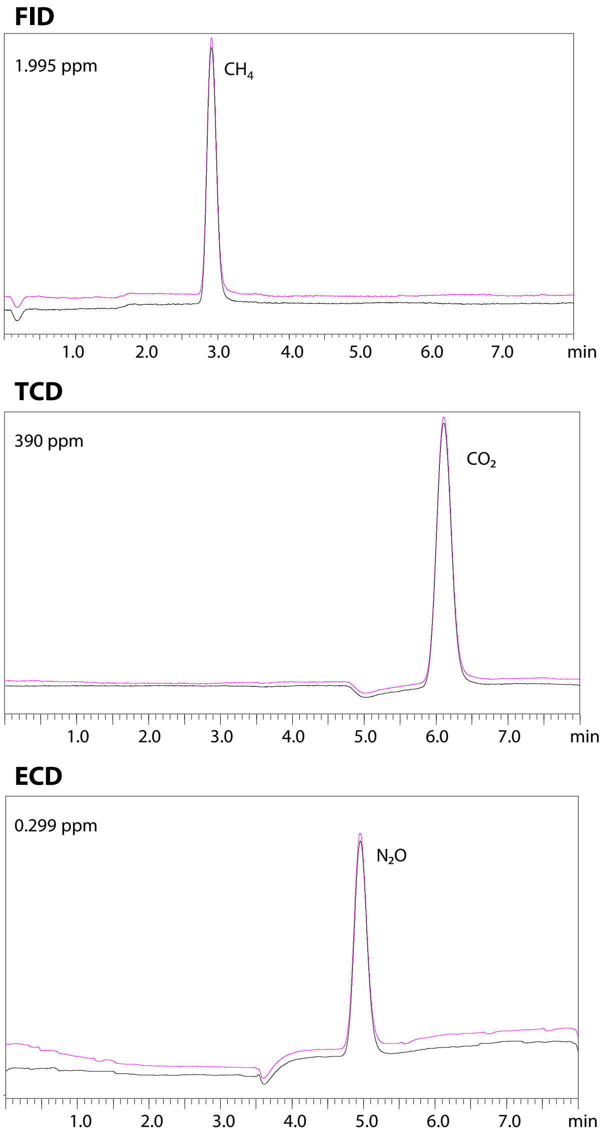

Fig. 4 Chromatograms of Standard Samples

■ Analysis of Real-World Samples

Fig. 5 shows the chromatograms obtained from atmospheric air analyzed 6 times in succession. Table 2 shows the analyte levels from standard samples and the repeatability of the results.

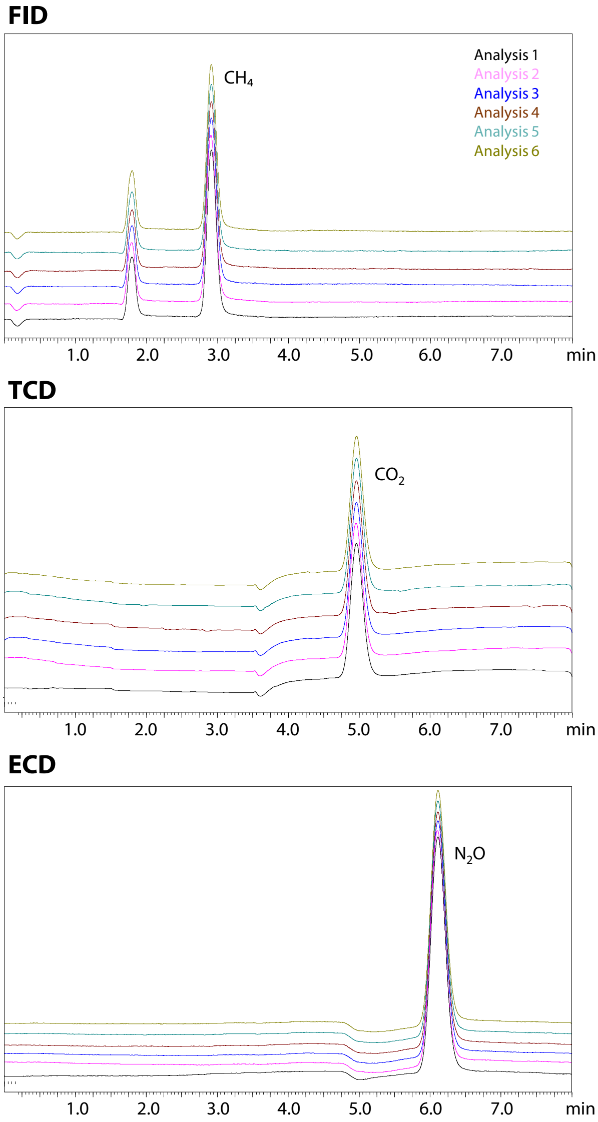

Fig. 5 Chromatograms for Atmospheric Air (Successive Analysis)

Table 2 Peak Area Repeatability and Gas Levels in Atmospheric Air (n = 6)

	CH_4	CO_2	N_2O
Peak Area Repeatability (% RSD)	0.53	0.49	0.41
Measured Level (ppm)	2.02	434	0.332

■ Conclusion

The Greenhouse Gas Analyzer can simultaneously measure 3 greenhouse gases in atmospheric air in a single analysis. Each analysis by the Greenhouse Gas Analyzer is performed in 8 minutes with an analysis cycle time of 10 minutes.

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