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Application News

No. G328A

Gas Chromatography

Comparison of Separation Performance with Various Carrier Gases and Introduction of Gas Selector

Various carrier gases are used in gas chromatography, including He, N_2 and H_2. In particular, the most frequently used is He, but alternative carrier gases have also been in demand in response to recent He supply shortages and a subsequent sharp price increase. When switching to an alternative carrier gas, it is necessary to select a carrier gas according to a critical separation required in analysis as separation performance depends on the type of carrier gas. In this article, a Grob test mix was analyzed with three types of carrier gases (i.e. He, N_2 and H_2). In addition, separation performance was investigated with each carrier gas at various linear velocities.

The gas selector is shown in Fig. 1 (an optional part for Nexis™ GC-2030, P/N: S221-84916-41). It makes it possible to switch two types of carrier gases from LabSolutions™ without changing the gas lines.

Y. Nagao, T. Ishii

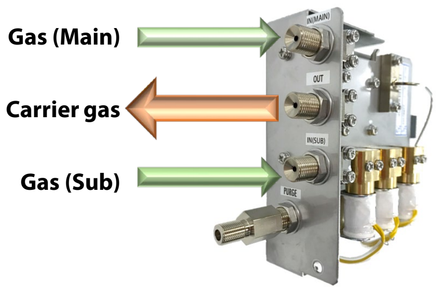

Fig. 1 Gas Selector

Carrier Gas Switching Utilizing LabSolutions

Carrier gas switching is programmable on Shimadzu LabSolutions GC and the remaining time for the completion of carrier gas switching process is shown on the software as it proceeds. Although the carrier gas switching time depends on instrument configurations, a switching commonly takes place in about 10 to 15 mins in GC-FID.

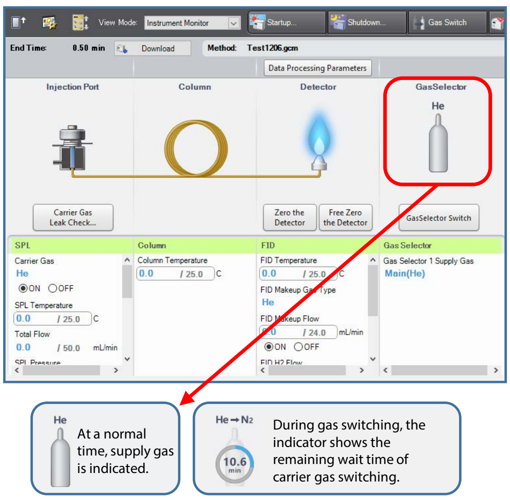

Fig. 2 Carrier Gas Switching Function in LabSolutions

Analysis Conditions

Table 1 shows the GC instrument configurations and the analysis conditions used in this experiment. The composition of the Grob test mix is listed in Table 2.

Table 1 Analysis Conditions

Model	: Nexis GC-2030 / AOC-20i Plus
Injection volume	: 0.5 µL
Injection temp.	: 260 °C
Injection mode	: Split
Split ratio	: 1:39
Carrier gas	: H_2 / He / N_2
Carrier gas control	: Linear velocity (20, 30, 40, 50 cm/s)
Column	: SH-PolarWax (30 m × 0.25 mm I.D., d.f. = 0.50 µm) *1
Column temp.	: 70 °C (2 min) - 20 °C /min -180 °C - 5 °C /min - 200 °C (15 min)
Detector	: Hydrogen gas flame ionization detector (FID)
Detector temp.	: 260 °C
Detector gas	: H_2 32.0 mL/min, Air 200 mL/min
Makeup gas	: When using H_2 /N_2 carrier gas N_2 (24 mL/min)
	: When using He carrier gas He (24 mL/min)

*1 P/N: 227-36248-01

Table 2 Composition of Grob Test Mix (10 ppm each)

1.	Decane
2.	Nonanal
3.	Octanol
4.	2,3-Butanediol
5.	Dicyclohexylamine
6.	Methyllaurate
7.	Xylidine
8.	2,6-Dimethylphenol
9.	2-Ethylhexanoicacid

in Hexanes

Comparison of Chromatograms

The linear velocity of the carrier gas is one of the key parameters affecting peak separation in gas chromatography.

Separation performance was first examined with He as a carrier gas at various linear velocities (Fig. 3). Secondly, separation performance with N_2 and H_2 carrier gases was obtained and compared to that of He with all carrier gases at the linear velocity of 30 cm/s (Fig. 4).

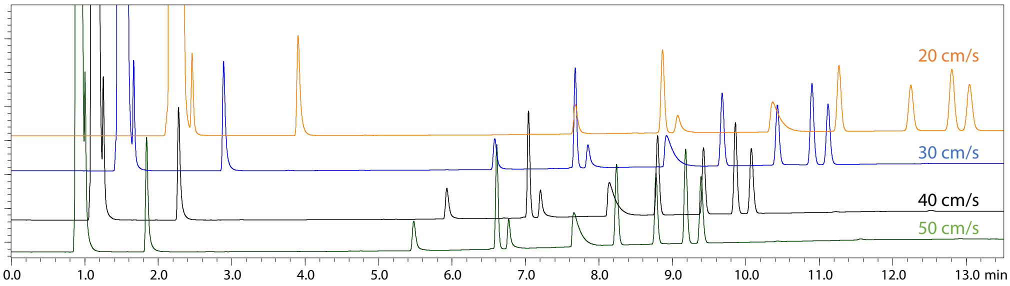

Fig. 3 Comparison of Chromatograms of Grob Test Mix with He Carrier at Different Linear Velocities

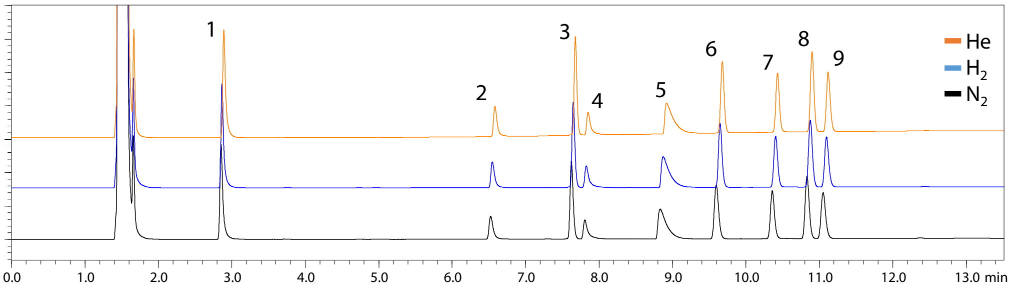

Fig. 4 Comparison of Chromatograms of Grob Test Mix at Constant Linear Velocity of 30 cm/s and Different Carrier Gases

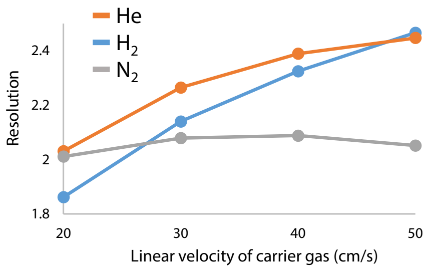

Fig. 5 Relationship Between Linear Velocity and Resolution

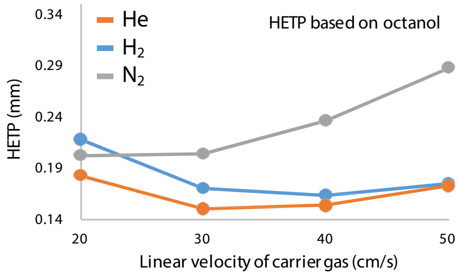

Fig. 6 Relationship Between Linear Velocity and Height Equivalent to Theoretical Plate (HETP)

Relationship Between Linear Velocity and Resolution

Fig. 5 shows the relationship between the linear velocity of the carrier gas and the resolution for octanol and 2,3-butanediol. He and H_2 carrier gases displayed better separation than N_2 carrier gas did at linear velocities of > 30 cm/s. Between H_2 and He, the former showed higher resolution than the latter at 50 cm/s.

Relationship Between Linear Velocity and HETP

Fig. 6 shows the relationship between the linear velocity of the carrier gas and the height equivalent to a theoretical plate (HETP). HETP is a parameter for the separation efficiency of a column and the lower the value of HETP, the higher the separation efficiency. Here, it can be understood that HETP depends on the combination of the carrier gas type and its linear velocity. High column efficiency was achieved with N_2 at the linear velocity of 20 cm/s while with He and H_2 at 30 to 50 cm/s.

Conclusion

In gas chromatography, the optimum linear velocity for separation depends on the type of carrier gas. N_2 is a safe and inexpensive choice, but rather unsuitable for analyses that require high resolution. H_2 is inexpensive and suitable for high speed analyses, but care must be taken when handling due to its high inflammability. Hydrogen sensor (P/N: S221-78910-41) to monitor H_2 concentration in the column oven is available.

He consumption can be effectively reduced by switching to an alternative carrier gas according to the needs of an analysis. For instance, N_2 is used for low cost analyses in which high separation is not required while H_2 is used when high separation/high speed analysis is called for.

In addition, a carrier gas can be switched by a gas selector automatically even within a batch run. With this gas selector, a range of analyses can be run automatically with each analysis matched with the most suitable carrier gas with regards to its required separation performance.

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