

Application Data Sheet

No. 16

GC

Gas Chromatograph

Analysis of Insulation Gas SF₆ by the GC-BID System

Sulfur hexafluoride (SF₆) gas has superior insulation properties and is highly stable. For this reason, it is used as the insulation in gas-insulated transformers, breakers, and other electrical equipment. Moreover, as a tracer gas, it is widely used in a variety of fields. On the other hand, SF₆ is known to be a highly significant greenhouse effect gas, and has been targeted for emissions control by the COP3 Kyoto Protocol.

Conventional methods specify analyzing SF₆ using an ECD detector, which is capable of the highly sensitive detection of electrophilic compounds. However, this method results in some unresolved issues, such as the accuracy of quantitation in high concentration ranges and the fact that radioisotopes need to be used, which involves tedious and complicated procedural work. With a barrier ionization discharge detector (BID), the highly sensitive detection of a wide range of components is possible^{*1}. This detector offers both the stability and high sensitivity of conventional general-purpose detectors by incorporating unique barrier ionization discharge technology.

This data sheet introduces an example of the analysis of SF₆ using a highly sensitive Shimadzu Tracera gas chromatograph equipped with a BID.

^{*1} Helium and neon cannot be detected.

Analysis Results

SF₆ is a powerful greenhouse effect gas, so its release into the atmosphere needs to be prevented. For this reason, there are many instances when SF₆ needs to be analyzed, such as when testing for leaks of the insulation gas contained in electrical equipment, or when testing for trace amounts of residual SF₆ after a gas recovery procedure. The following shows the results of the analysis of atmospheric SF₆ using a BID.

0.1 ppm of SF₆ could be detected (S/N=24^{*2}) and good linearity was obtained within the range from 0.1 to 50 ppm.

^{*2} Noise was calculated from the baseline of 0.5 to 1.5 min.

Table 1: Analysis Conditions (Analysis of Trace Amounts of SF₆ in Atmosphere)

Model:	Tracera (GC-2010 Plus + BID-2010 Plus) + SPLITTER INJ	Inj. Temp.:	150 °C
Column:	Rt-Msieve 5A (0.53 mm I.D. × 30 m, d.f.50 μm)	Det. Temp.:	280 °C
Column Temp.:	35 °C (2.5 min) – 20 °C /min – 250 °C (0 min) – 15 °C /min – 270 °C (3.42 min)	Inj. Method:	Split (1:7)
Carrier gas:	He, 45 cm/sec (Constant Linear Velocity Mode)	Inj. Volume:	3 mL (MGS-2010)

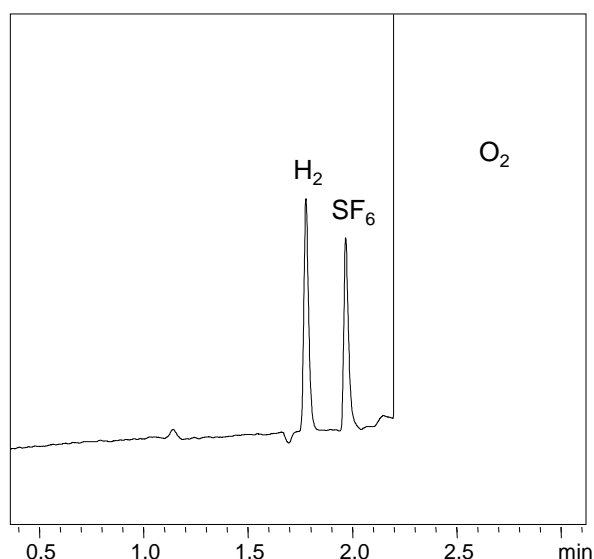


Fig. 1: Chromatogram of Trace Amounts of SF₆ (0.1 ppm) in Atmosphere

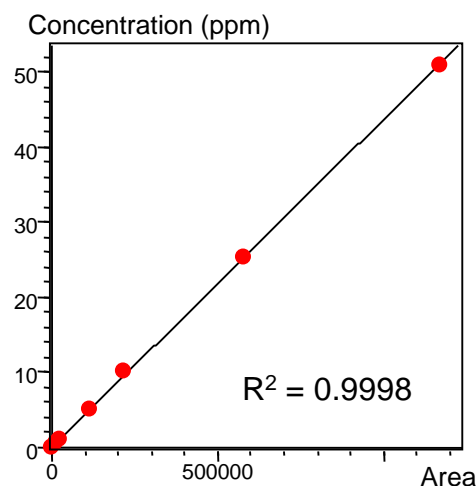
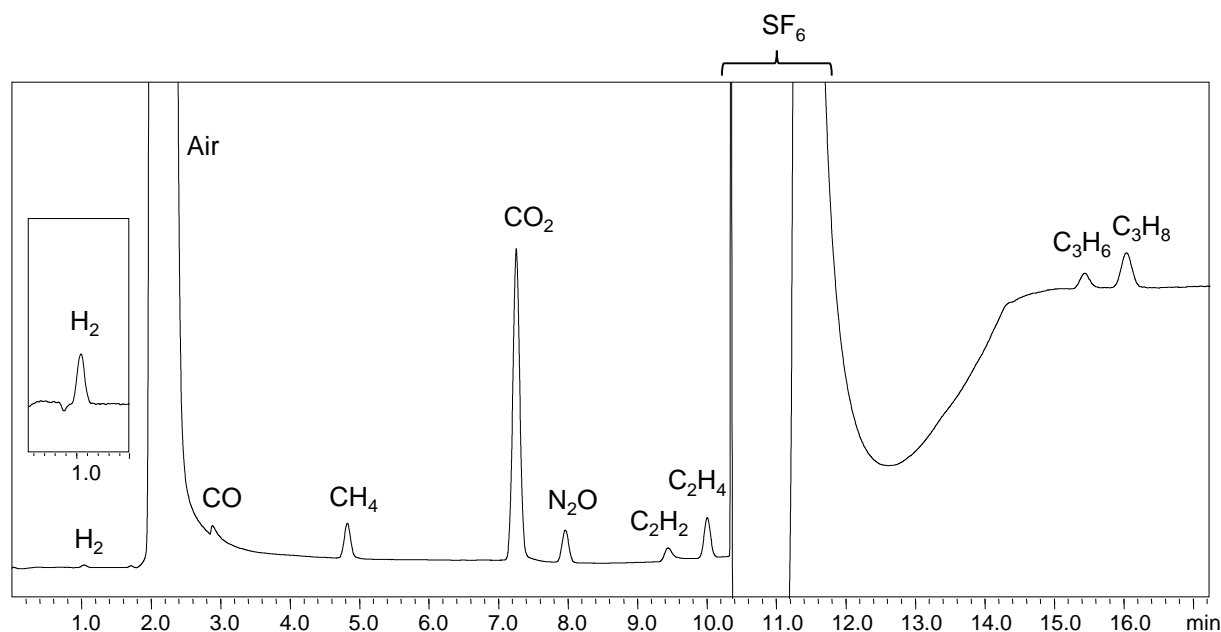


Fig. 2: Linearity of SF₆ in Atmosphere (0.1 to 50 ppm)

SF₆ is used as the insulation gas in a variety of electrical equipment. For this reason, determination of its purity is demanded for quality control purposes to ensure it maintains its insulation capabilities, or during the recovery process. The results of the analysis of impurities in SF₆ using BID is shown in the following. Even though SF₆, the primary component, was at saturation status, it was possible to perform a highly sensitive simultaneous analysis of impurities, including inorganic gases and lower hydrocarbons, without producing a negative impact on the quantitation accuracy relative to surrounding components.

Table 2: Analysis Conditions (Analysis of Impurities in SF₆)

Model:	Tracera (GC-2010 Plus + BID-2010 Plus) + SPLITTER INJ	Inj. Temp.:	150 °C
Column:	Micropacked ST(1 mm I.D. × 2 m)* ³	Det. Temp.:	280 °C
Column Temp.:	35 °C (2.5 min) - 20 °C /min - 250 °C (0 min) - 15 °C /min - 265 °C (3 min)	Inj. Method:	Split (1:4)
Carrier gas:	He, 226.8 kPa (2.5 min) – 15 kPa/min – 400 kPa (3.2 min) (Pressure Mode)	Inj. Volume:	3 mL (MGS-2010)



Concentrations of Impurity Components

H ₂ : 0.9 ppm	CH ₄ : 1.7 ppm	C ₂ H ₂ : 2.4 ppm	C ₃ H ₈ : 1.0 ppm
Air: 11460 ppm	CO ₂ : 21 ppm	C ₂ H ₄ : 1.4 ppm	
CO: 0.9 ppm	N ₂ O: 2.0 ppm	C ₃ H ₆ : 1.0 ppm	

*3 With conditions using this column, there is an overlap of ethane (C₂H₆) with SF₆

Fig. 3: Chromatogram Resulting from the Analysis of Impurities in SF₆

Instruments Used

Gas Chromatograph	Tracera (GC-2010 Plus + BID-2010 Plus)
Injection Port Unit	SPLITTER INJ* ⁴
Gas Sampler	MGS-2010
Software	LabSolutions LC/GC

*4 This unit is specialized for the analysis of trace components in gas, while preventing the intrusion of atmospheric components.

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