Parker ChromGas® Hydrogen Generators

Is your lab wasting money on bottled gas?

by Barry Burger, Petroleum Chemist

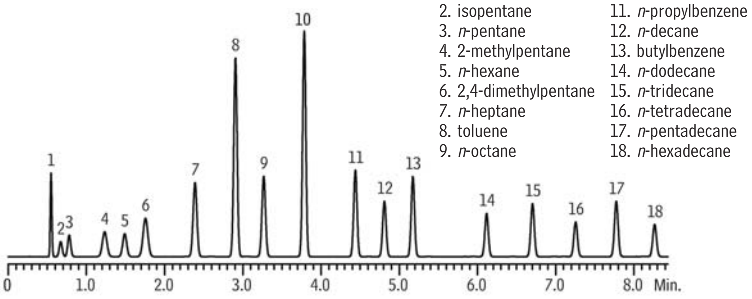
- Economical, continuous source of ultra-pure hydrogen (99.9995%).
- Safe and easy to use and maintain.
- Hydrogen reduces gas costs, cuts analysis time by 50%, increases column lifetimes.

If you use 2-3 cylinders of helium and/or hydrogen per week, as carrier gas and/or fuel gas, bottled gas is an expense in the range of $15,000 to $25,000 per year•, including overhead: expenses and time involved with ordering, transporting, installing, and periodically inspecting cylinders. You also contend with unquantifiable costs, such as floor space lost to an inventory of cylinders. Helium, widely used as carrier gas, is a non-renewable resource extracted from natural gas and, because it is a petrochemical product, its cost will continue to rise, domestically and internationally. Chromatographers must look for cost effective, ultra-pure gas alternatives to supply their instruments and state-of-the-art analytical columns. Fortunately, we do have options.

Past practice in gas chromatography was to select either nitrogen or helium as the carrier gas. Hydrogen wasn't given much consideration, primarily because of flammability and storage issues, even though it offers several distinct advantages over nitrogen or helium. Now, Parker ChromGas® hydrogen generators are a safe, reliable source of ultra-pure (99.9995%) hydrogen, and effective replacements for bottled gas. A Parker ChromGas® hydrogen generator stores less than 50mL of hydrogen (less than 0.002 cubic feet) at 1 atm., or 305mL of hydrogen (0.01 cubic feet) at 6.1 atmospheres (90psig.) From a safety standpoint there is no compromise, compared to a 300 cubic foot cylinder of hydrogen at 2500 psig.

Parker ChromGas® hydrogen generators continuously produce dry, ultra-pure hydrogen by electrolytic dissociation of deionized water and hydrogen proton conduction across a membrane. The hydrogen product is dried by passing it through a coalescing filter, a drying tube, and a desiccant cartridge. Maximum output pressure, 90psig, is controlled to the point of use via a pressure adjust regulator. Other safety features include a pressure relief valve to prevent overpressurization and a

Figure 1 A simulated distillation reference mix is well resolved, in 8 minutes, showing a Parker ChromGas® hydrogen generator can meet gas volume demands.



Column:	Rtx®-1 30m, 0.53mm ID, 5.0µm (cat.# 10179)
Sample:	custom paraffin mix, neat, 2.7-12.9% each component
Inj.:	0.1µL splitless (hold 1 min.), 4mm single gooseneck inlet liner (cat.# 20904)
Inj. temp.:	250°C
Carrier gas:	hydrogen, constant flow (Parker ChromGas® hydrogen generator)
Linear velocity:	184cm/sec. @ 40°C
Oven temp.:	40°C (1 min.) to 265°C @ 25°C/min. (hold 4 min.)
Det.:	FID @ 280°C

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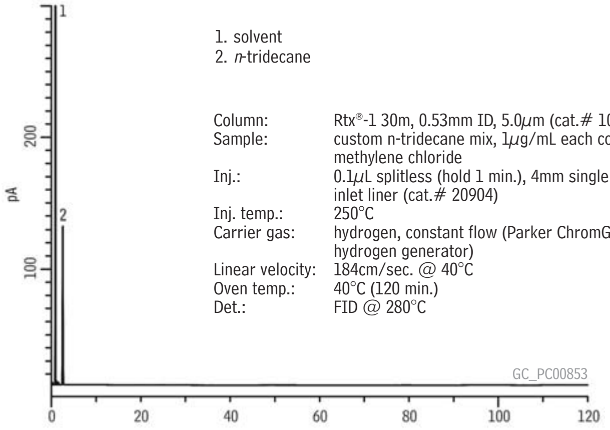
Table 1 Repeatable retention times for simulated distillation mix components confirm the hydrogen generator's steady and precise flow of carrier gas.

				Run Number / Retention Time (min.)									
Component	Mean	SD	%RSD	1	2	3	4	5	6	7	8	9	10
1. ethanol	0.547	1E-03	0.1765	0.546	0.548	0.548	0.548	0.549	0.546	0.547	0.547	0.547	0.548
2. isopentane	0.67	1E-03	0.1484	0.669	0.67	0.671	0.67	0.672	0.669	0.669	0.67	0.669	0.67
3. *n* pentane	0.779	0.001	0.169	0.777	0.779	0.78	0.779	0.781	0.777	0.778	0.779	0.778	0.78
4. 2-methylpentane	1.232	0.001	0.1198	1.229	1.231	1.233	1.232	1.234	1.23	1.232	1.232	1.232	1.233
5. *n*-hexane	1.488	0.001	0.0992	1.485	1.487	1.489	1.488	1.49	1.486	1.488	1.488	1.488	1.489
6. 2,4-dimethylpentane	1.753	0.001	0.0721	1.751	1.752	1.754	1.754	1.755	1.752	1.754	1.754	1.754	1.754
7. *n*-heptane	2.387	0.001	0.0442	2.385	2.386	2.388	2.387	2.388	2.386	2.387	2.387	2.388	2.388
8. toluene	2.904	0.001	0.0356	2.902	2.904	2.905	2.904	2.905	2.903	2.904	2.905	2.905	2.905
9. *n*-octane	3.266	7E-04	0.0214	3.264	3.265	3.266	3.266	3.266	3.265	3.266	3.266	3.266	3.266
10. *p*-xylene	3.784	7E-04	0.0195	3.783	3.784	3.785	3.784	3.784	3.783	3.784	3.784	3.785	3.785
11. *n*-propylbenzene	4.438	5E-04	0.0109	4.437	4.438	4.438	4.438	4.438	4.437	4.437	4.438	4.438	4.438
12. *n*-decane	4.809	4E-04	0.0088	4.809	4.809	4.809	4.809	4.809	4.808	4.808	4.809	4.809	4.809
13. butylbenzene	5.174	5E-04	0.0102	5.173	5.174	5.174	5.174	5.173	5.173	5.173	5.173	5.174	5.174
14. *n*-dodecane	6.116	5E-04	0.0079	6.116	6.116	6.116	6.116	6.116	6.115	6.115	6.116	6.116	6.115
15. *n*-tridecane	6.703	5E-04	0.0077	6.704	6.704	6.704	6.704	6.703	6.703	6.703	6.703	6.703	6.703
16. *n*-tetradecane	7.255	7E-04	0.0097	7.256	7.255	7.255	7.255	7.254	7.254	7.254	7.254	7.254	7.254
17. *n*-pentadecane	7.774	6E-04	0.0081	7.775	7.775	7.775	7.774	7.774	7.773	7.774	7.774	7.774	7.774
18. *n*-hexadecane	8.264	6E-04	0.0069	8.265	8.265	8.264	8.264	8.264	8.263	8.264	8.264	8.264	8.264

Figure 2 Carrier gas from a Parker ChromGas® hydrogen generator assures a stable baseline, for sensitive analyses. Performance equivalent to cylinders, at lower cost.



Column:	Rtx®-1 30m, 0.53mm ID, 5.0µm (cat.# 10179)
Sample:	custom n-tridecane mix, 1µg/mL each component in methylene chloride
Inj.:	0.1µL splitless (hold 1 min.), 4mm single gooseneck inlet liner (cat.# 20904)
Inj. temp.:	250°C
Carrier gas:	hydrogen, constant flow (Parker ChromGas® hydrogen generator)
Linear velocity:	184cm/sec. @ 40°C
Oven temp.:	40°C (120 min.)
Det.:	FID @ 280°C

mass leak sensor to indicate hydrogen demand is exceeding instrument capability, in which case the generator will shut down. A low water level and/or poor quality water also will shut down the generator, to prevent damage to the electrolytic cell.

Maintaining the generator is simple. The 4-liter water reservoir may be filled at any time without shutting down the generator, eliminating the downtime associated with changing gas cylinders. At maximum hydrogen demand, the smallest generator will consume one 4-liter tank of deionized water in 8-10 days. The deionizer bags in the water tank should be replaced twice yearly. An LED indicator will illuminate when the desiccant cartridge requires regeneration.

To evaluate performance, we set up a small Parker ChromGas® hydrogen generator (90mL/min. maximum hydrogen output) to supply both carrier gas and fuel gas to an Agilent 6890 GC. We installed a 30 meter x 0.53mm ID x 5µm df Rtx®-1 column (100% polydimethylsiloxane (PDMS) phase, cat.# 10179) in the oven and set analytical parameters as specified in ASTM D-7096-05, a simulated distillation method, but substituted hydrogen for helium as the carrier gas. We used a column flow rate of 40mL/min., in the constant flow mode, which represented the optimum linear velocity for hydrogen. The 40mL/min. carrier gas flow rate, plus a 40mL/min. flow of fuel gas, was 90% of the generator's maximum output capacity, and tested the generator's capability to meet volume demands.

Figure 1 is a chromatogram of the calibration standard used for retention time-boiling point determination and response factor validation in the ASTM method. The components were well resolved and the analysis completed rapidly, in little more than 8 minutes. Reproducible retention times are vital to obtaining accurate initial boiling point (IBP) data. Table 1 shows retention times for the ASTM reference mix components were well within the method specification of ±0.05 minutes per compound, demonstrating the hydrogen generator's ability to maintain a steady and precise flow of carrier gas. Figure 2 monitors FID baseline stability over 2 hours. These figures and data clearly show that a Parker ChromGas® hydrogen generator is a dependable source of ultra-high purity carrier and fuel gas for demanding GC applications.

On average, yearly electricity and maintenance costs for operating a Parker ChromGas® hydrogen generator are approximately $225•. Offsetting the costs of purchasing and operating a generator with the savings made by not using gas cylinders indicates the generator will pay for itself in 1 to 2 years. With numbers like these, can you afford not to consider purchasing a Parker ChromGas® hydrogen generator for your laboratory?

Parker ChromGas® Hydrogen Generators

- Selectable delivery pressure: 0–100psig.
- High hydrogen purity—99.9995%.
- Greater convenience and safety.

Parker ChromGas® hydrogen generators are certified for laboratory use by Canadian Standards Association (CSA), Underwriters Laboratories (UL), and International Electrotechnical Commission (IEC) 1010.

Hydrogen Purity:	99.9995%
Outlet Port:	1/8" compression
Electrical:	117 Vac/234Vac
Pressure Control:	5 to 20 psig ±0.5% 20 to 90 psig ±0.2%
Delivery Pressure:	2 to 30 psig ±3% 30 to 100 psig ±2%
Shipping Weight:	40 lb (18 kg)
Dimensions:	13"H x 15"W x 14"D (33cm x 38cm x 36cm)

Description	Capacity	cat.#	price
Hydrogen Generator A9090	90cc/min.	22033	$4629
Hydrogen Generator A9150	160cc/min.	22034	$5956
Hydrogen Generator B9200	250cc/min.	22035	$7417
Hydrogen Generator B9400	500cc/min.	22036	$10,006
Replacement Deionizer Bag (for all models, 2-pk.)		21670	$52
Replacement Desiccant Cartridge (for all models)		21671	$203

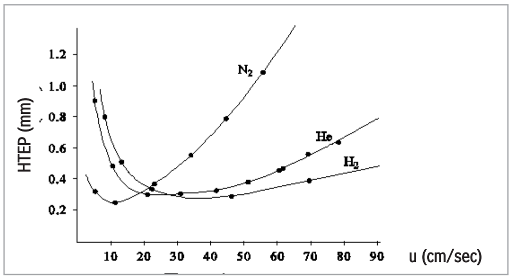
International Power Cord Sets

Location	cat.# suffix	price
United Kingdom (230VAC, 50/50Hz)	-550	N/C
European (230VAC, 50/60Hz)	-551	N/C
IEC Connector Only (230VAC, 50/60Hz)	-552	N/C
Japanese (200VAC, 50/60Hz)	-556	N/C
Japanese for Hydrogen (100VAC, 50/60Hz)	-554	$125

Just add the proper suffix to the catalog number for the gas generator you are ordering.

tech tip

Why use hydrogen as your carrier gas?



Hydrogen, helium, or nitrogen - which do you choose as your carrier gas? We need only look at the van Deemter curves to see the advantages of hydrogen as a carrier gas.Nitrogen generates the highest column efficiency (HETP = 0.22mm), but at an optimum velocity of only 8-10 cm/sec. This great sacrifice in the speed of analysis generally makes nitrogen a poor choice. Column efficiency is slightly reduced with helium (HETP = 0.29mm), but optimum linear velocity is 19-22 cm/sec. With an optimum linear velocity of 35-42cm/sec., hydrogen combines high column efficiency (HETP = 0.28mm) with analysis times 4x faster than nitrogen and 2x faster than helium, thus reducing costs per analysis. Linear velocities of up to 75-80cm/sec. can be used with only a small decrease in column efficiency. Another benefit: lower temperatures are needed to elute analytes, increasing column longevity.

• Cost estimate for USA, in US $.