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# Shimadzu's Recommendations for Dealing with Current Helium Gas Shortage

Shimadzu Corporation
GC/TA Business Unit, Analysis & Measurement Division
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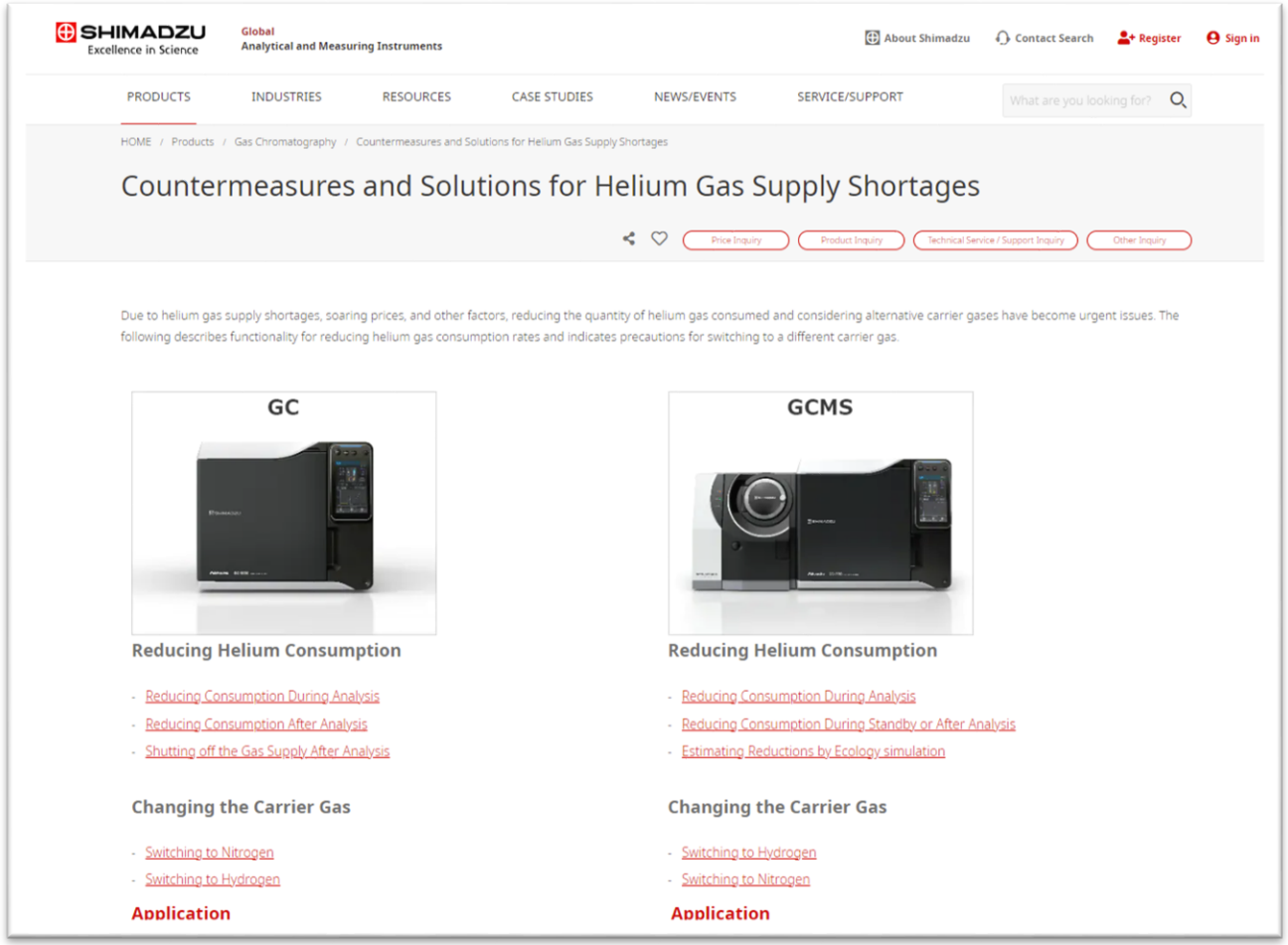
# Introduction




Because of the challenges seen by our customers, we have created a dedicated page for Countermeasures and Solutions for Helium Gas Supply Shortages

Please scan the above QR code to be taken to the webpage seen here.

# Introduction



## Is your system compatible with alternative carrier gases?

Check your instrument with the alternative carrier gas compatibility table

He Carrier Required

Alternative Carriers Available

### Reducing He Consumption

We have several solutions available.
Please refer to this document for details

### Changing the Carrier Gas

H2 N2

Please check the alternative carrier gases that can be used with your equipment again.

# Introduction

## Alternative carrier gas compatibility table

| GC Main Unit | Nitrogen | Hydrogen |
|---|---|---|
| Nexis GC-2030 | ✓ | ✓ |
| GC-2014 | ✓ | ✓ |
| GC-2025 | ✓ | ✓ |
| GC -2010 Series | ✓ | ✓ |
| GC -8 Series | ✓ | - |
| GC -14 Series | ✓ | - |
| GC -17 Series | ✓ | - |

| GC Options | Nitrogen | Hydrogen |
|---|---|---|
| AOC-30/20 | ✓ | ✓ |
| AOC-6000/5000 | ✓ | ✓ |
| HS -20 Series | ✓ | ✓ |
| HS-10 | ✓ | ✓ |
| TD-30/20 | ✓ | - |
| Aqua PT6000/PT7000 | ✓ | - |
| PY-3030D/PY-2020iD | ✓ | - |

| GC Detector | Nitrogen | Hydrogen |
|---|---|---|
| FID (packed) | ✓ | ✓ |
| FID (Capillary) | ✓ | ✓ |
| TCD (packed/capillary) | ✓ | ✓ |
| FPD (packed) | ✓ | - |
| FPD (Capillary) | ✓ | ✓ |
| ECD (packed) | ✓ | - |
| ECD (Capillary) | ✓ | ✓ |
| FTD (packed/capillary) | - | - |
| BID | - | - |
| SCD | ✓ | - |

**In order to use an alternative carrier, your “GC Main unit”, ”Options”, and “Detector” must all be compatible. There are also other precautions and limitations. Please refer to the "Changing the Carrier Gas" session for details.**

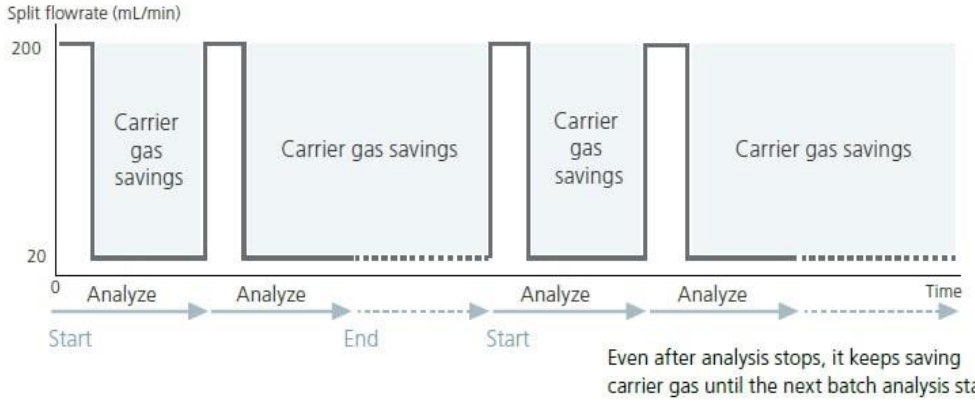
**Additional notes:**
・GC-8, 14, and 17 are not designed to be safe for use with hydrogen.
・Ar carriers have been used as substitutes for nitrogen in TCD detectors. For other detectors, substitution with nitrogen and hydrogen is recommended.

# Reducing Helium Consumption

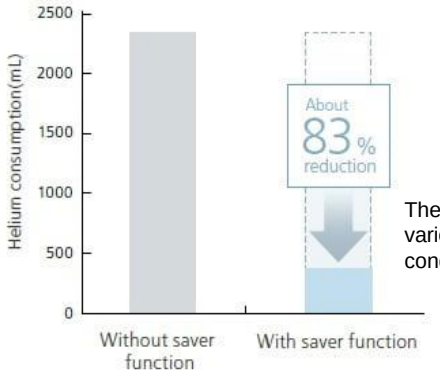
## Reducing Consumption During Analysis

### Carrier gas saving function

Shimadzu GC is equipped with a carrier gas saver mode that changes the split ratio after introducing a sample to the column to reduce gas consumption.
**This mode is standard on the Nexis GC-2030, GC-2014, GC-2025 and GC-2010 series.**



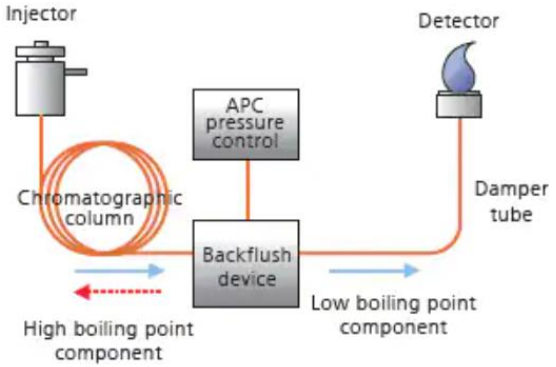

Even after analysis stops, it keeps saving carrier gas until the next batch analysis starts.



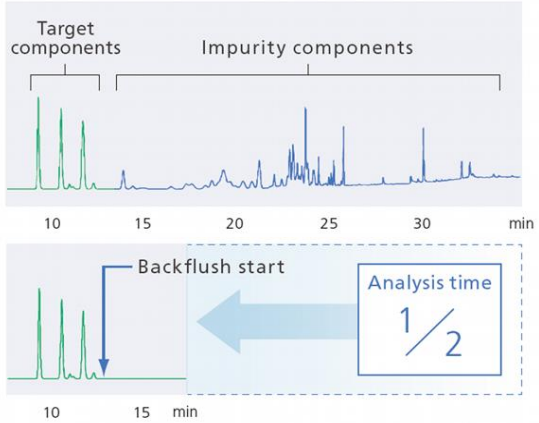

The amount of reduction varies depending on the conditions.

### Backflush function

Backflush function reduces carrier gas consumption by significantly shorten the analysis time.
**This is an option for Nexis GC-2030 and GC-2010 series.**




Schematic diagram of backflush system



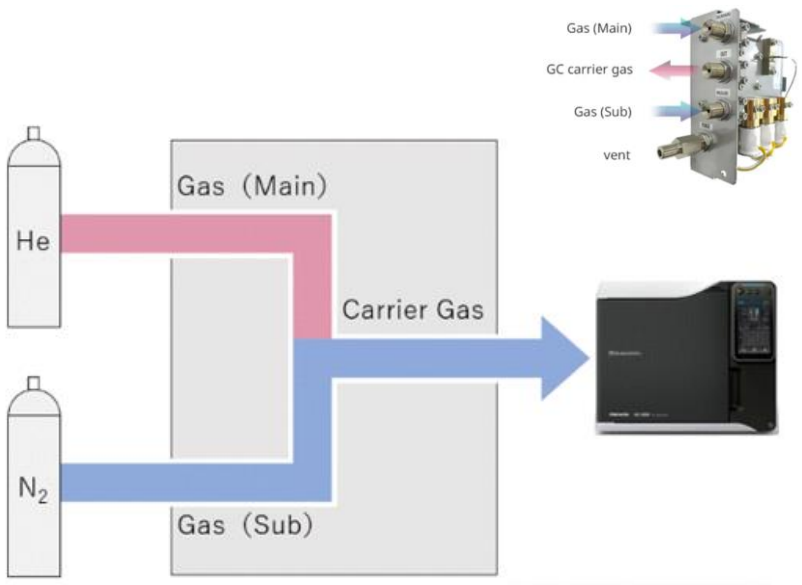
# Reducing Helium Consumption

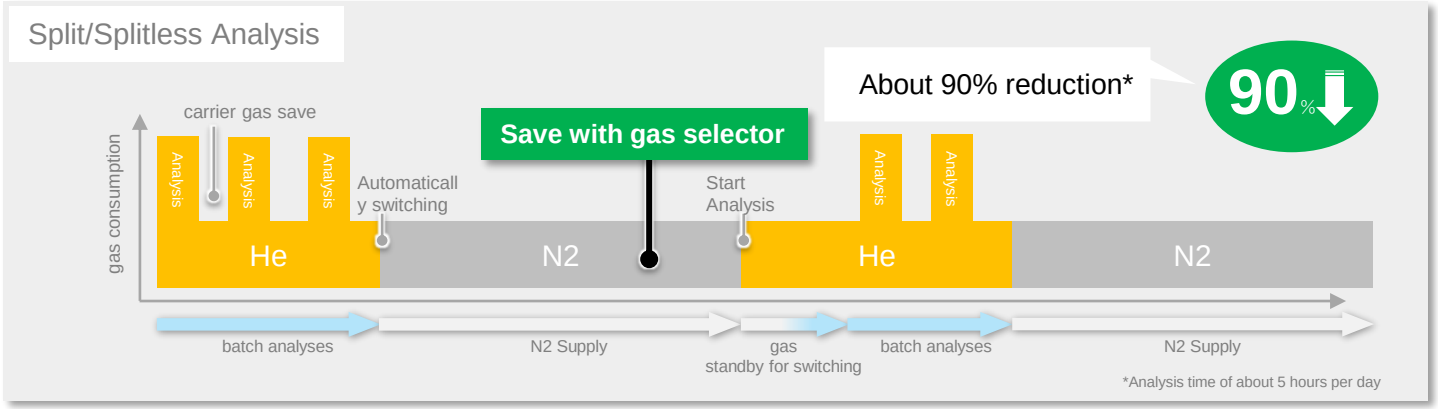
## Reducing Consumption After Analysis

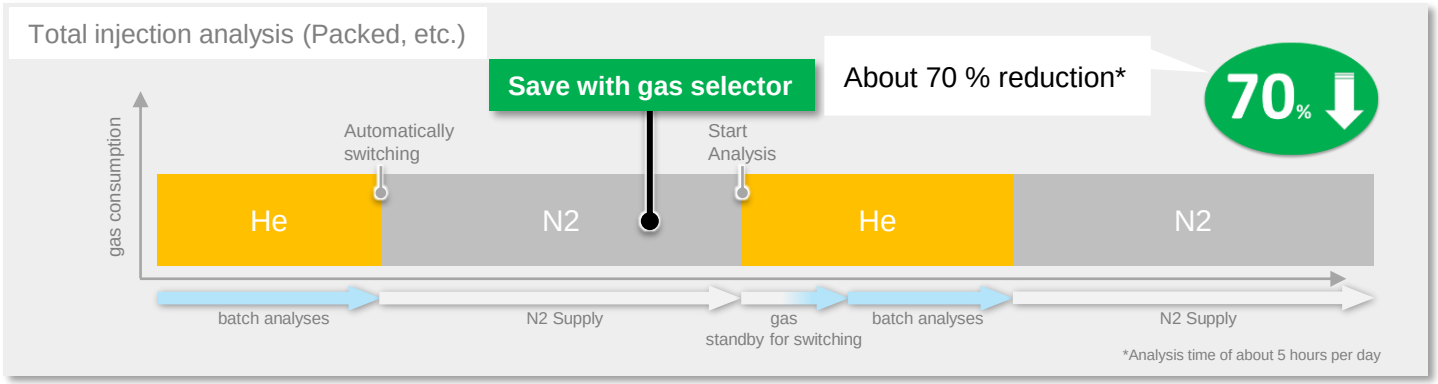
### Gas Selector

**This is a dedicated option for Nexis GC-2030 and GCMS-NX series.**

If the Nexis GC-2030 system is equipped with a gas selector, it can automatically switch to an alternative gas after analysis to save a significant amount of He consumption. (A manual gas switching valve is also available for conventional models.)



# Reducing Helium Consumption

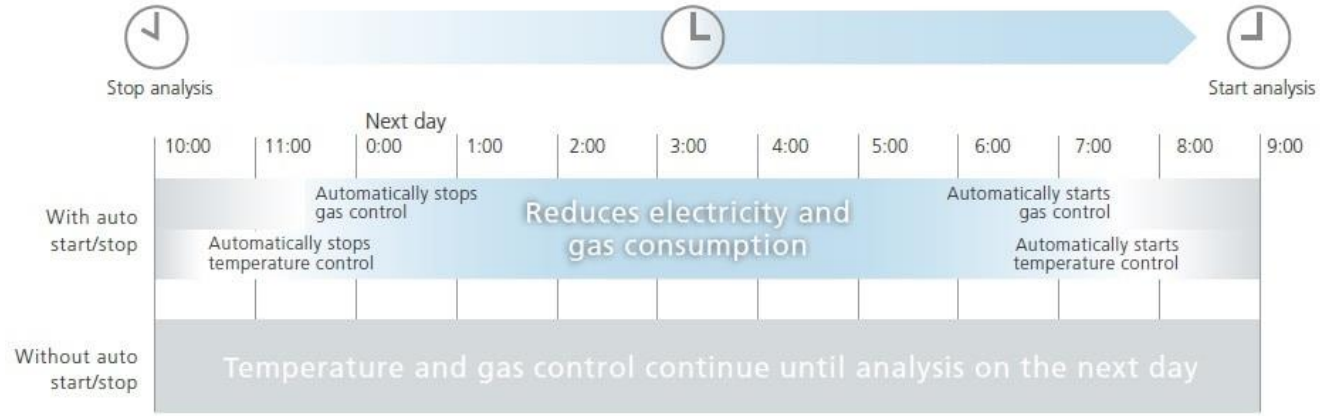
## Shutting off the Gas Supply After Analysis

### Automatic start/stop

GC system can be scheduled to automatically startup and shutdown. Prevents waste of helium when not analyzing sample.

**This feature is included with LabSolutions GC and GCsolution.**

**This feature is standard on Nexis GC-2030, GC-2014, GC-2025, and GC-2010 series.**

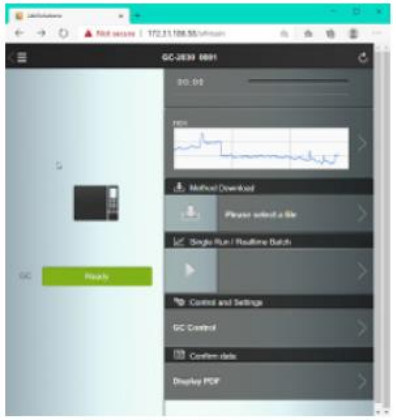



### Remote start/stop

The LabSolutions Direct feature allows you to start and stop equipment remotely.

**This feature is included with LabSolutions GC and GCsolution.**

**This feature is standard on Nexis GC-2030, GC-2014, GC-2025, and GC-2010 series.**



# Reducing Helium Consumption

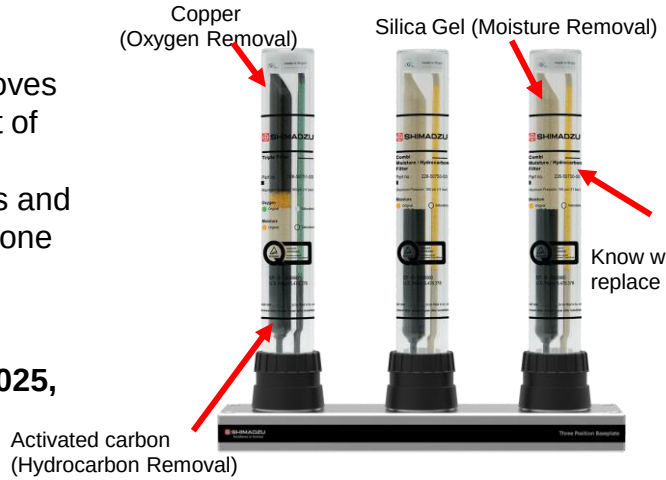


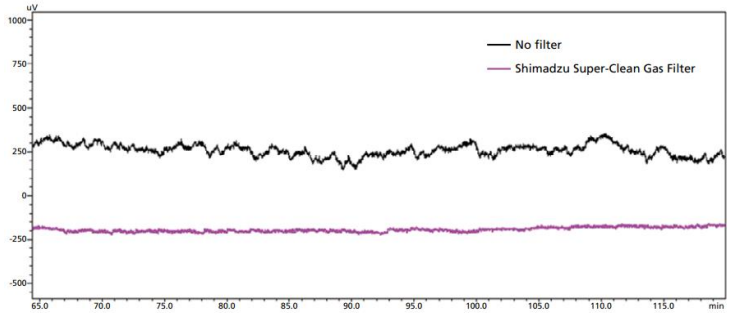
## Utilization of correct purity is key

### Shimadzu Super Clean Gas Filter

The Shimadzu Super Clean gas filter adsorbs and removes impurities from the feed gas and purifies it to equivalent of 99.9999% purity.
It is more effective to use a gas filter for both carrier gas and detector gas. (The recommended replacement cycle is one year.)

**This is an option for Nexis GC-2030, GC-2014, GC-2025, and GC-2010 series.**




Using the Shimadzu Super-Clean Gas Filter results in significantly lower detector noise.

### Helium Purifier

This is effective for detectors that require high purity helium, such as BID detectors.

For example, if there are 10 ppm impurities in the carrier gas (helium purity 99.999%), the helium purifier can be used to remove the impurity concentration to 10 ppb or less.

**This is an option for Nexis GC-2030, GC-2014, GC-2025, and GC-2010 series.**
**A power supply is required for use.**

# Changing the Carrier Gas

- **There are alternate options for helium as a carrier gas**
  - ✓ Hydrogen
  - ✓ Nitrogen
  - ✓ Argon (in some situations)
- **Based on selected, there may be additional considerations that need to be taken prior to use.**
- **Keep in mind, your laboratory needs and safety requirements when choosing an alternative gas!**

**Hydrogen is a flammable gas and is not right for every lab.**
**Please remember to take precautions when utilizing hydrogen gas with any instrument.**
**Please refer to the Safety Instructions which is shipped with the Instrument.**

# Changing the Carrier Gas



## Comparison table of nitrogen and hydrogen

In the case of a device configuration in which both nitrogen and hydrogen can be used as alternative carrier gases, consider the following advantages and disadvantages when choosing a carrier gas.

**The two gases differ mainly in terms of "separation characteristics" and "safety".**

| | Nitrogen | Hydrogen |
|---|---|---|
| Advantage | ◆ **No safety concerns** compared to hydrogen.<br>◆ It's often cheaper than hydrogen. | ◆ As the separation ability is superior to that of nitrogen, the analysis speed can be increased.<br>◆ Because the separation characteristics are close to those of helium, **equivalent separation can be obtained without method review** in many cases. |
| Disadvantage | ◆ When using carrier gas flow setting from original helium method, it is likely the **separation will be bad, and the method needs to be reexamined.**<br>◆ The analysis time is often extended compared to helium to improve the separation. | ◆ **Safety considerations and additional measures may be necessary,** such as proper exhaust and hydrogen leakage countermeasures.<br>◆ In the case of a detector using hydrogen, a detector sensitivity variation due to a flow rate variation of the carrier gas (hydrogen) may occur.<br>◆ Because of its reducibility, it may react with the measured compounds and affect the results. |

# Changing the Carrier Gas

## Alternative carrier gas compatibility table: GC Detectors

✓ in the table means that the carrier can be used for analysis and does not guarantee the same performance as helium.

Please be sure to perform a method validation prior to changing to an alternative carrier gas.

| | Nitrogen | Hydrogen | Cautionary Notes |
|---|---|---|---|
| FID (packed) | ✓ | ✓*1 | *1: Adjustment of detector H2 flow rate is required due to sensitivity variation. If the column flow rate is high, sensitivity degradation is expected. |
| FID (Capillary) | ✓ | ✓*2 | *2: Adjustment of detector H2 flow rate is required due to sensitivity variation. |
| TCD (packed/capillary) | ✓*3 | ✓ | *3: When changing from He, a significant decrease in sensitivity is expected. |
| FPD (packed) | ✓ | - | |
| FPD (Capillary) | ✓ | ✓*4 | *4: Due to sensitivity fluctuation, adjustment of detector H2 flow rate is required. |
| ECD (packed) | ✓ | - | |
| ECD (Capillary) | ✓*5 | ✓*5 | *5: When using H2, sensitivity fluctuations are expected; N2 is recommended. |
| FTD (packed/capillary) | -*6 | - | *6: Although it is possible to use only N2 as a carrier gas, a significant decrease in sensitivity is expected. In addition, helium is required for the detector to operate, so we have determined that this is not possible. |
| BID | -*7 | -*7 | *7 — Not available in principle |
| SCD | ✓ | - | |

Please also refer to the annex at the end of this document.

# Changing the Carrier Gas



## Alternative carrier gas compatibility table: Sample Introduction Options

✓ in the table indicates that the alternative carrier gas can be used for analysis. However, it does not guarantee the same analytical results as the helium carrier gas.

Please be sure to perform a method validation prior to changing to an alternative carrier gas.

| | Nitrogen | Hydrogen | Precautions and Auxiliary Gas |
|---|---|---|---|
| AOC-30/20 | ✓ | ✓ | |
| AOC-6000/5000 | ✓ | ✓ | Purge gas for HS/SPME: Only nitrogen can be used. |
| HS -20 Series | ✓ | ✓ | Vial Pressurization/Purge Gas (Trap only): Only Nitrogen can be used. |
| HS-10 | ✓ | ✓ | Vial Pressurization: Only Nitrogen Can Be Used |
| TD-30/20 | ✓ | - | |
| Aqua PT6000/PT7000 | ✓ | - | |
| PY-3030D/PY-2020iD | ✓ | - | Furnace cooling gas: Nitrogen, compressed air can be used.<br>Sample recovery gas: Only nitrogen can be used. |

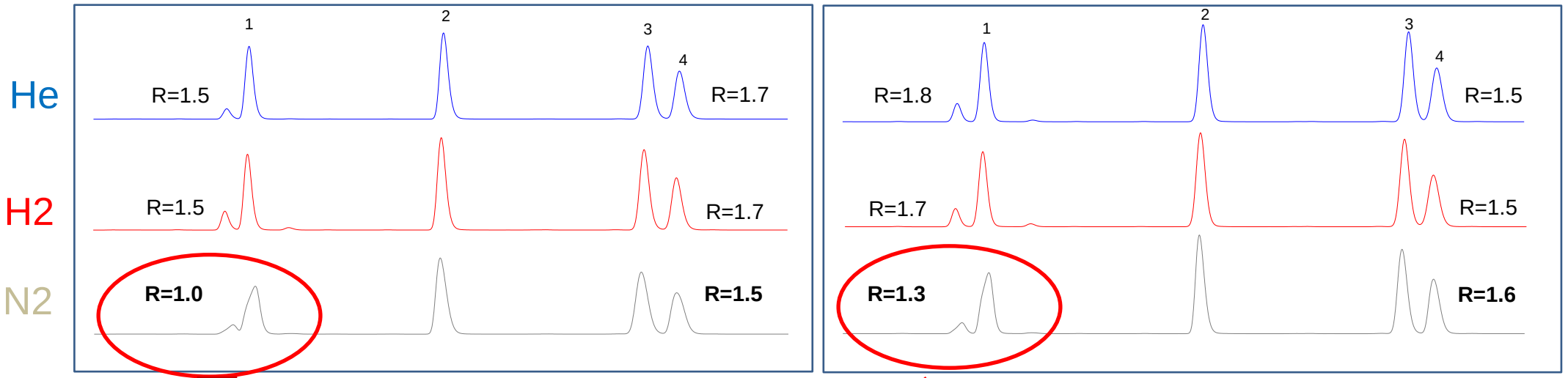
- Many GC option devcie require gas other than carrier gas.
  - In particular, hydrogen can be used as a carrier gas, but in many cases, it cannot be used as an auxiliary gas like as purge or etc.
- The available carrier gas varies also depending on the detector used, so please refer to the detector's table in next page.

Please also refer to the annex at the end of this document.

# Changing the Carrier Gas

## Example method adjustment based on alternative carrier gas

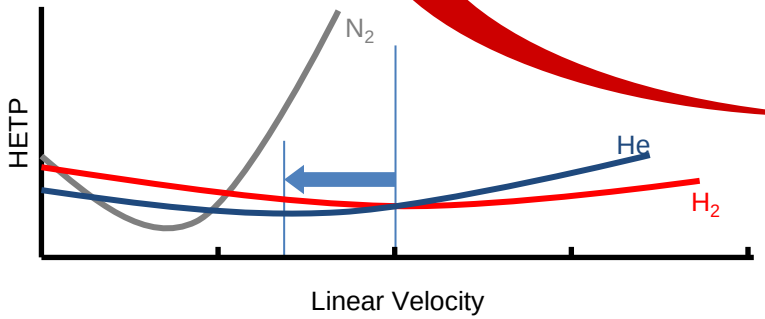
Method development of alternative carriers is simplified by using **constant linear velocity control.**




**Constant linear velocity control [40 cm/sec]**

**Constant linear velocity control [25 cm/sec]**

1: Acetaldehyde
2: Acetone
3: Ethyl acetate
4: Methanol
Concentration: 1% each
Solvent: Ethanol

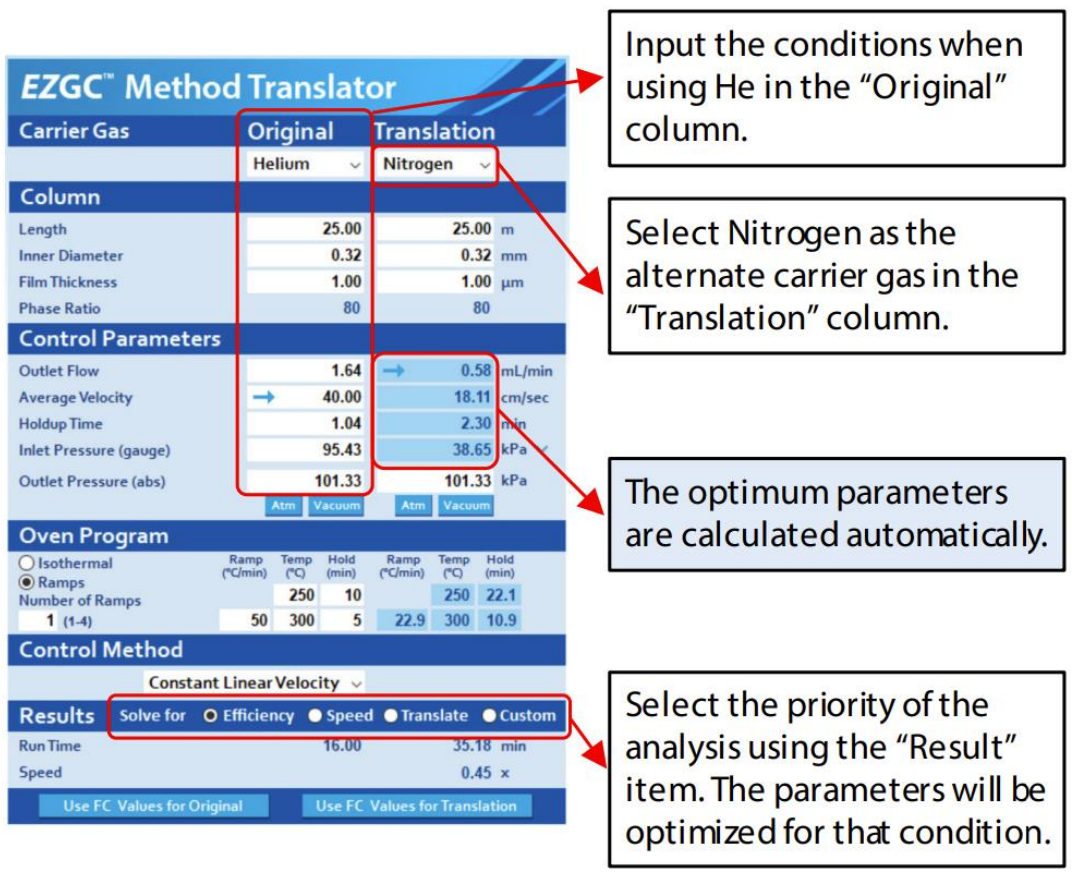



**Comparison of separation degree by changing linear velocity**

# Changing the Carrier Gas

## Method development of alternative carriers

### EZGC Method Translator from Restek Corporation




The EZGC Method Translator from Restek is useful translating original settings to alternative carrier gases. (You can use it for free.)

After you enter the current method and select an alternate carrier gas type and preferred control method, the conversion method appears based on the result you are trying to meet.

See the Restek Corporation website for more information.
http://www.restek.com/ezgc-mtfc

# Changing the Carrier Gas

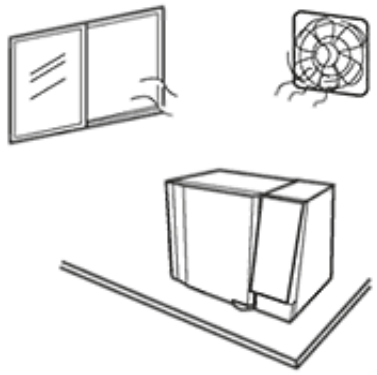
## Gas Chromatograph Hydrogen Gas Safety

Hydrogen gas is classified as a dangerous substance and is extremely flammable. When using hydrogen gas, please understand the properties of hydrogen gas and handle it correctly. Please review the below website as well as SDS from supplier.

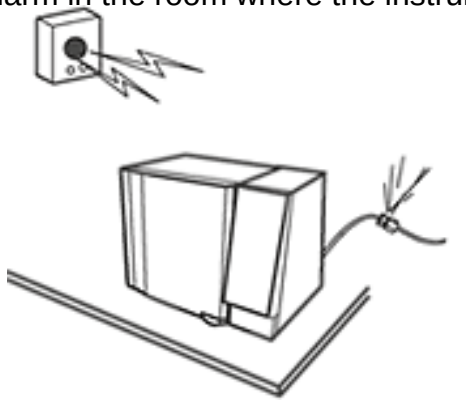
https://www.shimadzu.com/an/service-support/technical-support/handling-precautions/gas-chromatography/index.html

### Excerpts of caution

The room in which the instrument is installed should be well ventilated. If a large amount of hydrogen gas leaks into a poorly ventilated room, there is a risk of explosion.



Always have a hydrogen leak check device available and periodically check the hydrogen gas line for leaks. We recommend the use of a hydrogen gas alarm in the room where the instrument is installed.



In addition, the gas chromatograph itself has safety measures for use with hydrogen.

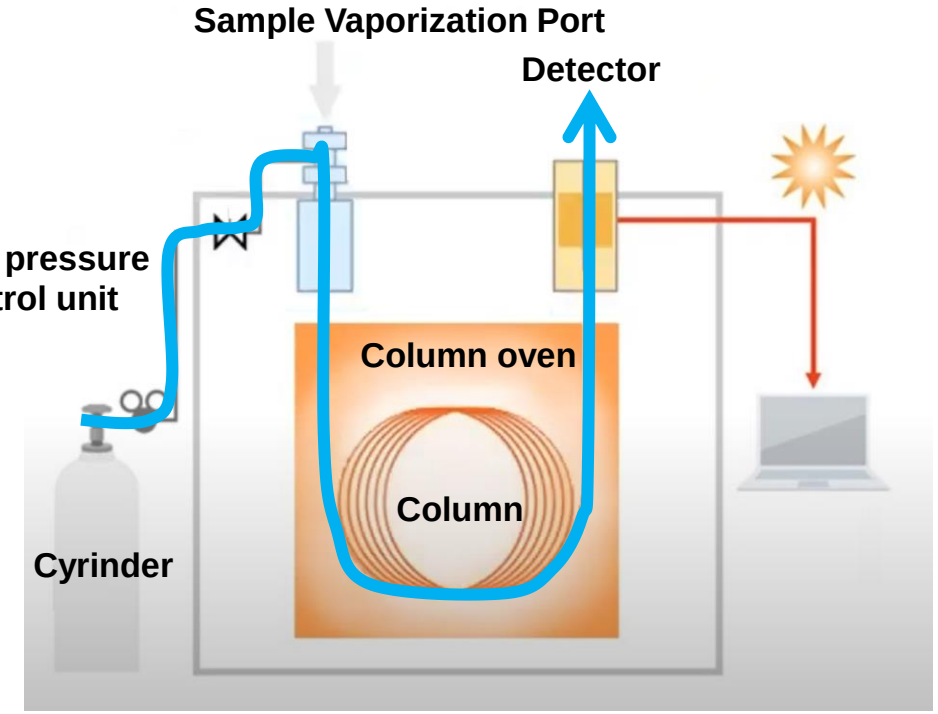
# Changing the Carrier Gas

## Hydrogen Safety Measures in GC Main unit

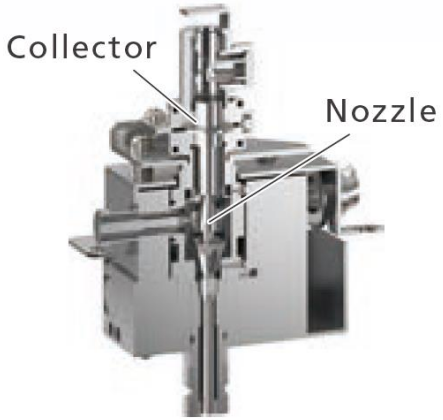
**SUS piping with high resistance to hydrogen embrittlement is used for the carrier gas flow path.**

Copper piping in flowpath has safety risk when using hydrogen as carrier gas since hydrogen embrittlement. In Shimadzu GC, stainless steel material is used for entire flow path, a hydrogen carrier can be used without additional modify to the GC main unit.
**This is a standard feature of Nexis GC-2030, GC-2014, GC-2010 series, and GC-2025.**

**all metal inlet parts are SUS**




**all metal detector parts are SUS**

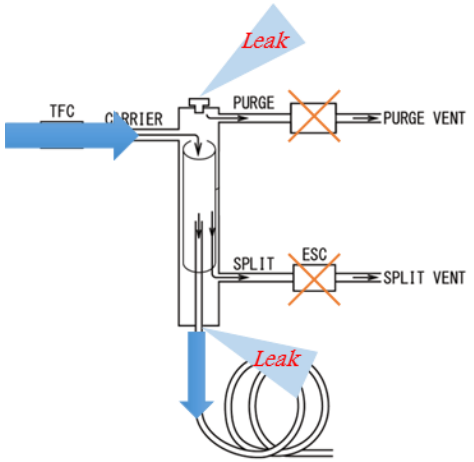


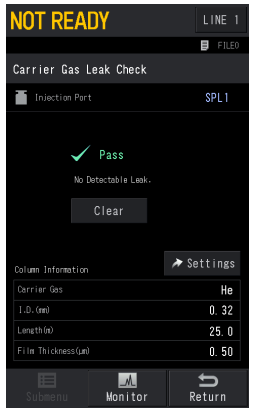
# Changing the Carrier Gas

## Hydrogen Safety Measures in GC Main unit

### Carrier gas leak check function

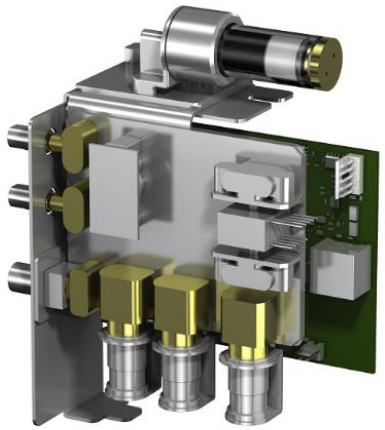
Gas leakage can occur from the sample vaporization port due to septum deterioration, untightened columns and other reasons. The presence of such gas leakage can be diagnosed with a single tap on the screen.
**(This function is only available on Nexis GC-2030)**




### Pressure/Flow monitoring function with electronically controlled flow controller

The flow controller for carrier gas installed in the GC constantly monitors the pressure flow rate. If excessive gas flow is detected due to column breakage, etc., the flow controller closes the valve to shut off the hydrogen supply.
**(This function is standard on the Nexis GC-2030, GC-2014, GC-2025 and GC-2010 series.)**

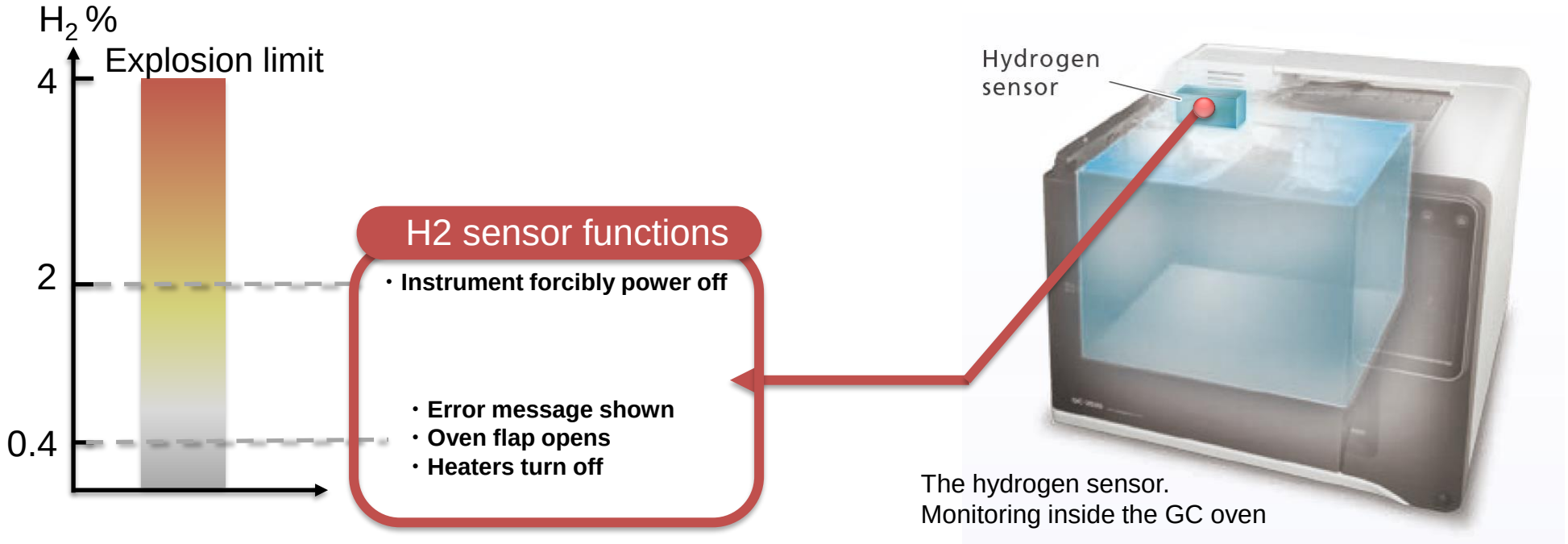


# Changing the Carrier Gas

## Hydrogen Safety Measures – Optional GC Accessory

### Hydrogen sensor

Shimadzu GC's newly designed hydrogen sensor monitors the hydrogen concentration in the GC oven and can detect potential leaks early. When leaks has been detected, it lowers the temperature and automatically switches to a safe standby mode. If the hydrogen concentration rises continueously, the main power is turned off to prevent accidents. **(This is an option for Nexis GC-2030)**



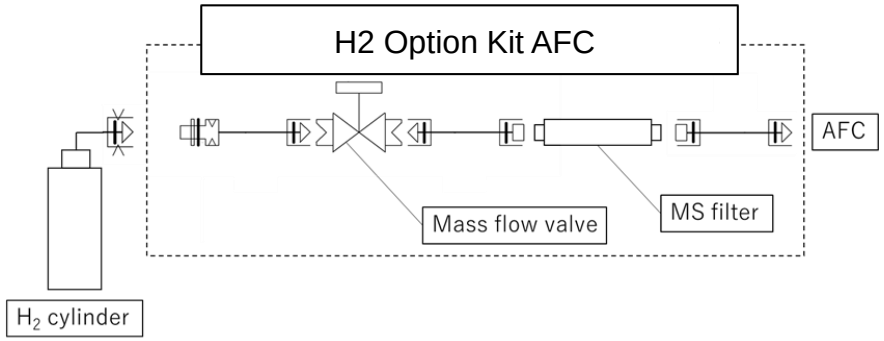

The hydrogen sensor.
Monitoring inside the GC oven

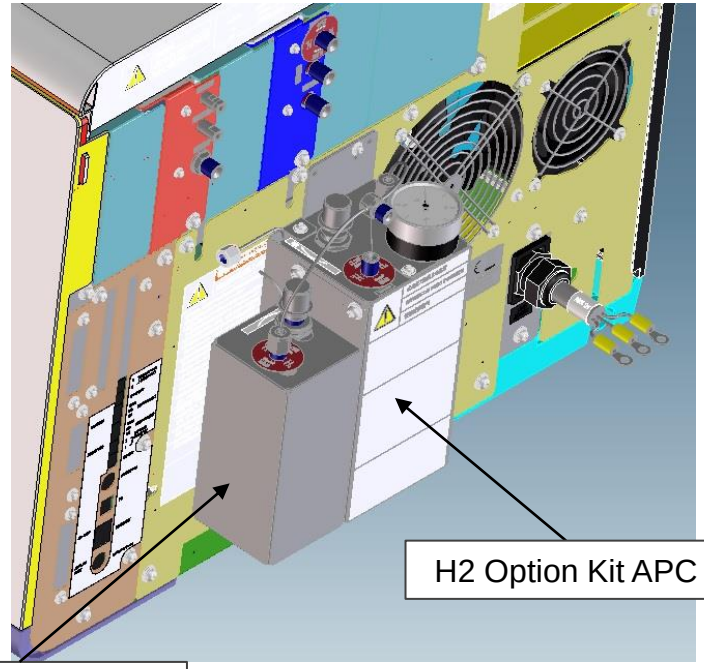
# Changing the Carrier Gas

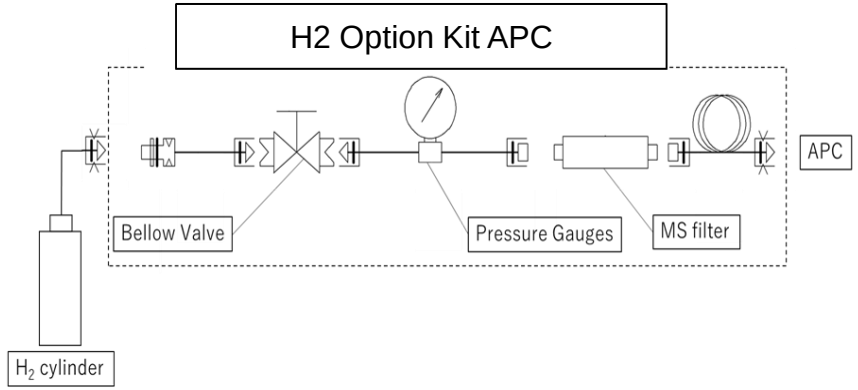
## Hydrogen Safety Measures - Optional GC Accessory

### Hydrogen Flow limiter

The hydrogen flow limiter controls the excessive flow of hydrogen into the oven in case a column is forgotten to be connected or the flow controller occur uncontrol error **(This is an option for Nexis GC-2030, GC-2014, GC-2025, and GC-2010 series.)**



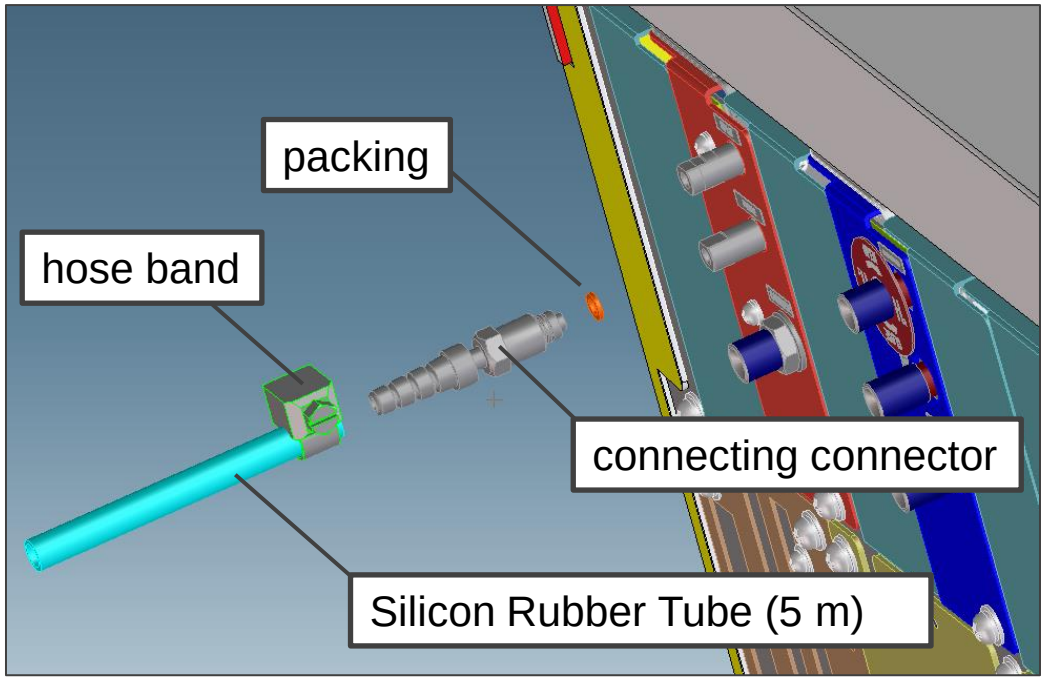



# Changing the Carrier Gas

## Hydrogen Safety Measures - Optional GC Accessory

When hydrogen gas is used as a carrier gas, the room should be well ventilated and the exhaust from the split vent of the AFC and the vents of the TCD and ECD should be exhausted to a ventilator where no retention occurs. We recommend installing a hydrogen gas exhaust option (see below, PN: S221-77174-41) or other equipment that can be connected to the vent area.

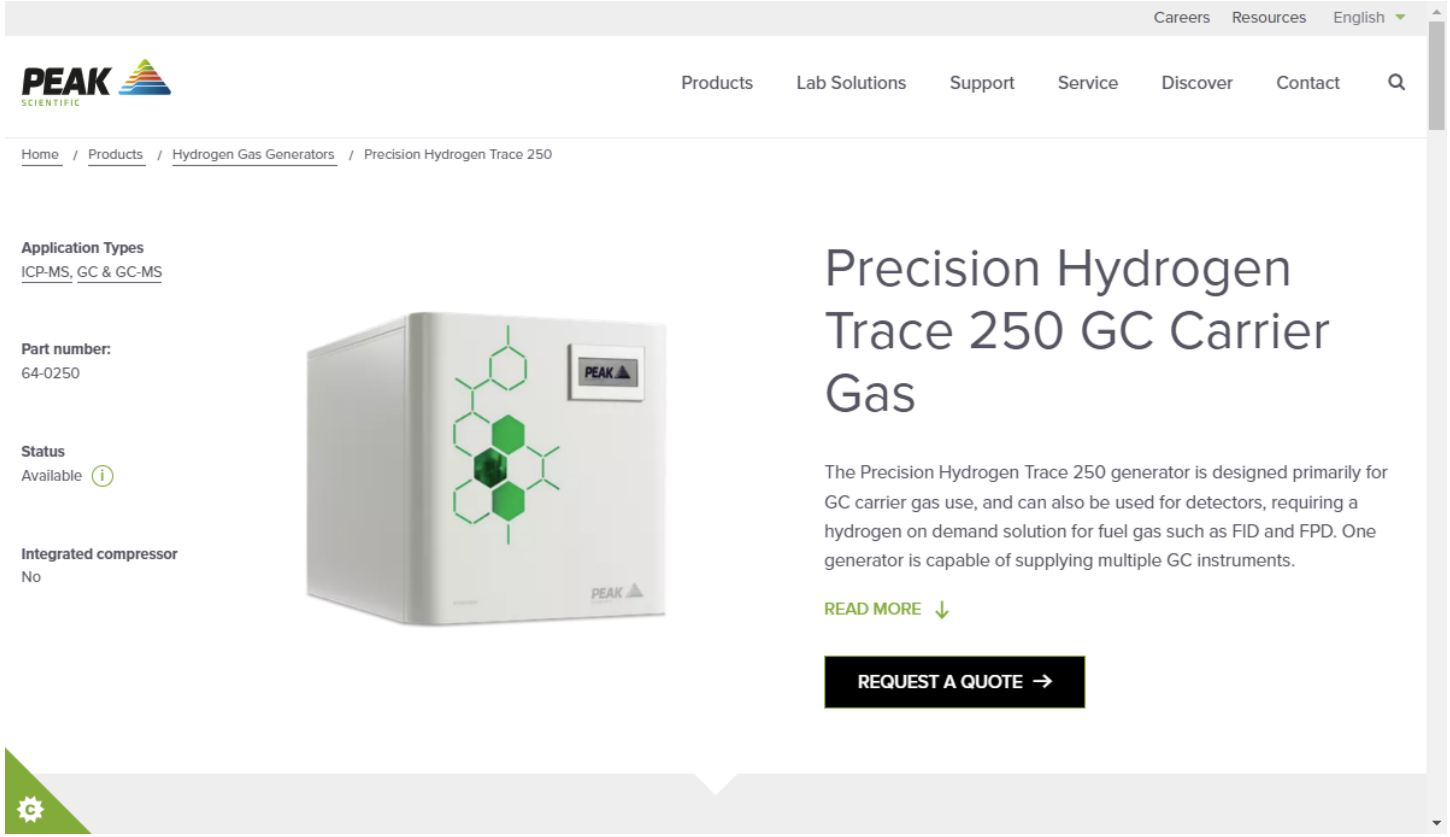



If the silicone rubber tubing is not long enough, the customer can prepare tubing with an inner diameter of 6 mm and an outer diameter of 8 mm for connection (up to 20 m).

# Changing the Carrier Gas

## Hydrogen Safety Measures – Gas Generators

A hydrogen gas generator can be a good choice when installing a hydrogen cylinder is difficult.
See the link below for more information.
https://www.peakscientific.com/products/hydrogen/




### Features

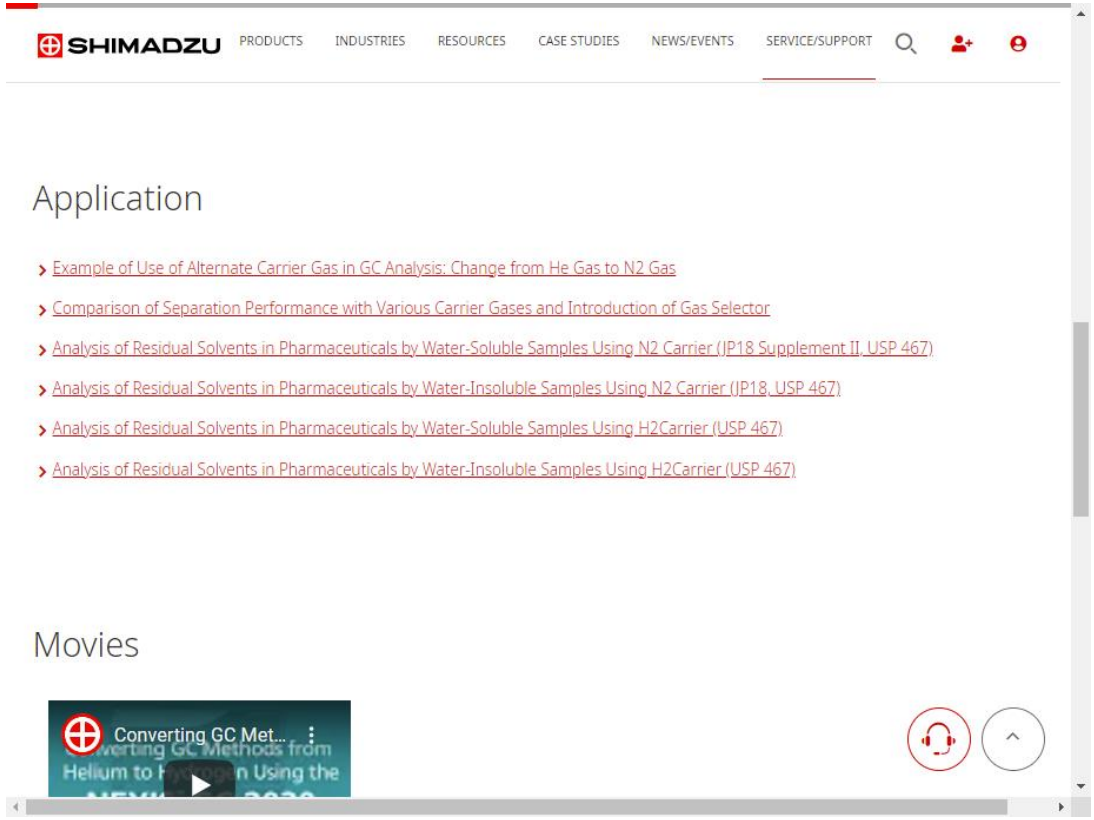
- Suitable for flame gas and carrier gas at trace detection limits
- 99.99999%* Purity
- Internal leak detection with automatic shutdown features
- Proven PEM technology to generate hydrogen safely and reliably
- Regenerative PSA dryers to ensure highest level of purity
- Automatic loading pump as standard
- Maintenance limited to replacing de-ionizer cartridge
- Compact, space-saving modular design
- Creates hydrogen on demand, minimal storage of hydrogen in the system
- Combine multiple units for higher flow requirements
- GC in-oven hydrogen leak detector available as an optional extra
- Peak offers a 3 year cell warranty with this generator as standard.

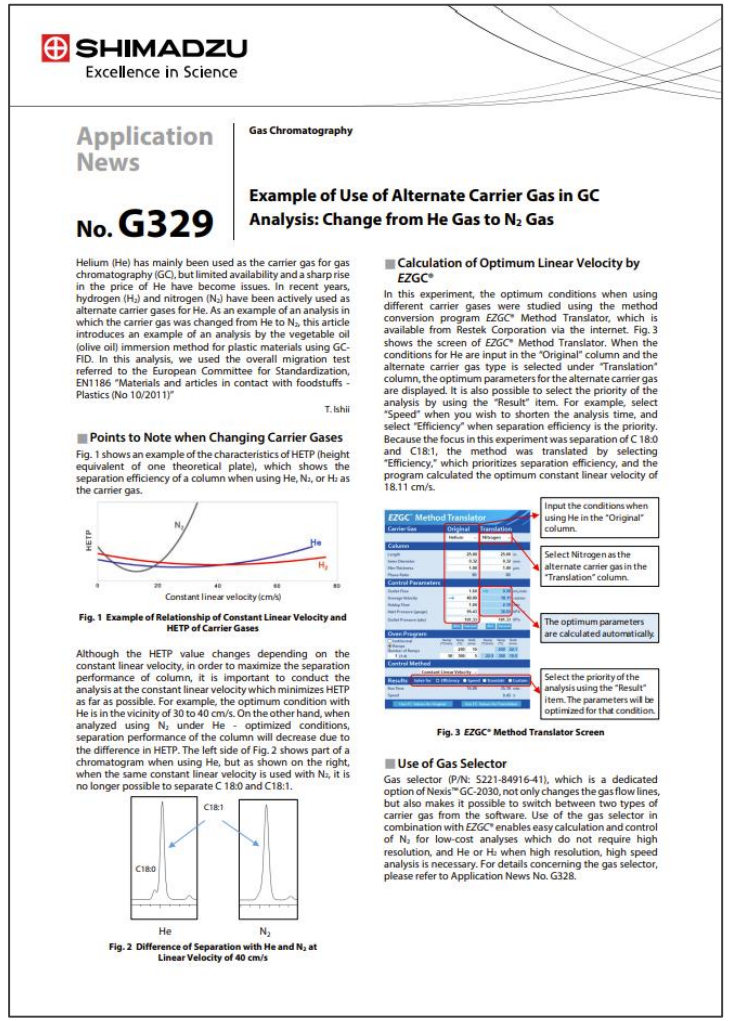
*based on O2 content independently verified by National Physical Laboratory, UK

# Changing the Carrier Gas

## Applications using Alternate Carrier Gas

Applications for using alternative carrier gas are posted on the Shimadzu website.
https://www.shimadzu.com/an/service-support/technical-support/technical-information/gas-chromatography/top/index.html



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Application News
No. G329

Gas Chromatography

**Example of Use of Alternate Carrier Gas in GC Analysis: Change from He Gas to $N_2$ Gas**

Helium (He) has mainly been used as the carrier gas for gas chromatography (GC), but limited availability and a sharp rise in the price of He have become issues. In recent years, hydrogen ($H_2$) and nitrogen ($N_2$) have been actively used as alternate carrier gases for He. As an example of an analysis in which the carrier gas was changed from He to $N_2$, this article introduces an example of an analysis by the vegetable oil (olive oil) immersion method for plastic materials using GC-FID. In this analysis, we used the overall migration test referred to the European Committee for Standardization, EN1186 "Materials and articles in contact with foodstuffs - Plastics (No 10/2011)"

T. Ishii

**Points to Note when Changing Carrier Gases**

Fig. 1 shows an example of the characteristics of HETP (height equivalent of one theoretical plate), which shows the separation efficiency of a column when using He, $N_2$, or $H_2$ as the carrier gas.




**Fig. 1 Example of Relationship of Constant Linear Velocity and HETP of Carrier Gases**

Although the HETP value changes depending on the constant linear velocity, in order to maximize the separation performance of column, it is important to conduct the analysis at the constant linear velocity which minimizes HETP as far as possible. For example, the optimum condition with He is in the vicinity of 30 to 40 cm/s. On the other hand, when analyzed using $N_2$ under He - optimized conditions, separation performance of the column will decrease due to the difference in HETP. The left side of Fig. 2 shows part of a chromatogram when using He, but as shown on the right, when the same constant linear velocity is used with $N_2$, it is no longer possible to separate C 18:0 and C18:1.




**Fig. 2 Difference of Separation with He and $N_2$ at Linear Velocity of 40 cm/s**

**Calculation of Optimum Linear Velocity by *EZGC***

In this experiment, the optimum conditions when using different carrier gases were studied using the method conversion program *EZGC*® Method Translator, which is available from Restek Corporation via the internet. Fig. 3 shows the screen of *EZGC*® Method Translator. When the conditions for He are input in the "Original" column and the alternate carrier gas type is selected under "Translation" column, the optimum parameters for the alternate carrier gas are displayed. It is also possible to select the priority of the analysis by using the "Result" item. For example, select "Speed" when you wish to shorten the analysis time, and select "Efficiency" when separation efficiency is the priority. Because the focus in this experiment was separation of C 18:0 and C18:1, the method was translated by selecting "Efficiency," which prioritizes separation efficiency, and the program calculated the optimum constant linear velocity of 18.11 cm/s.




**Fig. 3 *EZGC*® Method Translator Screen**

**Use of Gas Selector**

Gas selector (P/N: 5221-84916-41), which is a dedicated option of Nexis™ GC-2030, not only changes the gas flow lines, but also makes it possible to switch between two types of carrier gas from the software. Use of the gas selector in combination with *EZGC*® enables easy calculation and control of $N_2$ for low-cost analyses which do not require high resolution, and He or $H_2$ when high resolution, high speed analysis is necessary. For details concerning the gas selector, please refer to Application News No. G328.

# Summary

## Recommendation: Reducing helium consumption

- Try carrier gas save mode.
- Use gas selector.
- Use the automatic start/stop function.
- Be mindful using low purity helium gas.

## Recommendation: Changing the carrier gas

- Options for alternative carrier gases are based on not only the main unit but detectors and sample introduction accessories.
- Consider the advantages and disadvantages of nitrogen and hydrogen before selecting an alternative carrier gas.
- Implement necessary safety measures when using hydrogen.

Please be sure to read the "Safe Use of Hydrogen Gas" on our website before using hydrogen.
https://www.shimadzu.com/an/service-support/technical-support/handling-precautions/gas-chromatography/index.html

# Summary

## Compatibility table for Shimadzu GC model with recommended functions

| | Helium gas reduction | | | | | | Operation of alternative carriers | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Carrier gas save function, backflush (P5) | Gas Selector (P6) | Manual changeover valve *Similar to gas selector (P6) | automatic shutdown automatic startup (P7) | remote shutdown remote start (P7) | Gas filter and He Purifier (P8) | EZGC Method Translator (P15) | Stainless steel piping for main body (P17) | Carrier gas leak check function (P18) | pressure flow monitoring function (P18) | Hydrogen sensor (P19) | H2 Safety options (P20,P21) | Hydrogen generator and hydrogen leak detection function *Similar to hydrogen sensor (P 22) |
| Nexis GC-2030 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| GC-2014 | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ |
| GC-2025 | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ |
| GC-2010 Series | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ |
| GC-17 Series | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | GC -8, GC -14 and GC -17 do not have additional safety features and are not recommended to be used with hydrogen carrier. | | |
| GC-14 Series | - | - | ✓ | - | - | ✓ | ✓ | ✓ | - | - | | | |
| GC-8 Series | - | - | ✓ | - | - | ✓ | ✓ | ✓ | - | - | | | |

# Summary

## Compatibility table for software programs with recommended functions

| | Helium gas reduction related functions | | | | Alternative Carrier Related Functions | | |
|---|---|---|---|---|---|---|---|
| | Carrier gas save function (P5) | Gas Selector (P6) | Auto Start automatic shutdown (P7) | remote start remote shutdown (P7) | Carrier gas leak check function (P18) | pressure flow monitoring function (P18) | Hydrogen sensor (P19) |
| LabSolutions | ✓ | ✓ (Nexis GC -2030 only) | ✓ | ✓ | ✓ (Since this function is part of the GC main unit, it is available regardless of software.) | | |
| GCsolution | ✓ | - | ✓ | - | | | |
| OpenLab | ✓ | ✓ (Nexis GC -2030 only) GC Driver Version 2.20 or later) | - (Automatic shutdown is not supported, but similar functionality can be achieved by using in the shutdown method at the end of a sample batch/list.) | - | | | |
| Empower | ✓ | ✓ (Nexis GC -2030 only, GC Driver Ver 3.20 or later) | | - | | | |
| Chromeleon | ✓ | ✓ (Nexis GC -2030 only, GC Driver Ver 2.20 or later) | | - | | | |

LabSolutions support models: Nexis GC -2030, GC -2014, GC -2010 series, GC -2025
GCsolutions support models: GC -2014, GC -2010 series, GC -2025, GC -17 series
OpenLab supported models: Nexis GC -2030, GC -2014, GC -2010 series
Empower compatible models: Nexis GC -2030, GC -2014, GC -2010 series
Chromeleon support models: Nexis GC -2030, GC -2014, GC -2010 series
(GC -2014 and GC -2010 series can be controlled using the Thermo Fisher Scienetic driver included with Chromeon TM 7.)
(GC -2030 is the only GC that the Chromeleon GC driver developed by Shimazu can control.)

SHIMADZU

# Thank you very much.