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Application News

Gas Chromatograph Brevis™ GC-2050

Gas Analysis Using a Brevis GC-2050 Gas Chromatograph with a GI-30 Auto Gas Injector and TCD and BID Detectors

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User Benefits

- The updated TCD detector has a shorter stabilization time and is suitable for analyzing high-concentration components.
- Shimadzu's unique BID detector can simultaneously analyze principal compounds including H_2 and also detect low-concentration components.
- The combination of TCD and BID detectors allows for analyzing a wide range of sample concentrations.
- The newly introduced GI-30 automatic gas injector enables automatic and reproducible analysis of gas samples.

■ Introduction

GC is used to analyze gases in a wide range of fields, such as natural resources/energy and environmental testing. Typical components analyzed include inorganic gases like H_2, CO, and CO_2, and lower hydrocarbons starting with CH_4. When analyzing these components with GC, either the TCD or BID detector can be selected as the detector.

Both TCD and BID detectors can detect all compounds except for carrier gases (the BID cannot detect Ne). TCD detectors are characterized by their ability to analyze high-concentration components reliably and its short stabilization time. In contrast, BID detectors are unique detectors, only offered by Shimadzu, that can detect low-concentration components that are difficult to detect with TCD detectors and can simultaneously analyze a variety of compounds including H_2.

This article describes using a Brevis GC-2050 system equipped with TCD and BID detectors to analyze gases with a GI-30 automatic gas injector. Using the GI-30, gas samples can be automatically injected into the GC unit, enabling reproducible continuous analysis. In addition, since the GI-30 can be used in conjunction with an AOC-30 series autoinjector or other units, gas samples and liquid samples can be efficiently analyzed with a single GC unit. This article also examines the analysis process flow and reproducibility when using the GI-30.

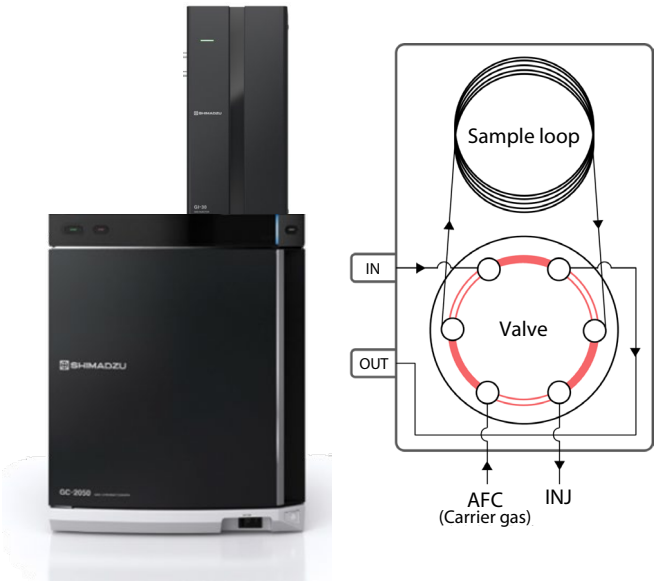

Fig. 1 (Left) Appearance of Brevis™ GC-2050 + GI-30 System
(Right) Schematic diagram of GI-30

■ Analysis Conditions

A Brevis GC-2050 gas chromatograph equipped with TCD and BID detectors was used to analyze gas samples obtained from gas cylinders. The gas samples were injected into the GC unit using a GI-30 automatic gas injector (P/N: S221-89755-41). Fig. 1 shows the equipment configuration and the schematic diagram of the GI-30 flow path. The analysis conditions used are indicated in Table 1.

Table 1 Analysis Conditions

Common Conditions		
Model	:	Brevis GC-2050 + GI-30
Inj. Mode	:	Split 4
Inj. Temp.	:	150 °C
Flow Mode	:	Column Flow (7.0 mL/min)
Purge Gas	:	3.0 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)
Oven Temp.	:	35 °C (2.5 min) – 20 °C/min – 250 °C (26.75 min)

TCD Conditions		
Detector Temp.	:	260 °C
Control Mode	:	Standard
Makeup Gas	:	2.0 mL/min
Reference Gas	:	50.0 mL/min
Carrier Gas	:	For analysis other than H_2 : He For H_2 analysis : N_2

BID Conditions		
Detector Temp.	:	260 °C
Discharge Gas	:	50 mL/min
Carrier Gas	:	He

GI-30 Conditions		
Loop Volume	:	1 mL
Purge Gas	:	20 kPa (Gas species is the same as the carrier gas)

■ Analysis Using TCD Detector

1. Overview

The TCD (thermal conductivity detector, Fig. 2) measures the temperature change of the filament due to the difference in thermal conductivity between the carrier gas and the eluted components. TCD detectors are widely used for gas analysis and other purposes due to their sensitivity to inorganic compounds, such as H_2, CO, and CO_2, to which FID detectors, the most commonly used universal detector, are not sensitive.

TCD detectors are characterized by their ability to analyze high-concentration components with concentrations up to the percentage level (Fig. 3). Additionally, while BID detectors cannot detect He and Ne, TCD detectors can detect all components except the carrier gas.

Furthermore, the new TCD model added to the lineup in 2025 has improved stability due to an updated single-filament system (switching TCD). The time required to start analysis after detector activation has been shortened, allowing analysis to begin without long waiting times after starting the GC unit.

2. Analysis Results

Gas samples were analyzed using the TCD detector in the Brevis GC-2050 system. In this analysis, He balance gas samples were used for components other than H_2, and N_2 balance gas samples were used for H_2 analysis. The chromatograms obtained are shown in Fig. 4.

Additionally, the updated TCD stabilized the baseline quickly after filament activation, allowing analysis to begin without long waiting times after startup.

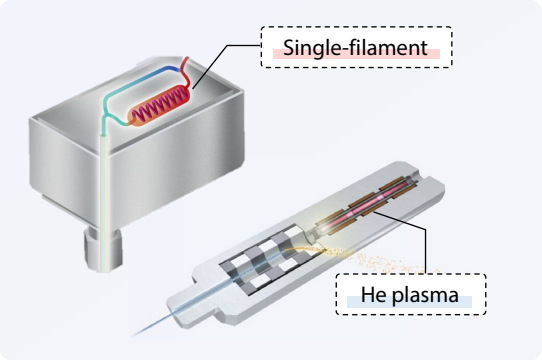

Fig. 2 (Left) Schematic Diagram of New TCD
(Right) Schematic Diagram of BID

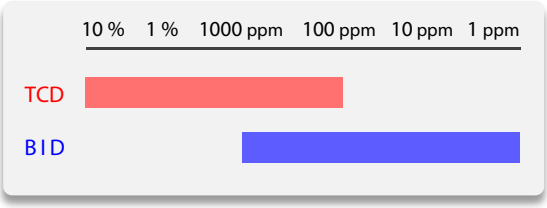

Fig. 3 Approximate Concentration Ranges Suitable for TCD and BID Detectors
(Varies Depending on Compound, Analysis Conditions, and GC Model)

■ Analysis Using BID

1. Overview

The BID (barrier discharge ionization detector, Fig. 2) is a unique detector from Shimadzu that detects components by ionizing eluted components with energy emitted from a He plasma and collecting the ions at the collector. The BID offers higher sensitivity than other universal detectors and maintains stability that is comparable to other universal detectors, due to its unique barrier discharge technology. Similar to the TCD, it can detect all compounds except He and Ne, making it useful in a variety of fields, including inorganic gas analysis.

A key characteristic of the BID is its ability to detect low-concentration components that are difficult to detect with TCD detectors (Fig. 3). Additionally, while TCD detectors require changing the carrier gas to a gas other than He (such as N_2 or Ar) for H_2 analysis, the BID allows simultaneous analysis of H_2 and other components using He as the carrier gas.

2. Analysis Results

Gas samples were analyzed using the BID detector installed in the Brevis GC-2050 system. In this example, He balance gas samples were used. The chromatograms obtained are shown in Fig. 5.

As shown in Fig. 5, even low-concentration components at 10 ppm were detected with sufficient sensitivity. Furthermore, the BID allowed simultaneous analysis of H_2 and other components without switching the He carrier gas, which reduces the time required for analysis.

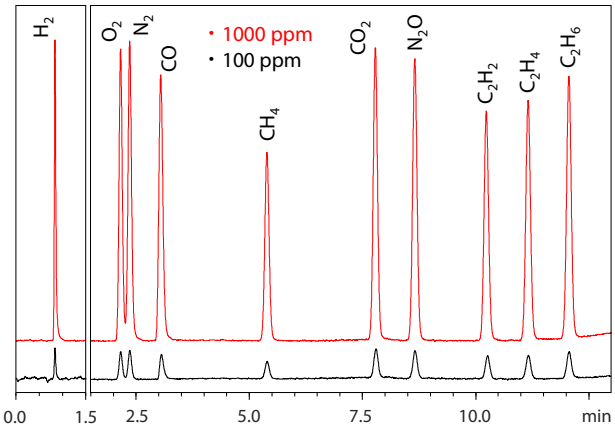

Fig. 4 Chromatograms of Respective Compounds Analyzed with the TCD
(Left: N_2 Carrier Gas, Right: He Carrier Gas)

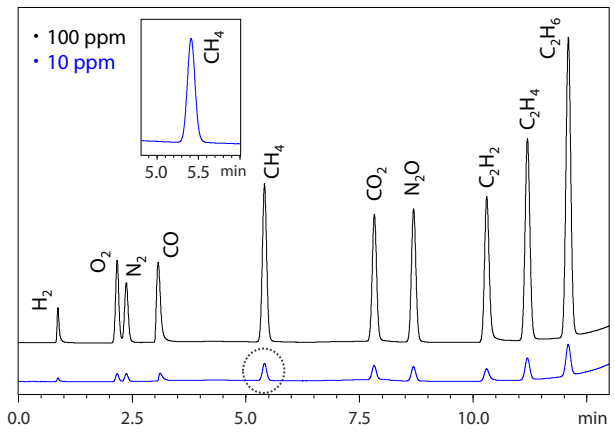

Fig. 5 Chromatograms of Each Compound Analyzed with the BID
(Inset: Chromatogram Enlargement of 10 ppm CH_4)

■ Sample Injection Using GI-30

1. Overview

The GI-30 automatic gas injector (Fig. 1) is a preprocessing device that automatically injects a fixed amount of gas samples into the GC unit. It can be used connected to a gas cylinder or sample bag.

Connecting the GI-30 to a gas cylinder enables automation of gas analysis. Fig. 6 shows the flow of gas samples when using a GI-30 for continuous analysis. Unlike manual injection, which requires sample injection operations for each analysis, automatic continuous analysis using the GI-30 requires no operations after the analysis starts, which reduces the burden on analysts. Continuous analysis can be performed by executing batch files created in the LabSolutions™ workstation, similar to liquid injection.

Additionally, the GI-30 achieves high reproducibility, which is difficult to achieve with manual injection, by measuring a fixed amount of gas sample into the sample loop and injecting it into the GC.

Moreover, the GI-30 is equipped with a valve purge mechanism (optional), which reduces the amount of air entering the valve by purging the valve interior with gas. That is useful when analyzing compounds present in the atmosphere, such as N_2 and O_2, or when analyzing trace components.

The valve and sample loop are kept at 80°C to ensure a stable sample injection amount and prevent the condensation of moisture in the samples.

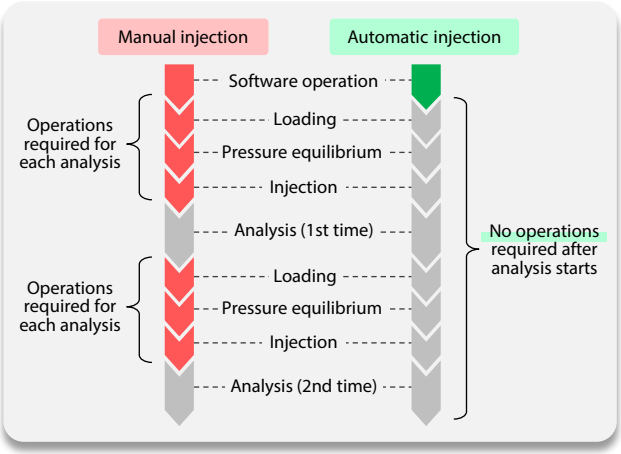

Fig. 6 Comparison of Continuous Analysis Process Flow for Manual and Automatic Injection (Colored Areas Indicate Required Operations)

2. Reproducibility Using GI-30

Batch files were created in LabSolutions for continuous GI-30 analysis using TCD and BID detectors. Gas samples of 1000 ppm for TCD analysis and 10 ppm for BID analysis were used to confirm the reproducibility of area values during five successive analyses.

Fig. 7 shows the chromatograms from the successive analyses of CH_4 in the gas samples and Table 2 shows the area value reproducibility (%RSD) for each component. The %RSD range for area values was 0.258 to 0.552 for the TCD detector and 0.0961 to 0.392 for the BID detector, confirming high reproducibility comparable to liquid injection, which is difficult to achieve with manual injection.

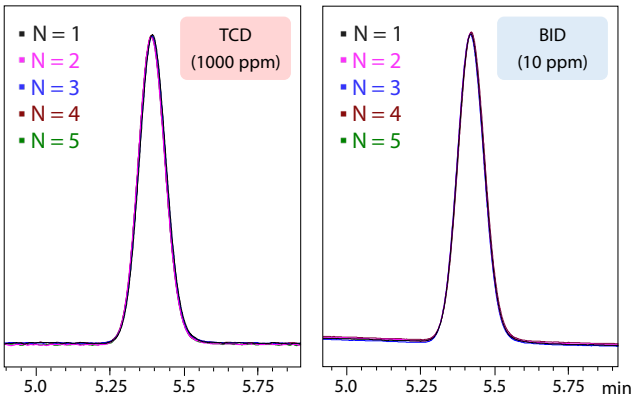

Fig. 7 Overlaid Chromatograms of CH_4 (Carrier Gas: He)

Table 2 Area Value Reproducibility for Each Component with N = 5 (Carrier Gas: He)

	Area Value Reproducibility (%RSD)	
	TCD (1000 ppm)	BID (10 ppm)
CO	0.445	0.268
CH_4	0.258	0.220
CO_2	0.497	0.178
N_2O	0.410	0.142
C_2H_2	0.330	0.392
C_2H_4	0.552	0.171
C_2H_6	0.443	0.0961

■ Conclusion

TCD and BID detectors, which can be installed in Brevis GC-2050 systems, are both effective detectors for gas analysis. TCD detectors can analyze high-concentration components and is characterized by a short stabilization time. BID detectors can detect trace components that are difficult to detect with a TCD detector and allow simultaneous analysis including H_2.

Additionally, the newly released GI-30 model not only reduces the burden on analysts through automatic continuous gas analysis but also enables highly reproducible analysis, which is difficult to achieve with manual injection.

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