How to Convert Helium to Hydrogen as a Carrier Gas in Gas Chromatography

Benefits of Using an Onsite Hydrogen Gas Generator

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How to Convert Helium to Hydrogen as a Carrier Gas in Gas Chromatography

This How to Guide will take you though the steps necessary to convert from Helium to Hydrogen as a carrier gas for Gas Chromatography. The use of Hydrogen from an onsite gas generator will lead to considerable benefits in cost, safety and convenience in the laboratory. Please follow these steps carefully and you will benefit from a quick and easy conversion to Hydrogen as a carrier gas.

step one

Review and document all existing run conditions

1. Leak check the system — leaks may affect the determination of the actual flows you are using for your analysis.
2. Measure and record the existing dead volume time and calculate the linear gas rate (LGR).
3. Measure and record the Septum Flow at the initial run temperature.
4. Measure and record the Make-up Gas rate.
5. Measure and record Vent flow at initial run temperature.
6. Measure and record the fuel gas (hydrogen) flow rate.
7. Measure and record the Air Gas Flow rate.
8. Document any flow changes that take place during the run.
9. Document any temperature program rates used.
10. Obtain a good sample chromatogram for comparison with the chromatogram obtained after conversion.

step two

Perform all routine maintenance before switching to Hydrogen

1. Change Purifiers — add purifiers to lines as needed to obtain at least 99.9999% pure gas.
2. Change Septa — use a good low bleed septum.
3. Change injection port liners/inserts and seals and clean as needed to avoid contamination with oils. Be sure to clean parts with acetone before installation.

Caution: Acetone is flammable and can cause health issues. Avoid open flames in the laboratory (clean detector, detector inserts and jets).

step three

Installation of new lines and purifiers

1. Carrier gas lines – Depressurize and vent the Hydrogen line. Then cut the fuel gas line (hydrogen) and add a tee. Extend a line into the Carrier Gas in-port behind the GC from the other side of the tee. See Figure 1.
2. Add purifiers to this line if gas purity does not meet at least 99.9999% purity. Use hydrocarbon, oxygen and moisture removing purifiers or a combination purifier to obtain the needed gas purity.

   Hint: *Add purifiers that have indicators to show the percentage of usage of the purifier so that you know when to change the purifiers.*
3. Add new make-up gas line preferably for use with nitrogen. See Figure 2.

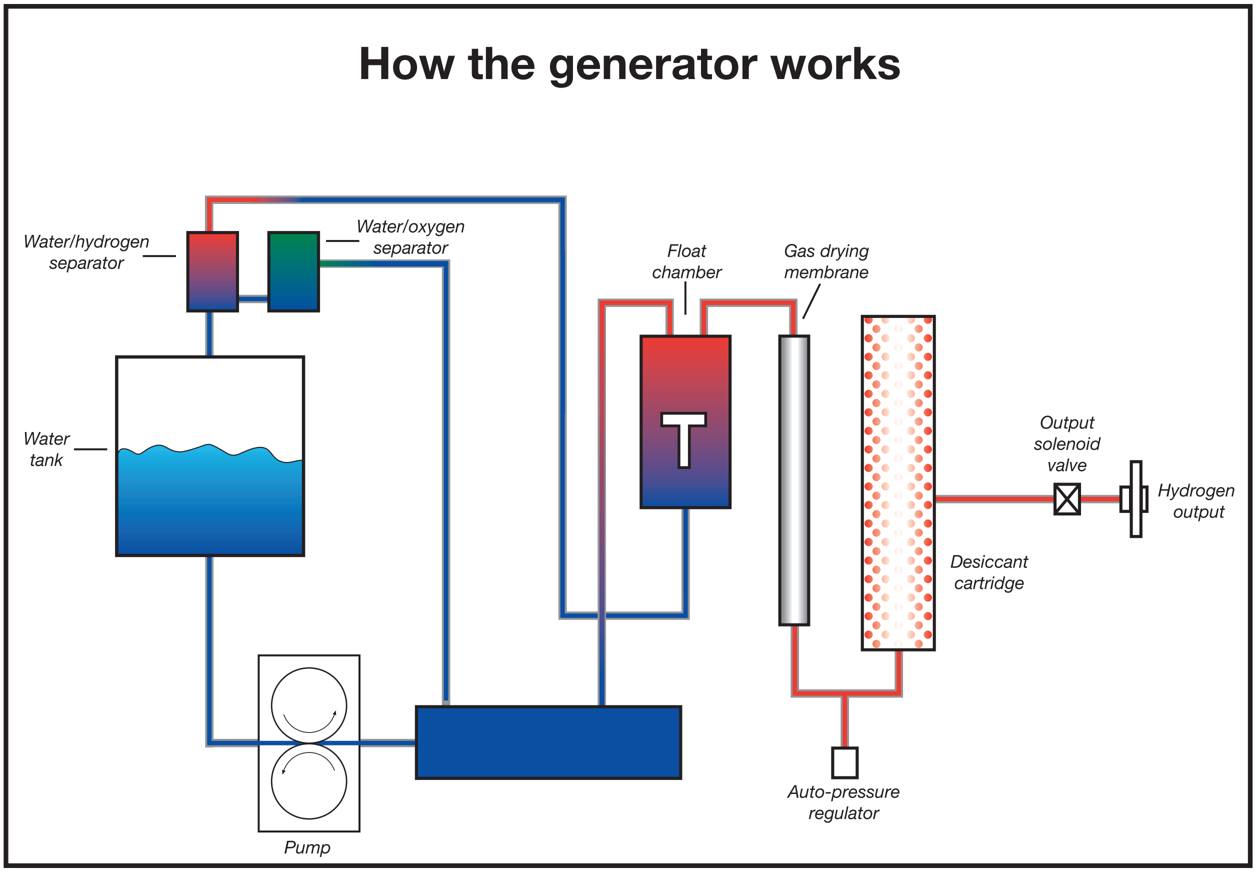


Figure 1: Hydrogen Technology

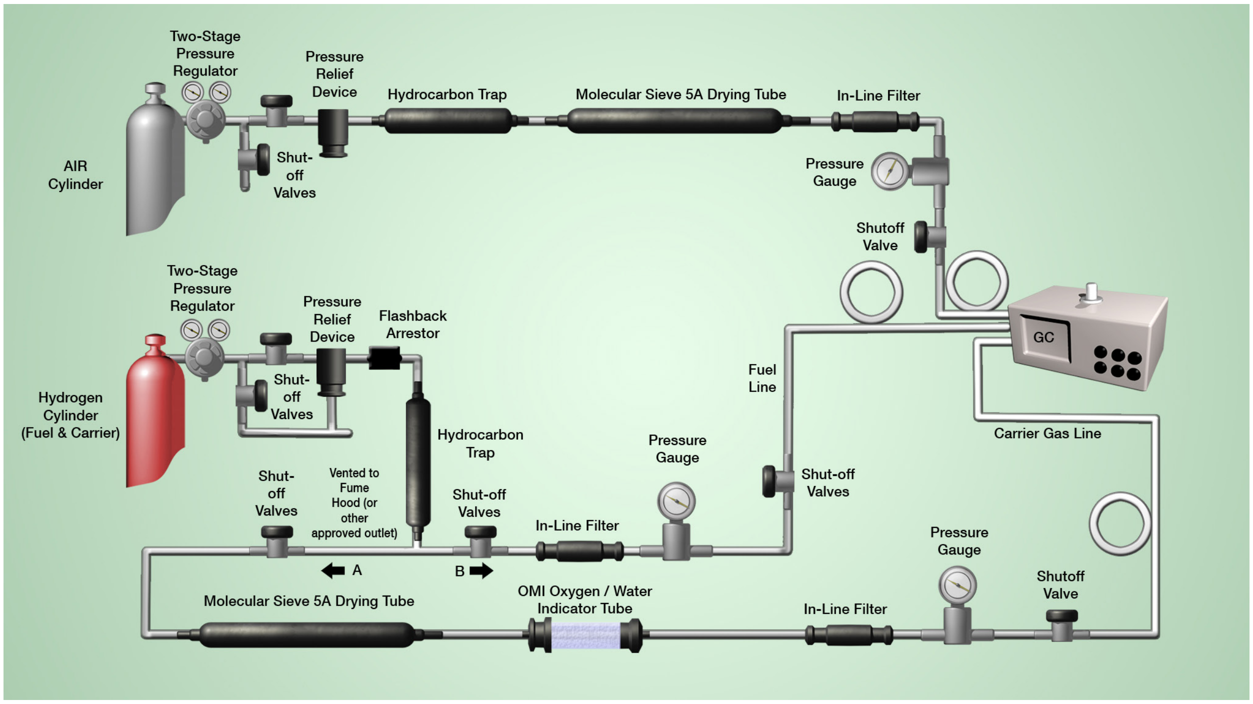


Figure 2: Ideal Configurations for a Single-GC System: Hydrogen Used as Carrier and Fuel Gas

step four

Establish Flows for Hydrogen and Nitrogen (Make-up Gas)

Carrier Gas

1. Turn gas on and establish column flow with the oven off. With some computer controlled systems, it may be necessary to change the carrier gas input to indicate you are using hydrogen so that the system makes the correct flow adjustments based on the density of Hydrogen.
2. Turn Oven, Injection port, and Detector on after one hour of flow. It is important to purge all lines and purifiers before establishing temperatures in the various zones of the GC. It takes a considerable amount of time to purge lines and purifiers.

   Hint: *If time permits, it would be best to purge the system overnight.*
3. Establish Split Vent flow and measure Septum Vent flow.
4. Bring the column/oven up to run temperature and again measure the column flow.

Detector Flows

5. Establish the correct flow of Hydrogen to the detector (this includes the sum of all sources of hydrogen going into the detector).
6. Establish the correct Make-up Gas flow.
7. Establish the correct Air flow.

System Adjustments

8. Ignite the detector and turn on any needed detector electronics. Give the system one hour to stabilize.

   Hint: *A longer warm up period (ex. overnight) may lead to a more stable response.*
9. Recheck the system to make sure that all run conditions and temperatures are correct.
10. Inject and measure the dead volume time using methane and calculate the Linear Gas Rate (LGR). Make corrections to the LGR as needed.

First Run

- Inject sample and compare run to previous Helium run.
- Consider if you want to speed run up by doubling LGR or if your goal is just to duplicate the Helium analysis times and separation.

Calibration

- Re-establish peak identification – there should be no changes unless you are using very polar columns.
- If the run is as you desire, proceed to run your Calibration Standards

- **Flow = π r2 L / tm**
  Where π = 3.1416
- **r = radius of the column in cm (convert from mm)**
- **L = Length of the column in cm (convert from meters)**
- **TR = Retention time of a non retained peak typically methane**
- **Where LGR = L / tm = L / µ**
- **Simplified Flow = π r2 µ (Use units in cm.)**

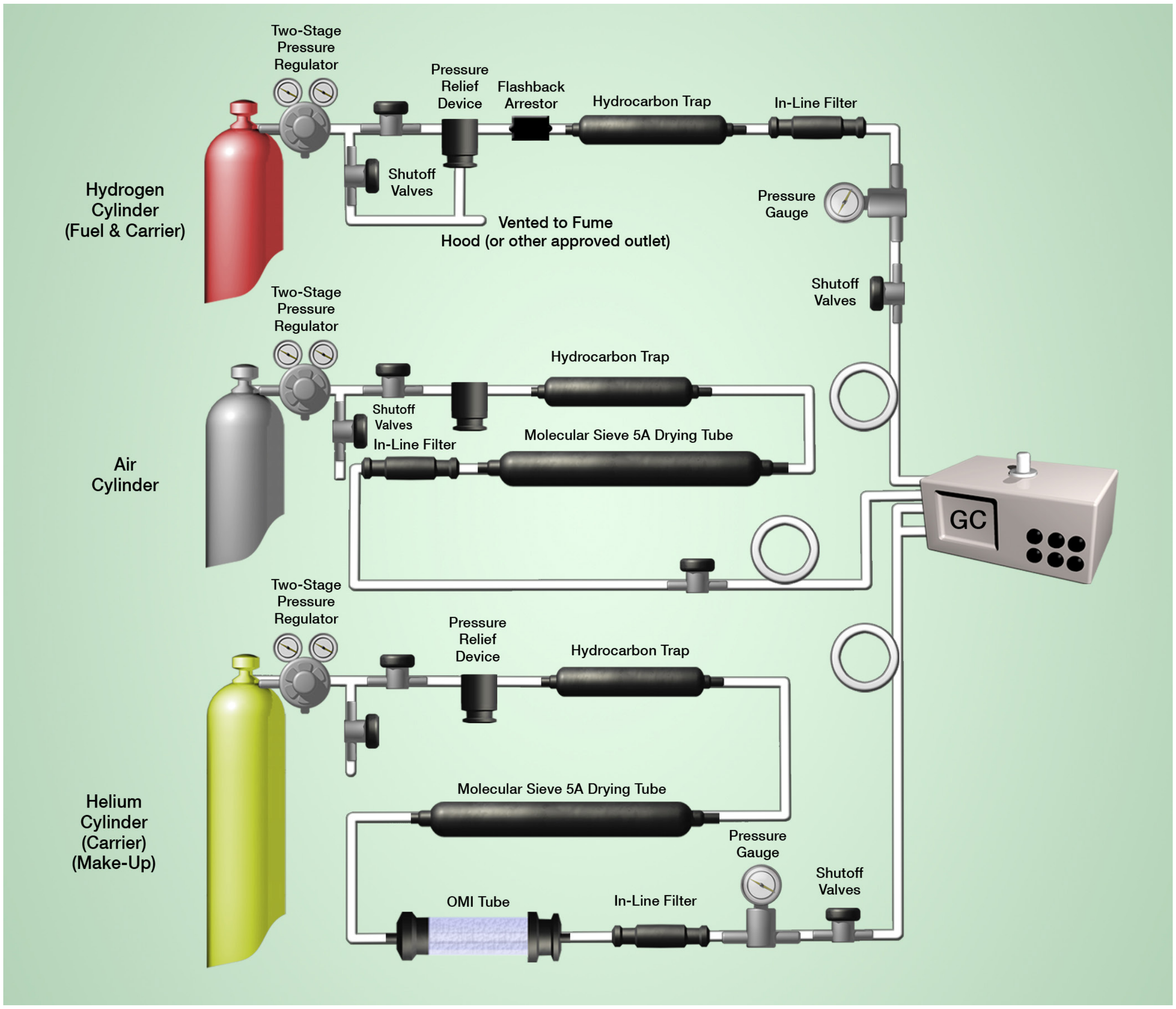
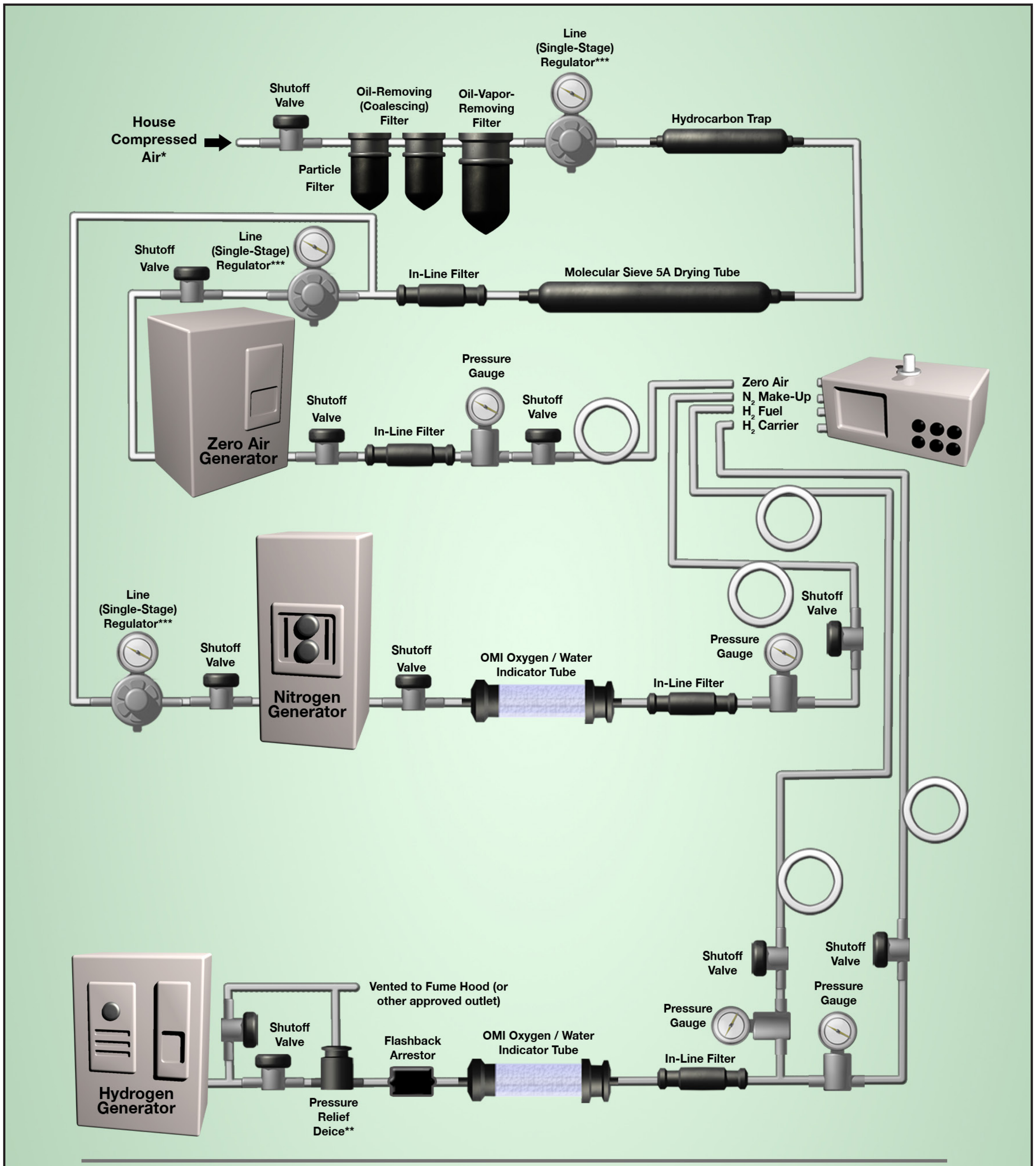


Figure 3: Standard Configuration for a Single GC System: Gas Delivered from Cylinders

step five

Changing from Cylinders to Gas Generators

1. Install gas generators on bench following instructions provided in the installation manuals.
2. Reduce tubing line lengths as much as possible. See Figure 3.
3. Use high quality GC grade stainless steel tubing or clean new lines with solvents and bake dry under nitrogen flow.
4. Add gas purifiers as needed. Different makes and models of gas generators provide different purities of hydrogen. You will need to add purifiers if the delivered gas is not at least 99.9999% pure.
5. Consider adding Nitrogen generators and high quality air generators to eliminate cylinders and the use of high-pressure gases in the laboratory. A schematic diagram for a typical system using an inhouse generator is shown in Figure 4 on next page.



* Replace an oil-sealed compressor with an oilless unit to eliminate the need for the particle filter, oil-removing / coalescing filter, and oil vapor-removing filter.
**Not needed if the hydrogen generator has a buil-in relief device.
***Consult generator manual for correct injet pressure.

Figure 4: Ideal Configurations for a Single-GC System: All Generator System

Benefits of Onsite Gas Generators

Minimizing safety hazards

An in-house generator is considerably safer than tank gas; only a small amount of the generated gas is present at low pressure at a given time and the gas is ported directly to the instrument. If a leak occurred, only a small quantity of gas is dissipated into the laboratory. In contrast, serious hazards exist if gas is supplied using a high-pressure gas tank. If a full tank of hydrogen were suddenly vented into the laboratory, up to 9000 L of gas would be released, displacing laboratory air and reducing the breathable oxygen content.

An onsite gas generator also eliminates the possibility of injury or damage from the transportation and installation of a gas tank. Since a gas tank is heavy and can be a hazard to staff and facilities if the valve is compromised during transport. A leaking hydrogen tank could lead to an explosion.

Maximizing conveniences

An onsite gas generator can supply gas on a continuous basis with little operator attention requied. In contrast, when tank gas is employed, the user must monitor the level of gas in the tank and ensure that there is sufficient gas for the desired analyses.

The onsite gas generating system removes the need to procure replacement tanks. When it is necessary to get a replacement gas tank, the chromatographer may need to get an individual who is qualified to handle the tanks. Tanks are typically stored outside in a remote area for safety reasons and replacing tanks can be a significant inconvenience, especially in inclement weather.

In addition, a pressurized tank could be a significant hazard if the laboratory is located in a seismic zone. A major benefit of onsite gas generators is that once they are installed, the worry about the gas supplyis eliminated. Maintenance intervals are minimal, simply replace the filters and perform routine maintenance and monitor the water in the hydrogen generators.

Minimizing the cost

An important advantage of an in-house generator is the dramatic economic benefit compared to the use of gas tanks. The running cost of an onsite gas generator is extremely low because the hydrogen gas is obtained from water and maintenance is a few hundred dollars a year for periodic filter replacement.

However, when a gas tank is used, the actual cost is significantly greater than the cost of the tank. In addition, the time required transporting the tank, installing it, returning the used tank to storage, and wait for the system to re-equilibrate must be considered. While the calculation of the precise cost of the use of gas from tanks for a given user is dependent on a broad range of local parameters and the amount of gas that is used, significant potential savings can be obtained by the onsite generation of gas.

A comparison of the cost of supplying gas via tanks versus the cost for use of an in-house gas generator is presented in Table 1.

In this analysis, a tank of gas costing $60 is consumed/week and four are in-house (i.e., tanks are replaced monthly). In comparison, the maintenance cost of the onsite generator is for replacement of filters at perhaps $1000/year or approximately $20 per week.

Table 1 — Annual Costs in USD
Onsite gas generation vs. high-pressure tanks

	Onsite Gas Generator	Tanks
Maintenance	$800	$0
Cylinders	$0	$3120
Demurrage	$0	$336
Labor	$0	$1040
Order processing	$30	$360
Shipping	$50	$3720
Invoice processing	$10	$120
Inventory control	$0	$72
Total	**$890**	**$8768**

Hydrogen is a Safe Alternative to Helium to Cylinders.

Is it safe to use Hydrogen with my Gas Chromatographs?

Yes. Hydrogen has to reach a temperature of 500˚C to ignite and a concentration between 4%-76% to be explosive, which is nearly impossible when using a hydrogen gas generator and a modern GC.

How much Hydrogen is necessary for there to be a safety concern?

The lower explosive limit of hydrogen is 4%, which in a 6x4x3 meter, air-tight space requires 2,265 L of hydrogen. This would require a generator supplying 500 mL/min to vent directly into the air continuously for over 4 days without any air exchange. A hydrogen cylinder could instantly vent this much hydrogen with a single leak.

Can my GC make concentrated areas of Hydrogen at its exhaust?

It is nearly impossible. Hydrogen diffuses four times faster than air and is the smallest of all molecules. It diffuses almost immediately in air. All laboratories have air turnover and air movement, which further aides in the diffusion process.

Can my GC make concentrated areas of Hydrogen internally?

Modern GC's are made with safety features to handle hydrogen as a carrier gas and can automatically shut off the carrier gas flow in case an issue is detected. Also, ovens are not sealed. Please check with your GC manufacturer.

Are generators a safe source of Hydrogen?

Gas generators are considered the only safe source of hydrogen. Parker generators produce hydrogen on demand and at low pressure, so there is very little stored volume. A larger stored volume equates to a larger potential issue. Cylinders contain up to 6000 L at 2500 psi whereas Parker gas generators store, at most, 300 ml.

Do Parker generators have additional safety features?

Yes. Parker hydrogen generators utilize built in pressure transducers to detect any internal or external leaks. In the event that a leak is detected, the generator will shut down and an alarm will sound.

Hydrogen Generators for Fuel Gas

ChromGas™ H2F Series

Parker's ChromGas™ H2F hydrogen gas generators provide an optimal blend of safety, reliability, and performance. They employ proven Proton Exchange Membrane (PEM) cell technology to generate high-purity hydrogen on-demand from deionized water and electricity, maintaining low pressure and minimal stored volume.

Our cutting-edge control system enhances user-friendliness, offering unparalleled operational safety and dependability. With the optional Remote Monitoring Module, users gain the ability to visually oversee and manage their ChromGas™ H2F generators from a central computer. Alarm outputs sent to a centralized computer can help to minimize downtime, while remote access to status indicators and real-time operating data have been shown to improve lab efficiency and productivity.

- Eliminate dangerous hydrogen cylinders from the work place
- Simple to install and operate
- Compact, reliable with minimal maintenance
- Produces a continuous supply of 99.9995% pure hydrogen at up to 100 psi (6.9 bar)
- 3 year standard cell warranty
- Optional automatic water fill and remote networking capability
- Stackable with other ChromGas™ products
- Meets NFPA 50A CSA, UL, CE, UKCA, and IEC 61010-1 regulations

Principal Specifications

Model	H2F-100	H2F-165	H2F-260	H2F-510
Flow Rates	100 mL/min	165 mL/min	260 mL/min	510 mL/min
Purity	99.9995%			
Hydrogen Outlet Port	1/8" compression			
Electrical Requirements	100-230V 50/60 Hz			
Delivery Pressure	5-100 psig ± 0.5 psig (0.3-6.89 barg ± 0.03 barg)			
Shipping Weight	70 lb (32 kg) dry			
Dimensions	17.1" h x 13.5" w x 18" d (435 mm x 342 mm x 457 mm)			

Ordering Information

Description	Model
Desiccant Cartridge (1 each)	MKH2F-D
6 Month Service Kit	MKH2F-6M
24 Month Service Kit	MKH2F-24M
Preventative Maintenance Plan	H2F-PM and H2F-PMPLUS
Installation Service	H2F-100-INST, H2F-165-INST, H2F-260-INST, H2F-510-INST
Remote Monitoring Module	604970903

Hydrogen Generators for Carrier Gas

ChromGas™ H2C

Parker's ChromGas™ H2C hydrogen generators use PEM technology to produce ultra-high purity hydrogen on-demand from deionized water and electricity, with low pressure and minimal stored volume. Catalytic Thermal Swing Adsorption drying provides purity suitable for GC/GC-MS carrier gas and common combustion detectors used in today's laboratory workflows. A simple control system and optional Remote Monitoring Module enable remote status, alarms to reduce downtime, and real-time data to boost efficiency. The compact, stackable design comes in six models delivering 150–1300 mL/min to support multiple detectors and lab needs.

- Eliminate dangerous hydrogen cylinders from the workplace
- Simple to install and operate
- 3 year standard cell warranty
- Automatic water fill and remote networking capability
- Compact, reliable with minimal maintenance
- Produces a continuous supply of 99.99999% pure hydrogen at up to 120 psi (8.3 bar)
- Stackable with other ChromGas™ products
- Meets NFPA 50A CSA, UL, CE, UKCA, and IEC 61010-1 regulations

Principal Specifications

Model	H2C-150	H2C-300	H2C-500	H2C-700	H2C-1000	H2C-1300
Flow Rate	150 ml/min	300 ml/min	500 mL/min	700 ml/min	1000 ml/min	1300 ml/min
Purity*	>99.99999%					
Water Consumption** (24/7, full flow)	1200 ml/week	2400 ml/week	4100 ml/week	5700 L/week	8100 ml/week	10,500 L/week
Delivery Pressure	5 - 120 psi g (0.3-8.3 bar g)					
Water Supply Pressure	<60 psi g (<4.1 bar g)					
Water Quality	Deionized. ASTM II, >1MΩ, <1µs, filtered to <100µm					
Ambient Temperature Range	41 - 104°F (5 - 40°C)					
Supply Voltage Range	100-240V 50/60 Hz					
Dimensions		21.25" h x 13.5" w x 18" d (56.5 cm x 34.2 cm x 45.7 cm)				
Shipping Weight		68.8 lbs. (31.2 kg)				

Ordering Information

Description	Part Number	Kit Contents
6 Month Kit	MKH2C-6M	Deionizer Cartridge, Water Filter, Environmental Filters (2x), Filter Replacement Tool
24 Month Kit	MKH2C-24M	Deionizer cartridge, water filter, environment filters (x2), filter replacement tool, & water pump.
Remote Monitoring Module (Optional Extra)	604970903	**Required for:** Remote Monitoring, Remote Alarm, Remote Control

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