Gas Supply for Gas Chromatography: How to Compare the Costs of Cylinders and Generators

In addition to being a much more sensible source of gas from a cost standpoint, generators are safer, cosmetically better, take up much less space, and require much less daily and monthly labor than gas cylinders. This bulletin gives examples of how to compare the costs of purchasing and operating hydrogen, nitrogen, and air generators to the costs of using cylinders of these gases.

Key Words:
● carrier gas ● gas generators ● gas chromatography

Many gas chromatographers who have thought about replacing gas cylinders with gas generators have been unsure about how to determine whether there is a worthwhile economic advantage to generators in their particular circumstances. This bulletin gives examples of how to compare the costs of purchasing and operating hydrogen, nitrogen, and air generators to the costs of using cylinders of these gases. Tables on pages 2-5 show how long it would take to repay the purchase cost of a generator with money saved by not using cylinders. Your costs will differ, based on your total cylinder usage, the price you pay for each cylinder, and your choices of manufacturer and model of gas generator. However, these tables give you a format for accurately determining payback times under your specific conditions. There are some situations in which, from an economic standpoint, it is not worth changing to generators. In these situations, however, safety issues could be the driving force for using generators.

Because helium generators are not available, one cannot have every option when switching to generators. However, you can switch from using helium to using hydrogen as your carrier gas. Hydrogen is much less expensive than helium, and replacing helium cylinders with a hydrogen generator will pay for itself in a reasonably short time. In many countries helium is so expensive that use of hydrogen as a carrier gas has been common practice for years, with few if any problems. There are other advantages, in addition to economy – hydrogen has a greater flow range over which efficiency is high and generally appears to be a better carrier gas for capillary gas chromatography.

Cost Comparisons

Gas Generators are Safe, Economical, and Easy to Use

8970029, 9950116,9940085,9970175

How to Determine the Cost of Using Gas Cylinders

Start by carefully estimating the total amount of gas you use per year. For simplicity, we have calculated the number of cylinders of gas needed to maintain various flows 24 hours a day for one year. If you use these gases for a fraction of each day, or only several days each week, you can make adjustments.

We have established values for the cost of a cylinder of gas at our facilities in Bellefonte, Pennsylvania, USA, using current catalog prices for grades of gas reasonably likely to be used for typical gas chromatography applications. Your costs may be higher or lower.

You should include other costs associated with using gas cylinders. You will need two stage regulators and cylinder fasteners. We have calculated costs for these items. There are rental costs associated with the use of cylinders. We have included our local monthly rental rate of $4.87 for one month for one cylinder. This probably is an understatement of actual cost, as we will explain later.

Costs We Did Not Include In Our Evaluation (But Which You Should Calculate and Include)

Several costs associated with using cylinders are not included in the figures we give for yearly cylinder cost. These costs can be important for some chromatographers but not for others, and they are very hard to generalize.

We did not include *labor costs for changing cylinders.* The range of gas consumption we looked at involved changing a minimum of 12 cylinders per year, up to almost 200 cylinders per year. At some sites the labor cost would be for a technician; at other sites cylinders might be changed by a senior or junior scientist. Thus, you must determine your own labor costs. Typically, to change two cylinders at a time will require from half an hour to 1 hour. Multiply the number of changes you make per year by your estimated hourly labor rate to determine the yearly labor cost.

Cylinder rental costs can be a complicated issue – you might be surprised how much you pay simply for renting cylinders. In our calculations, we based cylinder rental cost on one month's use: a cylinder delivered, emptied, and returned in one month. [Most sites incur at least two months of rental per cylinder.] You should inventory your cylinders once a year, to make sure you have the cylinders that your supplier says you have. Many companies find out that their supplier has them credited for more cylinders than they actually have. Then they are billed for the cost of the lost cylinders. A company could face a bill of several thousand dollars – a good part of the cost of a new gas generator. On top of a large bill you could receive some day, you might now be paying monthly rental costs on cylinders you do not have. And, don't forget that inventorying the cylinders can involve one or two full days of chasing down cylinders. This is another labor cost.

Our estimate does not include *equipment items needed to work with cylinders.* If you use gas generators you don't need expensive gas manifolds. This could be a major cost saving if you are building or expanding a lab. If you can completely eliminate cylinders you will not need cylinder carts, special cylinder changing wrenches, or the safety gloves and goggles needed to change cylinders. You may not need the storage shed (and associated maintenance costs) you now use to store cylinders at the time of delivery. You should determine how much your company pays to maintain this area.

We did not include *cylinder delivery or pick-up costs.* Some companies don't pay for these services, but if you do, the cost can be much more than the cost of the cylinders.

There are other hidden costs in using cylinders that we have not included. We believe that the basic, normal costs of cylinder use, in themselves, usually provide sufficient economic justification to promote a switch to generators.

Pricing Generators

When we established costs for generators we included the initial (list) purchase price, plus routine replacement part costs. We did not include repair costs. These could range from $500 to $2000 over the normal life of a generator, depending on the instrument make and model. But repair costs normally do not appear until beyond the timeframe of our tables, and repairs will further extend the life of the instrument.

We did not include the cost of electricity. Like labor, it is hard to set a specific value on this cost. Most lab evaluations do not include the cost of electricity, and we have not found electricity use to operate gas generators to amount to large amounts of dollars. Considering the labor and other costs we ignored when estimating the cost of using cylinders, we felt that ignoring the costs for generator repairs and electricity was a fair balance.

We have assumed that most labs have a source of inexpensive house compressed air. If there is not such a source in your facility, you will need an air compressor to supply nitrogen or air generators. We have included cost and payback figures for these generators both with and without the appropriate compressor.

On page 5 of this bulletin is an evaluation sheet that summarizes two particularly significant values: the time required to recover the purchase cost of the generator (payback time) and, most important, how much you begin to save *after* paying back the cost of the generator. Most people stop their comparison after determining payback time, but the major saving to your company comes from years of having your generators operating with little to no cost for the gas they generate. You do not continually pay thousands of dollars, year after year – you get many years of essentially free gas. In most cases there is very strong justification for replacement if payback is in less than 24 months. With the exception of the low flow hydrogen generators, for which justification is really safety, not economy, most of the generators we evaluated have very short payback times, and the use of generators is often cheaper by thousands of dollars after a few years. Why would anyone using 500cc/minute or more of gas in a lab ever want to use another cylinder?

Table 1. Gas Costs: Hydrogen

0.125 liters/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 65.7m³/year or 2320.2ft³/year)

Packard Model 9100 Hydrogen Generator, 125cc/minute			
Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	4,300	
	desiccant cartridge	150	4,450
2nd year	desiccant cartridge	150	
	deionizer pk.	66	4,666
3rd year	desiccant cartridge	150	
	deionizer pk.	66	4,882
4th year	desiccant cartridge	150	
	deionizer pk.	66	5,098
5th year	desiccant cartridge	150	
	deionizer pk.	66	5,314
6th year	desiccant cartridge	150	
	deionizer pk.	66	5,530

Hydrogen generator versus hydrogen cylinders:
savings after 6 years: $188

Cylinders*		
	Cost ($)	
Item	Hydrogen	Helium
Cylinders/year (N)	(12)	(11)
Price/cylinder	$ 70	$ 171
Cost of gas/year	829	1,820
Cylinder rental/year ($4.87 x N)	58	52
Regulator (1st year only)	350	350
Cylinder fasteners (1st year only)	50	50
1st year costs	1,286	2,272
2 year costs (cumulative)	2,173	4,144
3 year costs (cumulative)	3,059	6,015
4 year costs (cumulative)	3,945	7,887
5 year costs (cumulative)	4,831	9,759
6 year costs (cumulative)	5,718	11,631

Hydrogen generator versus helium cylinders:
savings after 5 years: $4,445
savings after 6 years: $6,101

Table 1. Gas Costs: Hydrogen (contd.)

0.25 liters/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 131.4m³/year or 4,640.3ft³/year)

Packard Model 9200 Hydrogen Generator, 250cc/minute

Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	5,695	
	desiccant cartridge	150	5,845
2nd year	desiccant cartridge	150	
	deionizer pk.	66	6,061
3rd year	desiccant cartridge	150	
	deionizer pk.	66	6,277
4th year	desiccant cartridge	150	
	deionizer pk.	66	6,493
5th year	desiccant cartridge	150	
	deionizer pk.	66	6,709

Cylinders*

Item	Cost ($) Hydrogen	Helium	Your Cost
Cylinders/year (N)	(24)	(21)	
Price/cylinder	$ 70	$ 171	
Cost of gas/year	1,657	3,640	
Cylinder rental/year ($4.87 x N)	115	104	
Regulator (1st year only)	350	350	
Cylinder fasteners (1st year only)	50	50	
1st year costs	2,173	4,144	
2 year costs (cumulative)	3,945	7,887	
3 year costs (cumulative)	5,718	11,631	
4 year costs (cumulative)	7,490	15,374	
5 year costs (cumulative)	9,263	19,118	

Hydrogen generator versus hydrogen cylinders:
savings after 5 years: $2,554

Hydrogen generator versus helium cylinders:
savings after 5 years: $12,409

0.5 liters/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 262.8m³/year or 9,280.6ft³/year)

Packard Model 9400 Hydrogen Generator, 500cc/minute

Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	7,595	
	desiccant cartridge	150	7,745
2nd year	desiccant cartridge	150	
	deionizer pk.	66	7,961
3rd year	desiccant cartridge	150	
	deionizer pk.	66	8,177
4th year	desiccant cartridge	150	
	deionizer pk.	66	8,393
5th year	desiccant cartridge	150	
	deionizer pk.	66	8,609

Cylinders*

Item	Cost ($) Hydrogen	Helium	Your Cost
Cylinders/year (N)	(47)	(43)	
Price/cylinder	$ 70	$ 171	
Cost of gas/year	3,315	7,280	
Cylinder rental/year ($4.87 x N)	231	207	
Regulator (1st year only)	350	350	
Cylinder fasteners (1st year only)	50	50	
1st year costs	3,945	7,887	
2 year costs (cumulative)	7,490	15,374	
3 year costs (cumulative)	11,035	22,861	
4 year costs (cumulative)	14,580	30,348	
5 year costs (cumulative)	18,126	37,835	

Hydrogen generator versus hydrogen cylinders:
savings after 5 years: $9,517

Hydrogen generator versus helium cylinders:
savings after 5 years: $29,226

1.2 liters/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 630.7m³/year or 22,273.5ft³/year)

Packard Model 9800 Hydrogen Generator, 1200cc/minute

Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	14,675	14,675
2nd year	deionizer pk.	66	14,741
3rd year	deionizer pk.	66	14,807
4th year	deionizer pk.	66	14,873
5th year	deionizer pk.	66	14,939

Cylinders*

Item	Cost ($) Hydrogen	Helium	Your Cost
Cylinders/year (N)	(114)	(102)	
Price/cylinder	$ 70	$ 171	
Cost of gas/year	7,955	17,471	
Cylinder rental/year ($4.87 x N)	553	498	
Regulator (1st year only)	350	350	
Cylinder fasteners (1st year only)	50	50	
1st year costs	8,908	18,369	
2 year costs (cumulative)	17,417	36,338	
3 year costs (cumulative)	25,925	54,307	
4 year costs (cumulative)	34,433	72,276	
5 year costs (cumulative)	42,941	90,245	

Hydrogen generator versus hydrogen cylinders:
savings after 5 years: $28,002

Hydrogen generator versus helium cylinders:
savings after 5 years: $75,306

*Scott Specialty Gases TechniMate for HP GC, A size (hydrogen: 196ft³; helium: 218ft³)

Table 2. Gas Costs: Air

1 liter/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 525.6m³/year or 18,561.3ft³/year)

Packard Air Generator, Model 1000

Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	1,500	
	hydrocarbon traps (2)	180	
	oil filter	290	
	oil trap	95	
	particle filter	60	
	mol sieve trap	91	2,216
2nd year	hydrocarbon traps (2)	180	
	mol sieve trap	91	2,487
3rd year	hydrocarbon traps (2)	180	
	mol sieve trap	91	2,758
4th year	hydrocarbon traps (2)	180	
	mol sieve trap	91	3,029
5th year	hydrocarbon traps (2)	180	
	mol sieve trap	91	5,300
with Jun-Air Compressor (Model 200-1.5B, $1,195)			
1st year			3,489
2 years (cumulative)			3,839
3 years (cumulative)			4,189
4 years (cumulative)			4,539
5 years (cumulative)			4,889

Cylinders*

Item	Cost ($)	Your Cost
Cylinders/year (N)	(79)	
Price/cylinder	$ 92	
Cost of gas/year	7,298	
Cylinder rental/year ($4.87 x N)	386	
Regulator (1st year only)	350	
Cylinder fasteners (1st year only)	50	
1st year costs	8,084	
2 year costs (cumulative)	15,768	
3 year costs (cumulative)	23,452	
4 year costs (cumulative)	31,136	
5 year costs (cumulative)	38,819	

Air generator versus air cylinders:
savings after 5 years: $35,520 without compressor; $33,931 with compressor

2.5 liters/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 1314m³/year or 46,403.2ft³/year)

Packard Air Generator, Model 2500

Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	2,700	
	hydrocarbon traps (5)	450	
	oil filter	290	
	oil trap	95	
	particle filter	60	
	mol sieve traps (2)	182	3,777
2nd year	hydrocarbon traps (5)	450	
	mol sieve traps (2)	182	4,409
3rd year	hydrocarbon traps (5)	450	
	mol sieve traps (2)	182	5,041
4th year	hydrocarbon traps (5)	450	
	mol sieve traps (2)	182	5,673
5th year	hydrocarbon traps (5)	450	
	mol sieve traps (2)	182	6,305
with Jun-Air Compressor (Model 200-1.5B, $1,195)			
1st year			5,050
2 years (cumulative)			5,761
3 years (cumulative)			6,472
4 years (cumulative)			7,183
5 years (cumulative)			7,894

Cylinders*

Item	Cost ($)	Your Cost
Cylinders/year (N)	(198)	
Price/cylinder	$ 92	
Cost of gas/year	18,244	
Cylinder rental/year ($4.87 x N)	966	
Regulator (1st year only)	350	
Cylinder fasteners (1st year only)	50	
1st year costs	19,610	
2 year costs (cumulative)	38,819	
3 year costs (cumulative)	58,029	
4 year costs (cumulative)	77,239	
5 year costs (cumulative)	96,449	

Air generator versus air cylinders:
savings after 5 years: $90,144 without compressor; $88,555 with compressor

*Scott Specialty Gases TechniMate for HP GC, A size (air: 234ft³)

Table 3. Gas Costs: Nitrogen

1 liter/minute (x 1/1000m³/liter x 60 min/hr x 24 hr/day x 365 days/year = 525.6m³/year or 18,561.3ft³/year)

Air Products Nitrogen Generator

Time	Item	Cost ($)	Cumulative Total ($)
1st year	generator	6,045	
	OMI-4 tube	250	6,295
2nd year	hydrocarbon filters (2)	80	
	OMI-4 tubes (2)	500	6,875
3rd year	hydrocarbon filters (2)	80	
	OMI-4 tubes (2)	500	7,455
4th year	hydrocarbon filters (2)	80	
	OMI-4 tubes (2)	500	8,035
5th year	hydrocarbon filters (2)	80	
	OMI-4 tubes (2)	500	8,615
with Jun-Air Compressor (Model 2000-40MD, $5,975; $482 annual electricity cost; $50 annual filter replacement)			
1st year			12,802
2 years (cumulative)			13,382
3 years (cumulative)			13,962
4 years (cumulative)			14,542
5 years (cumulative)			15,122

Cylinders*

Item	Cost ($)	Your Cost
Cylinders/year (N)	(81)	
Price/cylinder	$ 114	
Cost of gas/year	9281	
Cylinder rental/year ($4.87 x N)	396	
Regulator (1st year only)	350	
Cylinder fasteners (1st year only)	50	
1st year costs	10,077	
2 year costs (cumulative)	19,754	
3 year costs (cumulative)	29,431	
4 year costs (cumulative)	39,108	
5 year costs (cumulative)	48,786	

Nitrogen generator versus nitrogen cylinders:
savings after 5 years: $40,171 without compressor; $33,664 with compressor

*Scott Specialty Gases TechniMate for HP GC, A size (nitrogen: 228ft³)

Potential Savings from Using Gas Generators

Hydrogen Generator vs Hydrogen ($70/cylinder) or Helium ($171/cylinder) Cylinders#

Number of Detectors[1]	Gas Flow cc/min	Cylinders per year	Payback Period (months) Hydrogen	Payback Period (months) Helium	Potential Savings After 5 Years ($) Hydrogen	Potential Savings After 5 Years ($) Helium
3 FIDs	125	12	70	30	-483	4,445
7 FIDs	250	24	42	19	2,554	12,409
14 FIDs	500	48	27	12	9,517	29,226
34 FIDs	1200	114	21	10	28,002	75,306

Nitrogen Generator vs Nitrogen Cylinders ($114/cylinder)#

Number of Detectors[2]	Gas Flow cc/min	Cylinders per year	Payback Period (months)	Potential Savings After 5 Years ($)
33	1000	81	8	40,171
w/ compressor*	1000	81	17	33,664

Air Generator vs Air Cylinders ($92/cylinder)#

Number of Detectors[3]	Gas Flow cc/min	Cylinders per year	Payback Period (months)	Potential Savings After 5 Years ($)
2 FIDs	1000	80	3.5	35,520
w/ compressor**	1000	199	5.5	33,930
7 FIDs	2500	80	2.5	90,144
w/ compressor**	2500	199	3	88,555

[1]35cc/min to each column.

[2]Make-up gas, 30cc/min to each column.

[3]350cc/min to each detector.

*Air generator plus Jun-Air oilless air compressor, Model 2000-40MD.

** Air generator plus Jun-Air oilless air compressor, Model 200-1.5B.

#Cylinders: Scott Specialty Gases TechniMate for HP GC, A size (air: 234ft³; hydrogen: 196ft³; helium: 218ft³; nitrogen: 228ft³). Prices for cylinders are estimated at Bellefonte, PA and are for illustrative purposes; your prices probably will differ.

How Safety Considerations Affect Decisions

Every company considers safety and environment concerns to be among their highest concerns. They also can be the quickest pathway to justifying purchase of gas generators. Safety plays a major part in justifying hydrogen generators, but also plays a role in decisions concerning other generators.

Hazards at your site affect your company's insurance rating, and consequently the cost you pay for insurance. The removal of hydrogen cylinders could reduce costs in your plant. Most insurance companies look at hydrogen cylinders – 200 cubic feet or more of flammable, explosive gas at 2000-3000psi of pressure – as a risk. With this much gas in cylinders, large manifold systems, and lengthy tubing runs, you are vulnerable to accidents. Any break in a line can feed hydrogen into the room until the entire cylinder is empty. Hydrogen in the room may reach explosive levels. During any OSHA inspection the inspection team will want to look at how you handle these cylinders: Are they segregated from oxidants? Are they properly secured? Generators do not have these potential problems; they have automatic safety shutoff systems. Any time a large pressure decrease or large flow increase is sensed the generator automatically shuts off. If a line breaks, less than 200cc of hydrogen is released, in contrast to nearly 200 cubic feet of hydrogen from a cylinder.

The explosive nature of hydrogen aside, there are many other safety issues to consider with high-pressure cylinders. These hazards may not create a problem for years – or not at all – in your facility, but you should plan to avoid them, because accidents can happen. The biggest concern is that a full gas cylinder will be dropped, the valve will break off, and the cylinder will become a rocket. Although the occurrences are rare, cylinders have been known to shoot down hallways, smash through walls, and damage anything and everything in their path. Even dropping a full cylinder on its flat end can weaken it and, in fact, this is one of the largest causes of cylinder failure next to rust. You also must be careful every time you open a cylinder. Will the regulators retain the pressure, or will they fail and release full pressure into the lines? Very few labs build their plumbing systems to hold 2000-3000psi. Control devices downstream from the regulator would be ruined. Bourdon tubes in pressure gauges could burst and blow out the lens on the gauge – possibly causing injury. Such pressures are never encountered in systems with gas generators – pressures in these systems rarely exceed 125psig.

Transportation of cylinders creates additional safety concerns. Through numerous handling steps, you must take care never to drop a cylinder. The cylinders must be transported on carts, secured with chains, from the storage area to the site where they are to be used. This often means going up ramps or through long hallways. You must remove the chains to take cylinders out or return them. Do you always feel that a few chains adequately secure ten to twenty cylinders in the corner of a shed? Unsecured cylinders can fall over; such accidents occur every day. You should wear protective gloves, but even so you can bruise or break fingers between cylinders. Although less hazardous, the empty cylinder must make the return trip. The empty cylinder actually contains 25 to 100psi of gas you have paid for but cannot use, because the supplier insists that you return the cylinder with pressure in it. If you do not, he will charge a high cleaning and purging rate for the cylinder. Empty cylinders typically are stored in a separate area away from full cylinders, requiring still more costly space. Compare all this effort and potential problems to the time involved with adding deionized water or changing a few filters once a year – the only maintenance needed to maintain the efficient operation of a generator.

The cosmetic side of using cylinders also is unpleasant – cylinders are not conducive to the image of a nice-looking site. Transporting cylinders brings dirt though the facility and may leave track marks on the floor. It is very hard to clean around cylinders; the floor often has rust marks and dirt that cannot be removed. The tubing used to conduct the gas to the benches often is unsightly and hard to hide. The outside storage area becomes a site for bird nests, rodent homes, and spider webs. In contrast, generators present a neat and tidy appearance.

In summary, in addition to being a much more sensible source of gas from a cost standpoint, generators are safer, cosmetically better, take up much less space, and require much less daily and monthly labor than gas cylinders. There are time and safety advantages for anyone willing to convert to generators, and real cost advantages if your requirements for hydrogen, nitrogen, or air are greater than 500cc/min.

Ordering Information:

Packard 9000-Series Hydrogen Generators■

9940085

Generate ultra-high-purity hydrogen — reliably and with complete safety.

Packard hydrogen generators eliminate the hazards of high pressure cylinders and the dangers of alklaine electrolyte solutions.

- Regulated low pressure (2-100psig)
- No caustic solutions
- Minimal maintenance
- Long-life solid polymer electrolyte
- Produces 99.99999+% pure hydrogen gas

- CE approved
- UL listed
- CSA listed
- IEC 1010 certified
- Satisfies OSHA and NFPA requirements

Maintenance Requirements

Water Reservoir:	Refill as needed with deionized water (500,000 ohm/cm minimum)
Deionizer Bag:	Replace every 6 months, or whenever Charge Water indicator is on
Desiccant Cartridge:	Recharge (dry) or replace when cartridge turns from blue to pink

Request Product Brochure 696002.

Description	Cat. No.
Packard Hydrogen Generators	
Model 9100, 125cc/min	**22841**
Model 9200, 250cc/min	**22751**
Model 9400, 500cc/min	**22801**
Model 9800, 1200cc/min	**22835**
Replacement Parts	
Indicating Drying Cartridge•	**22837**
Deionizer Pack (box of 2)	**22963**

• Replaces desiccant cartridge discontinued by manufacturer.

Packard Zero Air Generators■

9950116

- CE approved
- UL, CSA listed
- IEC 1010 certified

A hazard-free alternative to pressurized gas cylinders.

These zero air generators produce ultra-high-purity (UHP) air from a standard compressed air supply, at continuous flow rates up to 2500cc/min, at pressures up to 125psig, with less than 0.1ppm total hydrocarbons. We recommend a Zero Air Generator for use with flame ionization detectors. The resulting noise reduction and improved baseline stability allow lower detection limits, increasing the sensitivity of your analyses.

The system consists of three stages: a 0.5µm coalescing inlet filter removes particles, oil, and water, a heated catalyst removes hydrocarbons, and a 0.01µm cellulose fiber outlet filter removes residual particulate material from the finished air stream. Maintenance is minimal: just clean the inlet and outlet filters every six months and change them every two years.

- Requires only house compressed air and a standard electrical outlet to produce UHP zero air.
- Reduces total hydrocarbons to less than 0.1ppm, improving detection and stabilizing baselines.
- Eliminates the need for cumbersome tanks and expensive safety cabinets – short payback periods.

Description	Cat. No.
Packard Zero Air Generators	
Model 2500 (110 VAC, 2500cc/min)	**22812**
Model 2501 (220 VAC, 2500cc/min)	**22814**
Model 1000 (110 VAC, 1000cc/min)	**22824**
Model 1001 (220 VAC, 1000cc/min)	**22830-U**
Replacement Filters	
Models 2500/2501	
inlet	**22818-U**
outlet	**22817**
Models 1000/1001	
inlet and outlet	**22817**

■ CE approved.

Air Products Nitrogen Generator

ECD-grade nitrogen – guaranteed!

- Economical and convenient
- Meets critical specifications for GC carrier gas purity
- No power required

9970175

This unit produces up to 1000cc of high-purity nitrogen/minute from your compressed air supply. It provides convenience and a significant cost savings, relative to using gas cylinders.

Selective permeation through polymeric hollow fiber membranes separates nitrogen from other air components – there are no moving parts to make noise or wear out.

Specifications

Nitrogen Purity:	Moisture:<0.5ppm Oxygen: <0.5ppm Halocarbons/Hydrocarbons: <2.0ppb
Outlet Pressure:	60-100psig (4.2-7.0kg/cm^2)
Flow:	0-1000mL/min
Inlet Air Requirement:	Moisture: <200ppm Hydrocarbons: <1.0ppm Particles: <5 microns
Inlet Pressure:	60-120psig (4.2-8.4kg/cm^2)
Dimensions (H x W x D):	31 x 13¼ x 13¼" (79 x 34 x 34cm)
Weight:	50.2 lbs. / 23kg
Outlet:	¼" female NPT

One-year warranty from Air Products.

Description	Cat. No.
Chromatographic Nitrogen Generator	**22753**
Replacement Parts	
0.1µm Filter Element with O-ring	**22796**
0.02µm Filter Element with O-ring	**22797**
Hydrocarbon Filter with O-ring	**22798**
OMI-4 Indicating Purifier	**23909**
Seal Kit for OMI-4 Indicating Purifier	**23917**
Swagelok to 1/4" NPT Connectors	
brass, pack of two	
1/8" Tube	**22066**
1/4" Tube	**21519**

Jun-Air Oilless Air Compressors■

- Oilless, dry, clean – no potential source of contamination
- Quiet and vibrationless
- CE approved
- UL and IEC listed

More than 30 years of experience and product development keep Jun-Air the leader in compressor technology. These compressors produce GC-quality compressed air quietly and reliably. Highly efficient cooling enables you to run the compressor continuously. The Model 2000-40MD compressor is ideal for use with the Air Products nitrogen generator; all models are compatible with the zero air generators in our catalog.

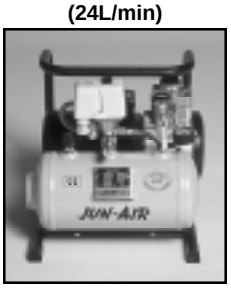
Model 2000-40MD (100L/min)

9970090

Model 600-25MD (42L/min)

8970029

Model 200-1.5MB (24L/min)



8970033

Two-year warranty.

Characteristic	2000-40MD	600-25MD	200-1.5B
Flow (liters/min at 4 bar)	100	42	115VAC: 14 220VAC: 24
Weight (kg)	115	86.5	14.8
Size (LxWxH in cm)	57x63x79	78.5x45x57	30.5x39x30.5

Request product specification sheets 497077, 498010, 498011.

Description	Cat. No.
Model 2000-40MD	**22825**
Model 200-1.5B	
115VAC	**503746**
220VAC	**503754**
Model 600-25MD	
115VAC	**503762**
220VAC	**503770**
Intake Replacement Filters*	
for Model 2000-40MD	**23153**
for Model 600-25MD	**503797**

* Compressors require two filters.

■ CE approved.