

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

The Benefits of using Hydrogen from an In-House Gas Generator

aerospace  
climate control  
electromechanical  
filtration  
fluid & gas handling  
hydraulics  
pneumatics  
process control  
sealing & shielding

# Table of Contents

Step 1: Review and document all existing run conditions	1
Step 2: Perform all routine maintenance before switching to Hydrogen	2
Step 3: Installation of new lines and purifiers	2
Figure 1: Hydrogen Technology / How the generator works	3
Figure 2: Ideal Configurations for a Single-GC System: Hydrogen Used as Carrier and Fuel Gas	3
Step 4: Establish Flows for Hydrogen and Nitrogen (Make-up Gas)	4
Carrier Gas	
Detector Flows	
System Adjustments	
First run	
Calibration	
Step 5: Changing from Cylinders to Gas Generators	5
Figure 3: Standard Configuration for a Single GC System: Gas Delivered from Cylinders	5
Figure 4: Ideal Configurations for a Single-GC System: All Generator System	6
Figure 5: Equity 1 Isothermal 50cm/sec Helium Carrier	7
Figure 6: Equity 1 Isothermal 25cm/sec Helium Carrier	
Figure 7: Bacterial Acid Methyl Esters - 25cm/sec LGR Equity-1	
Benefits of in-house gas generators	8
Minimizing safety hazards	
Maximizing convenience	
Minimizing the cost	
Specifications and Ordering Information	9
Zero Air Generators	10
Hydrogen Generators	11
High Purity Nitrogen Generators	12
GC Gas Stations	13
Explanation of Warning Symbols	14

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

This How to Guide will take you through the steps necessary to convert from Helium to Hydrogen as a carrier gas for Gas Chromatography. The use of Hydrogen from an in-house generator will lead to considerable benefits in cost, safety and convenience in the laboratory. For a detailed explanation of benefits, costs savings, time savings and many other factors affecting the benefits of converting to Hydrogen please see page 8. The order of the steps is important to the successful conversion to Hydrogen. Please follow these steps carefully and you will benefit from a quick and easy conversion to Hydrogen as a carrier gas.

## Step 1

### 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.

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

## Step 2

### 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 - Clean as needed and avoid contamination with oils. Clean parts with acetone before installation.



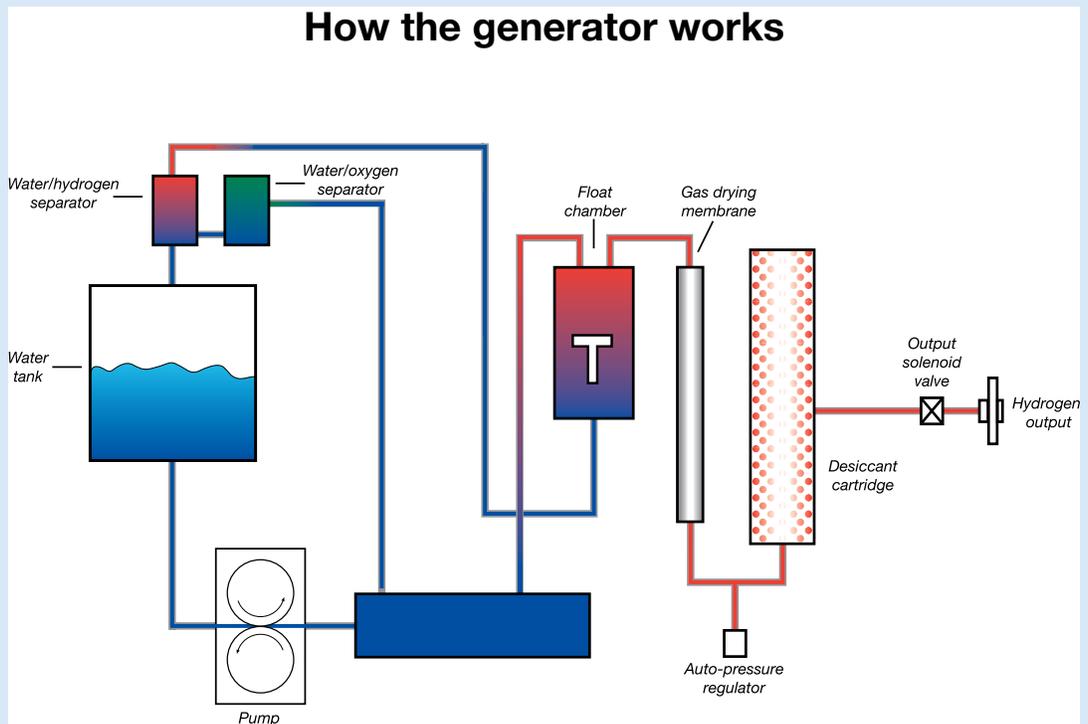
**Caution: Acetone is flammable and can cause health issues. Avoid open flames in the laboratory.**

- 4 Clean Detector/Detector inserts/Jets.

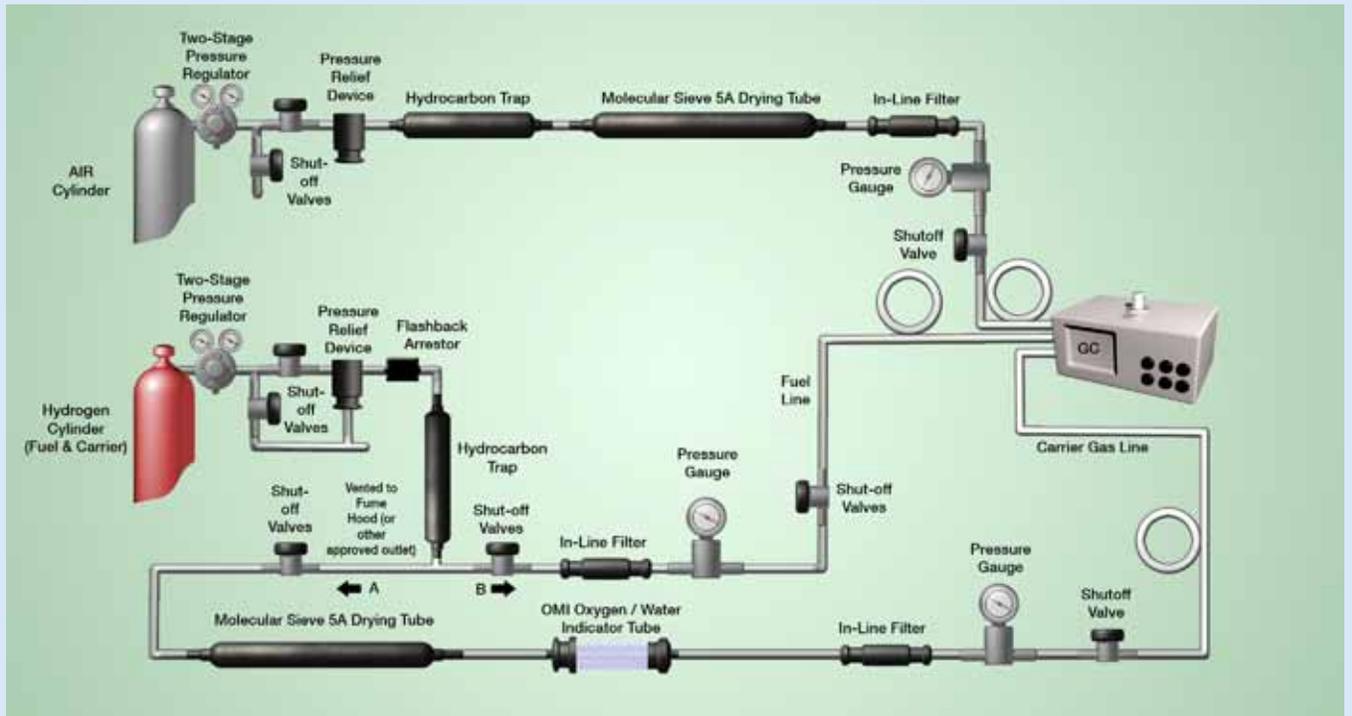
## Step 3

### 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

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

## Step 4 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

- 1 Establish the correct flow of Hydrogen to the detector (this includes the sum of all sources of hydrogen going into the detector).
- 2 Establish the correct Make-up gas flow.
- 3 Establish the correct Air flow.

### System Adjustments

- 1 Ignite the detector and turn on any needed detector electronics. Give the system one hour to stabilize.  
Hint: A longer warm up period (e.g. overnight) may lead to a more stable response.
- 2 Recheck the system to make sure that all run conditions and temperatures are correct.
- 3 Inject and measure the dead volume time using methane and calculate the Linear Gas Rate (LGR). Make corrections to the LGR as needed.

$$\text{Flow} = \pi r^2 L / t_m$$

Where  $\pi = 3.1416$

r = radius of the column in cm (convert from mm)

L = Length of the column in cm (convert from meters)

$T_R$  = Retention time of a non retained peak typically methane

Where  $\text{LGR} = L / t_m = L / \mu$

Simplified

$$\text{Flow} = \pi r^2 \mu \text{ (Remember to use units in cm.)}$$

### 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.

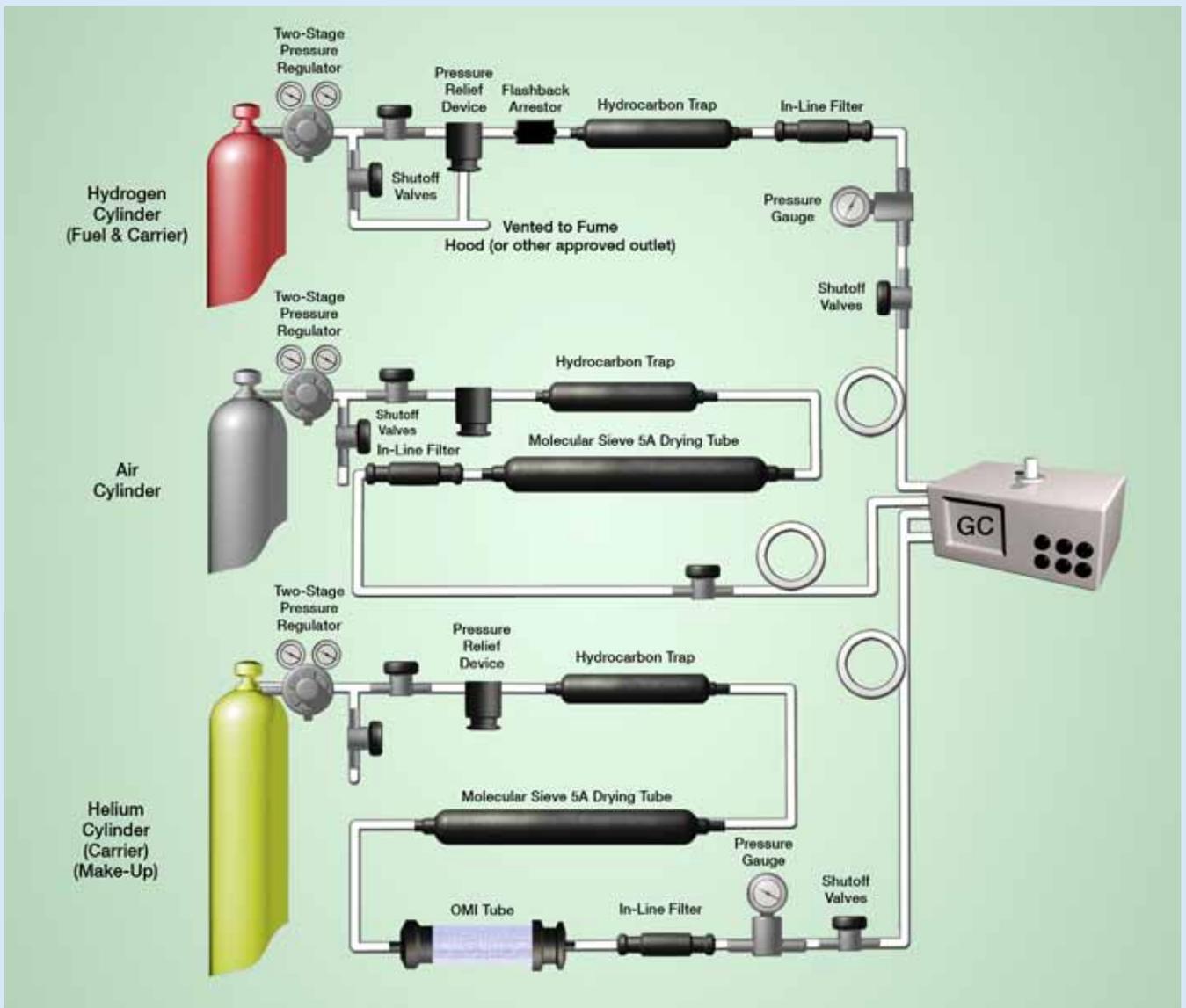
### Calibration

- 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.

## Step 5

### 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.



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

# All Gas Generator System Flow Schematic

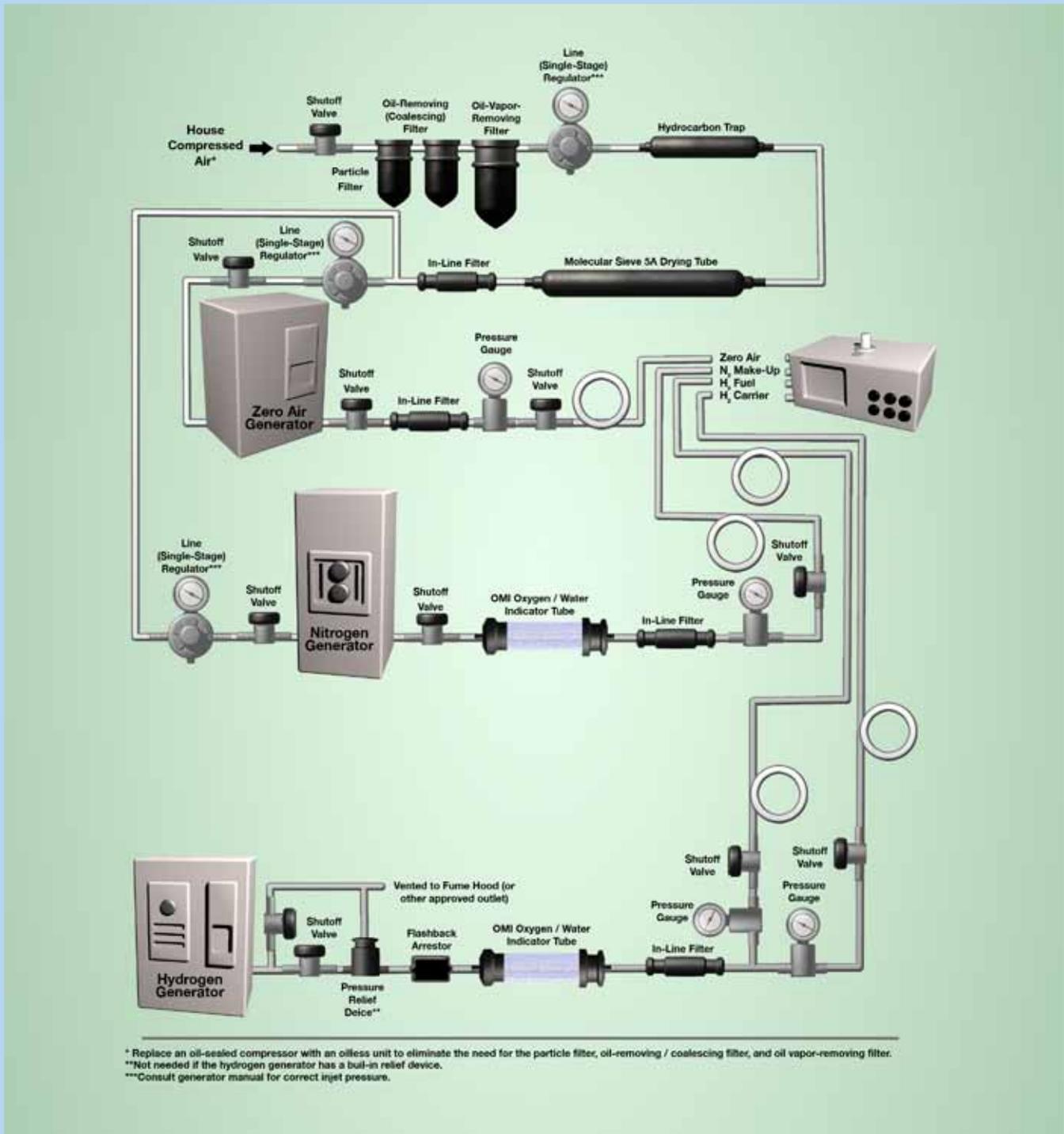
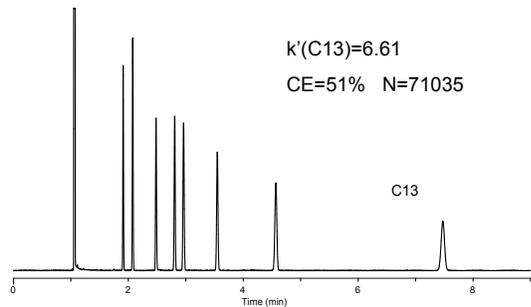


Figure 4: Ideal Configurations for a Single-GC System: All Generator System

Figures 5 to 7 demonstrate the equivalence of Helium and Hydrogen in typical separations.

### Hydrogen

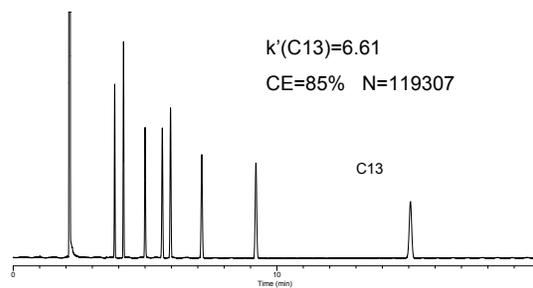


Reprinted with permission from Sigma-Aldrich Co.

Reprinted with permission of Supelco, Bellefonte, PA 16823

**Figure 5:** Equity® 1 Isothermal 50cm/sec Hydrogen Carrier

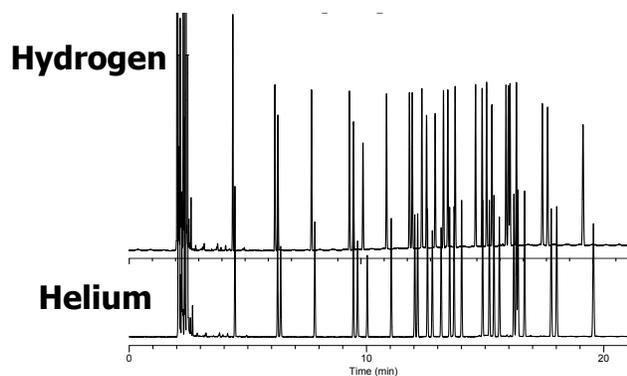
### Helium



Reprinted with permission from Sigma-Aldrich Co.

Reprinted with permission of Supelco, Bellefonte, PA 16823

**Figure 6:** Equity® 1 Isothermal 25cm/sec Helium Carrier



Reprinted with permission from Sigma-Aldrich Co.

Reprinted with permission of Supelco, Bellefonte, PA 16823

**Figure 7:** Bacterial Acid Methyl Esters - 25cm/sec LGR Equity®-1

# Benefits of in-house gas generators

In-house gas generators provide a number of significant benefits to the laboratory, including a dramatic improvement in safety, an increase in convenience, and a lower cost.

## 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 in-house gas generator also eliminates the possibility of injury or damage from the transportation and installation of a gas tank. A gas tank is heavy and can be a hazard to staff and facilities if the valve is compromised during transport (in many facilities, specially trained technicians replace gas tanks). A leaking hydrogen tank could lead to an explosion.

## Maximizing convenience

An in-house gas generator can supply gas on a 24 hr/7 day/week basis with no user interaction (other than routine annual maintenance). 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 in-house system obviates the need to obtain 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 in-house gas generators is that once they are installed, you don't have to worry about the gas supply. Maintenance requirements 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 in-house generator is extremely low; since the gas is obtained from water and maintenance is a few hundred dollars a year for periodic filter replacement.

In contrast, 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 in-house 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 in-house generator is for replacement of filters at perhaps \$1000/year or approximately \$20 per week.

**Table 1 Annual costs: In-house generation vs. high-pressure tanks (in U.S. \$)**

	<b>In-house Generator</b>	<b>Tanks</b>
Maintenance	\$800	\$0
Cylinders	\$0	\$3120
Demurrage	\$0	\$336
Labor (changing cylinders)	\$0	\$1040
Order processing	\$30	\$360
Shipping	\$50	\$3720
Invoice processing	\$10	\$120
Inventory control	\$0	\$72
<b>Total</b>	<b>\$890</b>	<b>\$8768</b>

# Specifications and Ordering Information

## Hydrogen Generators for Fuel and Carrier Gas Specifications

Hydrogen Generators	Models	Specifications
Hydrogen Purity		99.99999+%
Oxygen Content		<.01 ppm
Moisture Content		<1.0 ppm
Max Hydrogen Flow Rate	H2PD-150 H2PD-300 H2-500 H2-800 H2-1200	150 cc/min 300 cc/min 500 cc/min (1) 800 cc/min 1200 cc/min
Electrical Requirements	H2PD-150, H2PD-300 H2-500, H2-800, H2-1200	120 VAC/60 Hz, 3.15 Amps (2) 100-130 VAC/60 Hz (5.3 Amp@120VAC)
Hydrogen Outlet Pressure		Adjustable, 0 to 60 psig or 0 to 100 psig
Certifications		IEC 1010-1; CSA; UL 3101; CE Mark
Dimensions	H2PD-150, H2PD-300 H2-800, H2-1200 H2-500	12"w x 12"d x 22"h (30cm x 33cm x 58cm) 13"w x 17"d x 15.5"h (33cm x 43cm x 39cm) 15"w x 18"d x 13"h (38cm x 46cm x 33cm)
Outlet Port	H2PD-150, H2PD-300 H2-500/800/1200NA	1/8" Compression 1/4" Compression
Shipping Weight	H2PD-150, H2PD-300 H2-500, H2-800, H2-1200	58 lbs (26 kg) 45 lbs (20.4 kg)

### Notes:

- 1 Does not include automatic waterfeed feature and has maximum pressure output of 90 psig. Outlet port is 1/8" compression.
- 2 Contact factory for electrical requirements outside North America.

## Ordering Information

Description	Model Number
Hydrogen Gas Generator	H2PD-150, H2PD-300
UHP Hydrogen Gas Generator	H2-500NA, H2-800NA, H2-1200NA
Electrolyte Solution	920071
Deionizer Bags (2 each, replace every 6 months)	7601132 (for H2-500NA, H2-800NA, H2-1200NA)
Pressure Regulator	W-425-4032-000
Installation Kit	IK7532
Preventive Maintenance plan	H2PD-150-PM, H2PD-300-PM H2-500-PM, H2-800-PM
Extended Support with 24 Month Warranty	H2PD-150-DN2, H2PD-300-DN2 H2-500-DN2, H2-800-DN2, H2-1200-DN2

**Note:** To ensure consistent product performance and reliability, use only genuine Balston replacement parts and filter cartridges.

# Zero Air Generators

Parker Balston® Zero Air Generators are complete systems with state-of-the-art, highly reliable components engineered for easy installation, operation, and long term performance. Parker Balston® Zero Air Generators are much easier to install than dangerous, high pressure gas cylinders, and only need to be installed once! All that is required is a standard compressed air line and an electrical outlet.

Parker Balston Zero Air Generators are easy to operate, there is no complicated operating procedure to learn or any labor intensive monitoring required.

Parker Balston Zero Air Generators eliminate all the inconveniences and costs of cylinder gas supplies and dependence on outside vendors. Uncontrollable vendor price increases, contract negotiations, long term commitments and tank rentals are no longer a concern; Parker Balston Zero Air Generators offer long term cost stability.

There is no need to use valuable laboratory floor space to buy and store excessive reserves to protect yourself from late deliveries, transportation interruptions, or periods of tight supplies. With a Parker Balston Zero Air Generator, you control your supply.



## Zero Air Generator Selection Chart

Model Number	Flow Capacity
75-83NA	1.0 lpm
HPZA-3500	3.5 lpm
HPZA-7000	7 lpm
HPZA-18000	18 lpm
HPZA-30000	30 lpm
76-98N100	140 lpm
76-98N200	280 lpm

## Features & Benefits

- Produce UHP Zero Air from lab house compressed air supply
- Eliminates inconvenient and dangerous cylinders of air, breathing air, or zero air from the laboratory
- Increases the accuracy of analysis and reduces cleaning requirements of the detector
- Recommended and used by major GC and column manufacturers
- Payback period of typically less than 1 year
- Gas purity below 0.05 ppm Total Hydrocarbon Content (as methane)
- Silent operation and minimal operator attention required

# Hydrogen Generators



## Features & Benefits

- Eliminate dangerous and expensive hydrogen gas cylinders from the laboratory
- Produce a continuous or on-demand supply 99.9995% to 99.99999+% pure hydrogen gas
- Compact and reliable - only one square foot of bench space required
- Designed to operate continuously 24 hours a day, 7 days a week
- Certified for laboratory use by CSA, UL, IEC 1010, and CE mark
- Safe - produces only as much gas as you need



Parker Balston Hydrogen Generators eliminate the need for expensive, dangerous, high pressure cylinders of hydrogen in the laboratory. It is no longer necessary to interrupt important analyses to change cylinders.

Generator flow capacities of up to 1200 cc/min. of ultra-high purity hydrogen are available.

Parker Balston Hydrogen Generators are compact benchtop instruments designed for use in the laboratory or in the field.

Hydrogen gas is produced by electrolytic dissociation of water. The resultant hydrogen stream then passes through a palladium membrane.

Only hydrogen and its isotopes can penetrate the palladium membrane; therefore, the purity of the output gas is guaranteed to be 99.99999+% consistently. This technology produces hydrogen at a purity two orders of magnitude greater than competitive technologies using silica gel, desiccants, and drying tubes.

Parker Balston Hydrogen Generators offer many special features to ensure safe and convenient operation. These features include low-water audible alarms to indicate when the water reservoir needs filling and automatic shut-down to protect expensive laboratory equipment.

## Gas Generator Selection Chart

Hydrogen Gas Generator Model Number	Flow Capacity
H2PEM-100*	100 cc/min
H2PD-150	150 cc/min
H2PEM-165*	165 cc/min
H2PEM-260*	260 cc/min
H2PD-300	300 cc/min
H2-500NA	500 cc/min
H2PEM-510*	510 cc/min
H2-800NA	800 cc/min
H2-1200NA	1200 cc/min

\*99.9995% Fuel Grade Purity, no Palladium

# High Purity Nitrogen Generators

Parker Balston Models HPN2-1100, HPN2-2000, UHPN2-1100, 76-97NA, and 76-98NA Nitrogen Generators can produce up to 12.0 lpm of ultra high purity nitrogen gas. These systems are completely engineered to transform standard compressed air into 99.99% or 99.9999% nitrogen, exceeding the specification of UHP cylinder gas.

Nitrogen is produced by utilizing a combination of state-of-the-art purification technologies and high efficiency filtration.

Pressure swing adsorption is utilized for the removal of O<sub>2</sub>, CO<sub>2</sub>, and water vapor. A catalyst module is incorporated in models UHPN2-1100 and 76-98NA to oxidize hydrocarbons from the inlet air supply. The generators also have high efficiency coalescing prefilters and a 0.01 micron (absolute) membrane filter incorporated into each design.

Parker Balston UHP Nitrogen Generators are engineered and packaged in a small cabinet to fit on or beneath any benchtop. The systems eliminate the need for costly, inconvenient high pressure nitrogen cylinders. The HPN2-1100 and UHPN2-1100 are ideal for carrier gas applications. The 76-97NA and 76-98NA are ideal for purging ICP's.



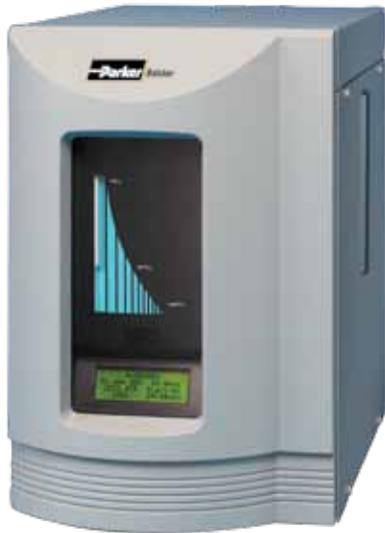
## Nitrogen Generator Flow Chart

Inlet Air Pressure (psig)	Max Outlet Flow (cc/min.)	Max Outlet Pressure (psig)
<b>Models HPN2-1100 and UHPN2-1100</b>		
125	1100	85
110	1000	75
100	900	65
90	800	60
80	700	50
70	600	45
60	500	35
<b>Model HPN2-2000</b>		
75-120	2000	90
<b>Model 76-97NA and 76-98NA</b>		
60-120	12000	83

## Features & Benefits

- Nitrogen Generators for a variety of disciplines including Gas Chromatography, LC/MS, ICP, and Thermal Analysis
- Eliminate inconvenient and dangerous nitrogen cylinders or dewars from the laboratory
- Compact designs free up valuable laboratory floor space
- Offers long term cost stability, uncontrollable vendor price increases, contract negotiations, long term commitments and tank rentals are no longer a concern

# GC Gas Stations



Parker Balston's GCGS-7890 GC Gas Station can provide both hydrogen gas and zero grade air for FID detectors on Gas Chromatographs. This system is specifically designed to provide fuel gas, support air, and hydrogen carrier gas.

Hydrogen gas is produced from deionized water using a Proton Exchange Membrane Cell. The hydrogen generator compartment utilizes the principle of electrolytic dissociation of water and hydrogen proton conduction through the membrane. The hydrogen supply produces up to 500 cc/min of 99.99999+% pure hydrogen with pressures up to 100 psig. Zero Air is produced by purifying on-site compressed air to a total hydrocarbon concentration of less than 0.05 ppm (measured as methane). The zero air supply is up to 3500 cc/min of Zero Grade Air.

The Parker Balston GCGS-7890 GC Gas Station will eliminate all the inconveniences and cost of zero air, helium and hydrogen cylinder gas supplies and dependence on outside vendors. With a GC Gas Station, you control your gas supply. All Parker Balston gas generators meet NFPA 50A and OSHA 1910.103 regulations governing the storage of hydrogen.

Produced and supported by an ISO 9001 registered organization, Parker Balston's GC Gas Station are the first built to meet the toughest laboratory standards in the world: CSA, UL, CE and IEC 1010.

## Features & Benefits

- Ideal for up to 3 FIDs and 3 capillary columns
- Produces UHP Zero Air from house compressed air (< 0.05 ppm THC) and 99.99999+% pure hydrogen in one enclosure
- Eliminates inconvenient and dangerous zero air, helium and hydrogen cylinders from the laboratory
- Increases the accuracy of analysis and reduces the cleaning requirement of the detector
- Recommended and used by many GC and column manufacturers
- Payback period of typically less than one year
- Automatic water fill as standard
- Silent operation and minimal operator attention required

### GC Gas Station Selection Chart

Model Number	# of FIDs	# of Columns
GCGS-7890	Up to 3 FIDs	Up to 3

# Explanation of Warning Symbols

## Symbol



## Description

Caution, refer to accompanying documents for explanation.