SHIMADZU
Excellence in Science

Application News

Gas Chromatograph Nexis™ GC-2060

Dual-line Gas Analysis Using a Nexis GC-2060 Gas Chromatograph with a GI-30 Auto Gas Injector and BID and TCD Detectors

Hikaru Inada and Natsuko Kanno

User Benefits

- The Nexis GC-2060 can be equipped with two GI-30 units, enabling automated gas analysis for two sample lines on a single GC.
- The combination of TCD and BID detectors enables analysis of a wide range of sample concentrations.
- Using the GI-30 auto gas injector enables automated gas-sample introduction with high repeatability.

■ Introduction

Gas analysis is performed across a wide range of fields, including resource and energy applications and environmental applications. Typical target analytes include inorganic gases such as H_2, N_2, CO, and CO_2, as well as light hydrocarbon gases such as CH_4. Because concentration ranges and matrices vary depending on the sample, detection sensitivity and separation performance must be optimized to meet the measurement objective.

Both BID and TCD detectors can detect all compounds except carrier gases (BID cannot detect Ne). The BID is a Shimadzu-developed detector that enables highly sensitive analysis of low-level components at the ppm level and simultaneous analysis of multiple compounds, including H_2. In contrast, the TCD provides stable analysis even at high concentrations on the order of percent, and it also has a short time from startup to analysis readiness. Using both detectors together allows a single GC system to cover a wide concentration range from low to high.

This article describes dual-line gas analysis using a Nexis GC-2060 equipped with both a BID and a TCD, combined with automated sample introduction using the GI-30 auto gas injector. By combining a BID and a TCD, samples across a broad concentration range can be measured. In addition, automated introduction of gas samples using the GI-30 improves repeatability in continuous analysis and enhances operational efficiency.

■ Dual-Line Gas Analysis Using the GI-30

The GI-30 is an auto gas injector that enables automated, continuous analysis of gas samples (Fig. 1 (right) shows a schematic diagram of the GI-30). With its highly expandable design, the Nexis GC-2060 can be equipped with two GI-30 units (Fig. 1 (left)). This enables high-throughput automated gas analysis of two sample lines on a single GC. In addition, because the injection unit, column, detector, and carrier gas can be configured independently for each line, the system can accommodate gas samples with diverse compositions and concentrations.

In this application, Line 1 was configured with an SPI/BID to provide highly sensitive detection of low-level components. The SPI is a split/splitless injection unit dedicated to gas analysis. Its high airtightness and inert deactivation of the flow path help suppress ambient air intrusion and analyte adsorption, making it effective for analyzing trace atmospheric components (e.g., N_2 and O_2) and components that tend to adsorb. In contrast, Line 2 was configured with an SPL/TCD. Using an SPL injection unit also allows liquid sample analysis and manual injection with a gas-tight syringe.

■ Analysis Conditions

A Nexis GC-2060 equipped with two GI-30 units and a BID/TCD was used to analyze gas samples from gas cylinders on two lines simultaneously. The gas samples were standard mixed gases containing H_2, O_2, N_2, CO, CH_4, CO_2, N_2O, C_2H_2, C_2H_4, and C_2H_6. On Line 1, a 10 ppm standard mixed gas balanced with He was analyzed. On Line 2, a 1000 ppm standard mixed gas balanced with He or N_2 was analyzed.

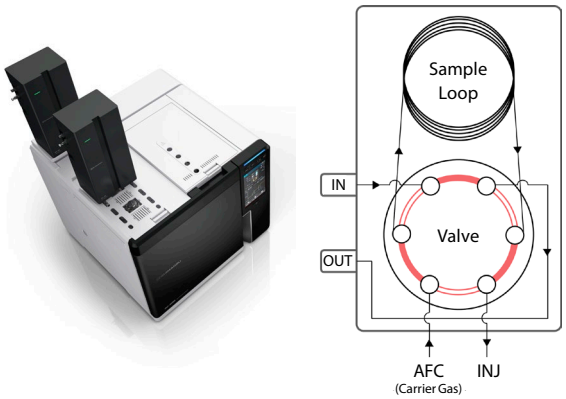

Fig. 1 Appearance of Nexis GC-2060 + Dual GI-30 Units (Left) and Schematic Diagram of the GI-30 (Right)

Table 1 Analysis Conditions

Common Conditions	
Main Unit:	Nexis GC-2060 / GI-30
Column Temp.:	35 °C (2.5 min) - 20 °C/min - 250 °C (26.75min)
<GI-30>	
Loop Volume:	1 mL

Line1 (SPI/BID) Conditions	
Injection Unit Temp.:	150 °C
Injection Mode:	Split
Split Ratio:	4.0
Carrier Gas Control:	Column Flow (7.0 mL/min)
Column:	MICROPACKED-ST (2.0 m × 1.0 mm I.D.) (input as 250 m × 0.50 mm I.D., df = 15 µm for flowrate calculation)
Det. Temp.:	260 °C
Discharge Gas Flow:	50.0 mL/min
Carrier Gas:	He

Line2 (SPL/TCD) Conditions	
Injection Unit Temp.:	150 °C
Injection Mode:	Split
Split Ratio:	4.0
Carrier Gas Control:	Column Flow (7.0 mL/min)
Column:	MICROPACKED-ST (2.0 m × 1.0 mm I.D.) (input as 250 m × 0.50 mm I.D., df = 15 µm for flowrate calculation)
Det. Temp.:	260 °C
Control Mode:	Standard
Makeup Flow:	2.0 mL/min
Reference Gas Flow:	50.0 mL/min
Carrier Gas:	For analysis other than H_2 : He For analysis H_2 : N_2, Ar

■ Dual-Line Gas Analysis Using BID and TCD

1. Features of Gas Analysis Using BID and TCD

BID

The BID (Barrier Discharge Ionization Detector; Fig. 2 (left)) is a unique detector developed by Shimadzu. It ionizes eluted components with energy from a He plasma and collects the ions with a collector. The BID offers higher sensitivity than other universal detectors and maintains stability comparable to those detectors, thanks to its proprietary barrier discharge technology. It can detect all compounds except He and Ne, making it useful in a variety of fields, including inorganic gas analysis.

A key feature of the BID is its ability to detect low-concentration components that are difficult to detect with TCD (Fig. 3). In addition, while TCD analysis of H_2 requires switching the carrier gas from He to another gas (such as N_2 or Ar), the BID enables simultaneous analysis of H_2 and other components using a He carrier gas.

TCD

The TCD (Thermal Conductivity Detector; Fig. 2 (right)) detects changes in filament temperature caused by differences in thermal conductivity between the carrier gas and the eluting components. Similar to the BID, TCD detectors are widely used for gas analysis and other applications due to their sensitivity to inorganic substances, such as H_2, CO, and CO_2, which FID detectors, the most common general-purpose detectors, are not sensitive to.

The TCD is characterized by its ability to handle high-concentration samples in the percentage range (Fig. 3). In addition, whereas the BID cannot detect He and Ne, the TCD can detect all components other than the carrier gas.

Furthermore, a new TCD model added to the lineup in 2025 adopts a single-filament (switching TCD) design, significantly shortening the stabilization time after startup compared with conventional designs. It also offers world-class sensitivity and excellent linearity, delivering high performance across a wide range of analyses.

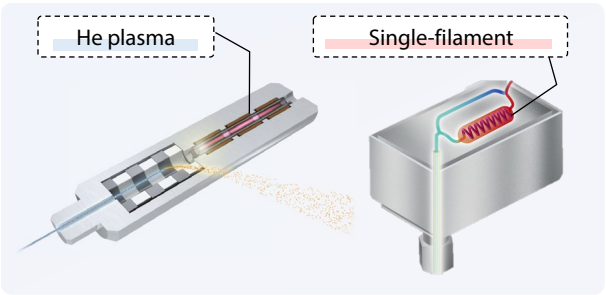

Fig. 2 Schematic Diagrams of the BID (left) and the New TCD (right)

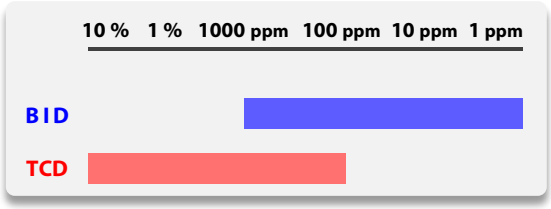

Fig. 3 Approximate Concentration Ranges Suitable for BID and TCD (Varies Depending on Compound, Analysis Conditions, and GC Model)

2. Analysis Results

First, chromatograms obtained by simultaneous analysis of standard mixed gases using He as the carrier gas on Line 1 (SPI/BID) and Line 2 (SPL/TCD) are shown in Figs. 4 and 5. With this configuration, a low-concentration sample (10 ppm, He balance) and a high-concentration sample (1000 ppm, He balance) can be measured simultaneously on a single GC.

Line 1 (SPI/BID)

Using the SPI/BID configuration, low-level components in the 10 ppm standard mixed gas were detected with high sensitivity. In addition, by using the BID, H_2 and other components can be analyzed simultaneously without switching the carrier gas from He, thereby reducing analysis time.

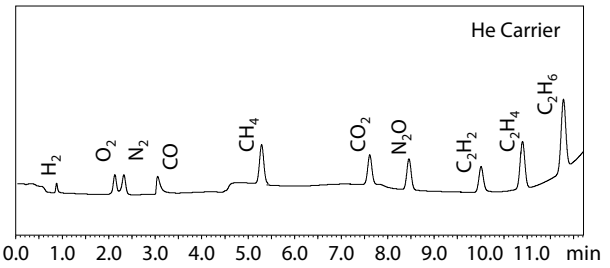

Fig. 4 Chromatogram of 10 ppm Standard Mixed Gas Obtained on Line 1 (SPI/BID)

Line 2 (SPL/TCD)

On Line 2, high-concentration gas components (1000 ppm) were analyzed using the TCD. Under He carrier conditions, H_2 was not detected; however, the other components were detected stably.

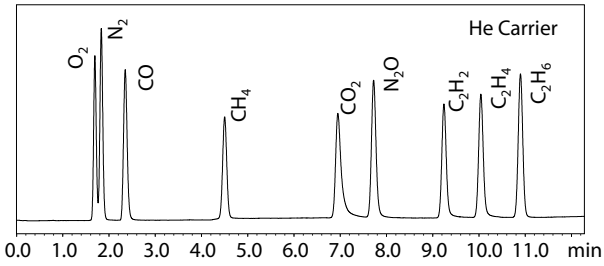

Fig. 5 Chromatogram of 1000 ppm Standard Mixed Gas Obtained on Line 2 (SPL/TCD)

■ Detection of H_2 by TCD Using N_2 and Ar Carrier Gases

Detection of H_2 by TCD Using N_2 and Ar Carrier Gases

Next, to detect H_2 by TCD, the carrier gas on Line 2 was switched to N_2 and Ar. Fig. 6 shows the chromatogram obtained when measuring a 1000 ppm standard mixed gas balanced with N_2. This confirmed that H_2 could be detected with both N_2 and Ar as the carrier gas. In addition, with Ar as the carrier gas, components other than O_2 could be detected simultaneously along with H_2 (Fig. 7).

Because the dual-line configuration allows the carrier gas and detector combinations to be changed on each line, the optimal configuration can be selected based on the sample's composition and concentration.

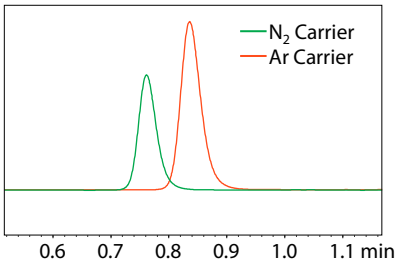

Fig. 6 Chromatogram of 1000 ppm H_2 Detected by TCD

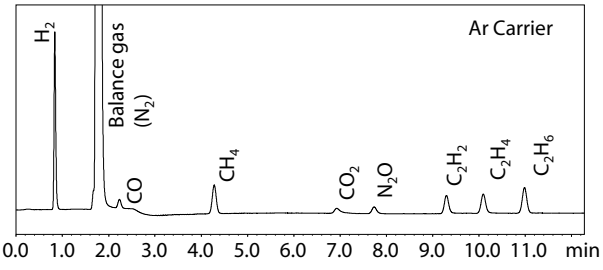

Fig. 7 Chromatogram of 1000 ppm Standard Mixed Gas Detected by TCD Using Ar as the Carrier Gas (Balance Gas: N_2)

Sensitivity Evaluation of the New TCD

The new TCD is characterized by a short time to baseline stabilization, enabling analysis immediately after startup, and by very high sensitivity. As a sensitivity evaluation in gas analysis, S/N values for each compound were calculated from measurements of the 1000 ppm standard mixed gas under He, Ar, and N_2 carrier conditions (Figs. 5, 6, and 7). The results are shown in Table 2.

Table 2 Average S/N Values for Each Component (N = 5)
(1000 ppm standard mixed gas)

	He Carrier	Ar Carrier	N_2 Carrier
H_2	—	767.81	405.76
CO	845.87	38.38	—
CH_4	572.10	125.26	—
CO_2	585.54	20.81	—
N_2O	774.33	29.31	—
C_2H_2	640.32	78.90	—
C_2H_4	690.25	83.91	—
C_2H_6	810.26	111.61	—

* Noise was calculated from the baseline between 5.5 and 6.5 min (ASTM method).

■ Repeatability with the GI-30

Automated Gas Sample Introduction with the GI-30

The GI-30 auto gas injector is a sample introduction device that automatically introduces a fixed volume of gas sample into the GC. It can be used by connecting a gas cylinder or a sample bag.

Connecting the GI-30 to a gas cylinder enables automation of gas analysis. Fig. 8 shows the workflow for continuous analysis using the GI-30. Unlike manual introduction, which requires sample injection for each analysis, automated continuous analysis with the GI-30 requires no additional steps once analysis begins, reducing the analyst's workload. Continuous analysis can be performed by creating and running a batch file on the LabSolutions™ workstation, similar to liquid injection workflows.

Because the GI-30 measures a fixed volume of gas sample into a sample loop before introducing it to the GC, it can deliver high repeatability that is difficult to achieve with manual introduction.

In addition, the GI-30 can be equipped with an optional valve purge mechanism. Purging gas through the internal valve reduces ambient air intrusion into the valve. This is effective for analyzing atmospheric components such as N_2 and O_2, as well as for measuring trace components.

The valve and sample loop are maintained at 80 °C, which helps stabilize the introduced sample volume and prevents water condensation in the sample.

Peak Area Repeatability

Using He as the carrier gas, five consecutive analyses were performed simultaneously on Line 1 (SPI/BID) and Line 2 (SPL/TCD), and peak area repeatability (%RSD) was evaluated for each component (Fig. 9 and Table 3). For both the BID and the TCD, %RSD was < 0.5 for all compounds, demonstrating excellent repeatability. These results confirm that automated gas sample introduction using the GI-30 enables highly repeatable measurements comparable to those obtained with liquid injection, which can be difficult to achieve with manual introduction.

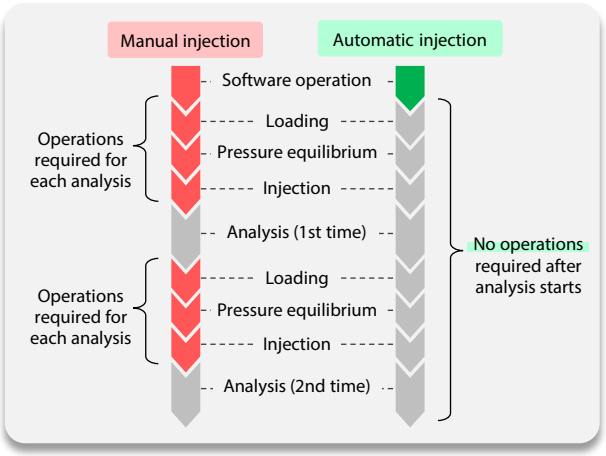

Fig. 8 Comparison of Continuous Analysis Process Flow for Manual and Automatic Injection (Colored Areas Indicate Required Operations)

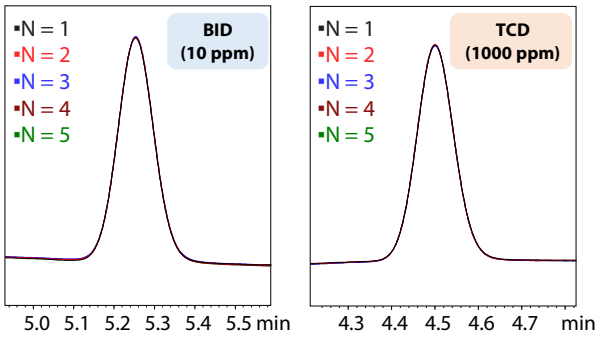

Fig. 9 Overlaid Chromatograms of CH_4 (Carrier Gas: He)

Table 3 Area Value Reproducibility for Each Component with N = 5
(Carrier Gas: He)

	Area Value Reproducibility (%RSD)	
	SPI/BID (10 ppm)	SPL/TCD (1000 ppm)
H_2	0.335	—
CO	0.417	0.153
CH_4	0.167	0.159
CO_2	0.226	0.0888
N_2O	0.0811	0.0654
C_2H_2	0.457	0.458
C_2H_4	0.131	0.395
C_2H_6	0.218	0.175

■ Conclusion

Low- and high-concentration gas samples were analyzed simultaneously on two lines using a Nexis GC-2060 equipped with two GI-30 units and a BID/TCD. By adopting a dual-line configuration with dual GI-30 units and selecting the injection unit, column, detector, and carrier gas according to the measurement objective, it is possible to expand the range of sample concentrations and compositions that can be measured. In addition, automated, continuous gas analysis using the GI-30 reduces the analyst's workload and enables highly repeatable analysis that is difficult to achieve with manual introduction.

01-01171-EN First Edition: Apr. 2026

SHIMADZU
Shimadzu Corporation
www.shimadzu.com/an/

› Please fill out the survey

Related Products Some products may be updated to newer models.

› Nexis GC-2060
Gas Chromatograph

Related Solutions

› Clean Energy

› Artificial Photosynthesis

› Environment

› Air

› Price Inquiry

› Product Inquiry

› Technical Service / Support Inquiry

› Other Inquiry