Industrial Nitrogen Gas Generation
Technology Overview

ENGINEERING YOUR SUCCESS.
Industrial Nitrogen Gas Generation

Parker offers a comprehensive range of nitrogen gas generation systems that enable users to produce their total demand for nitrogen gas, on their premises, under their complete control.

Benefits:

- **Up to 90% cost savings**
  Typical capital pay-back is achievable within 12-24 months

- **Energy savings**
  Produces nitrogen from standard compressed air supply. No gas is wasted, returned in part used cylinders or lost through boil-off. Economy stand-by stops air usage when no gas is required

- **Convenient and safe**
  The easy to use systems are simple to install, require minimal maintenance and eliminate safety hazards associated with traditional gas supplies

- **Space saving design**
  The compact design means the systems demand less floor space

- **Flexible and modular**
  The module concept allows the generators to grow with the factory/requirement

- **Reduced carbon footprint**
  The elimination of cylinder deliveries and transportation means carbon footprint can be reduced

Parker designs and manufactures generators, encompassing two core technologies; hollow fibre membrane and pressure swing adsorption (PSA). Due to this diverse product offering, there is a Parker solution available for almost any and every application which may use nitrogen gas.
Hollow Fibre Membrane

Membrane technology uses bundles of hollow fibres contained within a tube. The fibre walls selectively separate compressed air by diffusing oxygen and other waste gases to the atmosphere while retaining nitrogen and allowing it to pass through the centre of the fibres to the application.

Parker is one of the few manufacturers in the world that produces hollow fibre membrane technology used for the generation of nitrogen gas.

The fibres are made from Polyphenylene Oxide and are “spun” at one of the company’s modern production facilities.

This provides Parker with complete control over the quality of the fibres produced which are the most permeable and one of the most robust available.

In-turn, this benefits customers by offering a product that is long lasting, efficient and with very low cost of ownership.

Magnified image of a single hollow fibre showing dense 40 nanometre outer skin. Actual fibre diameter is approximately 0.5mm.

Highly magnified image showing fibrous support layer between inner and outer fibre walls.
Low Cost of Ownership

Parker fibres are the most permeable available, which means they can operate at inlet air pressures as low as 4 bar g, thus reducing energy and operating costs.

In addition, less fibres are needed for a given volume of gas, helping to reduce the generator size and cost. Moreover, the fibres are extremely robust ensuring less sensitivity to contamination and a long fibre life.

<table>
<thead>
<tr>
<th>Parker Generators Require Fewer Membranes</th>
<th>Parker Membranes Require Lower Compressed Air Pressure</th>
<th>Parker Membrane Fibres Are Very Robust</th>
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<tbody>
<tr>
<td>Less weight</td>
<td>Less maintenance</td>
<td>Less sensitive to contamination</td>
</tr>
<tr>
<td>Lower investment in membrane modules</td>
<td>Generators are designed for lower inlet air pressure</td>
<td>Longer fibre life</td>
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<tr>
<td>Smaller generators</td>
<td>Less noise and heat produced</td>
<td></td>
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<td></td>
<td>Lower energy consumption</td>
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LOWER COST OF OWNERSHIP

Gas separation via membrane technology
Operational Factors for Parker Membrane Technology

Compressed Air Inlet Pressure

Parker membrane nitrogen generators operate at air inlet pressures ranging from 4 bar g to 13 bar g. The higher the air inlet pressure the more nitrogen gas can be produced from a given fibre.

Compressed Air Inlet Temperature

Parker membrane nitrogen generators can operate at compressed air inlet temperatures ranging from 10°C to 40°C. The optimum temperature range is between 20°C to 30°C. At 10°C and 40°C correction factors apply to the nitrogen outlet flow rate and inlet air consumption.

Nitrogen Purity

Parker membranes can provide nitrogen gas with a maximum remaining oxygen content range from 0.5% to 5%. The more oxygen produced within the outlet gas stream, the higher the nitrogen flow rate and lower the air consumption per given fibre. Unlike the majority of other membrane products available, Parker fibres are pre-aged in the factory, which means the performance does not deteriorate over time.

Flow - Purity Graph Membrane technology (7 bar g)
PSA Technology

Pressure swing adsorption, (PSA), technology uses columns of carbon molecular sieve, (CMS), to separate compressed air. Oxygen and other waste gases are selectively adsorbed under pressure by the CMS, allowing nitrogen to pass through to the application.

CMS technology

The CMS is regenerated by releasing the pressure in the columns and venting the waste gases to the atmosphere.

The technology is called pressure swing adsorption because the operating pressure “swings” from 0 bar g up to typically 7 bar g to adsorb oxygen and from 7 bar g back to 0 bar g to desorb and release the waste gases.

Pairs of extruded aluminium columns are filled CMS. Pre-treated compressed air enters the bottom of the ‘online’ column and flows up through the CMS. Oxygen and other trace gases are preferentially adsorbed by the CMS, allowing nitrogen to pass through. After a pre-set time the on-line column automatically switches to regenerative mode, venting contaminants from the CMS. Carbon molecular sieve differs from ordinary activated carbons as it has a much narrower range of pore openings. This allows small molecules such as oxygen to penetrate the pores and separate from nitrogen molecule that are too large to enter the CMS. The larger nitrogen molecules by-pass the CMS and emerge as the product gas.
The Equalisation Process

The majority of MAXIGAS models from the PSA range (50 ppm to 5%), incorporate a process called "equalisation" to further improve efficiency and reduce operating costs.

To achieve equalisation, four additional valves are included.

Two equalising valves (one each top and bottom connecting columns A and B) plus two back-fill valves (one between column A and buffer tank and one between column B and buffer tank).

For the purposes of describing the principle, assume a MAXIGAS model operates on a 50 second / 50 second cycle time with 10 bar g air inlet pressure.

The equalising sequence would be:

1) After fifty seconds, column A is pressurised to 10 bar g and column B has de-pressurised at 0 bar g, all valves close.

2) Then for approximately two seconds, both equalising valves open (one top and one bottom of column) resulting in a pressure balance or "equalisation" of 5 bar g in each CMS bed.

3) After two seconds, both equalisation valves close.

4) Column B “valve to buffer” opens and the unit cycles with column B beginning to pressurise normally.

This “valve to buffer” creates a secondary force. The two additional solenoid valves between each column and the buffer tank allow a nitrogen “back-fill”.

This back-fill saturates the bed being pressurised which, in-turn, creates greater back pressure on the inlet air resulting in longer contact time with the CMS.

Longer contact time allows more oxygen to be removed.

This means that when compared to a non-equalising system, for a given volume of CMS, more nitrogen gas can be produced.

As column B begins pressurisation, column A now de-pressurises but because it is now at 5 bar g pressure instead of 10 bar g, only half the amount of air is exhausted which is why better air to nitrogen ratios are possible.

This means that when compared to a non-equalising system, for a given purity less compressed air is used.

However this process is not used on all of the Parker PSA range and is excluded on the higher purity 10 ppm as well as the MIDIGAS models.
The Snow Storm Filling Process

The design of the columns enable a filling process for the CMS called snow storm filling. This ensures maximum packing density to prevent the sieve bed moving and leaving leakage paths.

The advantages gained by using snow storm filling are:

- **The CMS bed cannot move or settle.** This prevents CMS granules from rubbing together and wearing away, (attrition), which reduces the life of the CMS and requires constant topping up.

- **There are no leakage paths for the compressed air to find, so all of the CMS is utilised.** This gives a very stable performance with maximum efficiency whilst reducing the overall amount of CMS required.

MAXIGAS and MIDIGAS aluminium columns and manifolds are alochromed. This is a type of hard anodizing process that ensures complete corrosion protection and a very long service life. The alochromed surface also provides an ideal substrate for the external powder coating finish, making sure it will not chip or peel, keeping the generator protected and looking good throughout its service life.
Operational Factors for Parker PSA Technology

**Compressed Air Inlet Pressure**

Parker PSA nitrogen generators operate at air inlet pressures ranging from 6 bar g to 15 bar g.* The higher the air inlet pressure the more nitrogen gas can be produced from a given volume of CMS.

*Inlet pressure up to 18 bar g available - Please contact Parker.

**Ambient Air Temperature**

Parker PSA nitrogen generators can operate at ambient air temperatures ranging from 5°C to 50°C. The optimum temperature range is between 20°C to 25°C. Outside of the optimum temperature range, correction factors apply to the nitrogen outlet flow rate and inlet air consumption.

**Nitrogen Purity**

Parker PSA technology can provide nitrogen gas with a maximum remaining oxygen content range from 10 ppm to 5%. The more oxygen produced within the outlet gas stream the higher the nitrogen flow rate and lower the air consumption per given generator model.

**Flow - Purity Graph PSA technology (7 bar g)**

![Graph showing flow rate against purity for MAXIGAS and MIDIGAS](image-url)
Parker Industrial
Gas Generation Products

Membrane technology models

• NitroFlow Basic
  Mobile and wall mount options available. 7.6 to 43 L/min

• NitroSource
  2.1 to 5000 m³/hr

• NitroFlow
  Low pressure models
  1.1 to 13.6 m³/hr
  High pressure models
  1.7 to 45 m³/hr

PSA technology models

• MAXIGAS
  1.7 to 5000 m³/hr

• MIDIGAS
  0.55 to 33.3 m³/hr
Simple Installation

Both technologies are designed for use with standard industrial oil lubricated rotary type compressors, using either spare capacity from a central factory air compressor, or from a compressor dedicated to the nitrogen generation system.

**Membrane typical installation**

![Membrane typical installation diagram]

**PSA typical installation**

![PSA typical installation diagram]
Compressed Air Pre-treatment

The quality of the compressed air used is important to maintaining the purity and efficiency of the nitrogen generator. The main contaminants that need to be removed include oil, particulate and water.

The NitroFlow and NitroSource membrane nitrogen generators have built-in filtration to remove oil and particulate contamination. To remove water vapour to an acceptable level, the generator needs to be protected by an existing or dedicated refrigerant type compressed air dryer with a pressure dew point better than 5°C.

The MAXIGAS and MIDIGAS PSA nitrogen generators require compressed air purification from an external source. This is typically provided by the appropriate Parker DME/N₂ or DAS/N₂ desiccant dryer and filtration package, this is designed to provide exactly the right quality compressed air for the nitrogen generator and also has the benefit of being controlled by the generators integral economy stand-by system.

Inlet compressed air quality to nitrogen generator

<table>
<thead>
<tr>
<th>Technology</th>
<th>Particulate</th>
<th>Oil</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane</td>
<td>-</td>
<td>&lt;3 mg/m³</td>
<td>&lt;5°C pdp</td>
</tr>
<tr>
<td>PSA</td>
<td>0.01 microns</td>
<td>0.01 mg/m³</td>
<td>-40°C pdp</td>
</tr>
</tbody>
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Under certain conditions it may be necessary to consider the inclusion of an activated carbon stage such as Parker’s OVR range. Please consult Parker for further details.
Interfaces (Controllers)

Both Parker membrane and PSA generators incorporate a user friendly control panel to display performance information and to permit adjustment of operating parameters.

Membrane technology control panels

NitroFlow Basic and NitroFlow

These models use a simple touch screen controller to display:

- Output gas oxygen level
- Output gas flow
- Output gas pressure

Outputs are available for:

- Digital remote stop start
- 0-20 milli Amp remote oxygen level and outlet pressure indication
- 48 Volt, 1 Amp, AC/DC remote alarm contacts

Additional access to analyser calibration, event log, alarm level settings, pressure settings and service data is available via password protected menus.

NitroSource

- Touch Screen controller to display
- Output gas oxygen level
- Output gas flow
- Output gas pressure
- Inlet air temperature

Outputs are available for:

- Remote monitoring of air inlet pressure, nitrogen outlet pressure, nitrogen flow rate and oxygen level.
- Digital remote stop start
- 5-220 Volt, 0.01 – 2.5 Amp, AC/DC remote alarm contacts

Additional access to analyser calibration, event log, alarm level settings, pressure settings and service data is available via password protected menus.
PSA technology control panels

MAXIGAS and MIDIGAS Controller

These models use a simple controller to display:

- Output gas oxygen level
- Running/Stand-by/Economy modes
- Service
- Alarm

Outputs are available for:

- Volt-free alarm contacts
- 4-20 milli Amp remote oxygen level indication
- Remote stop/start
- MODBUS*

Additional access to analyser calibration, event log, alarm level settings, pressure settings and service data is available via password protected menus.

*For further information on MODBUS please contact Parker.

Economy Control

Parker membrane and PSA nitrogen generators are equipped with energy saving features including economy stand-by control.

This is a system that stops the nitrogen generator consuming air when nitrogen is not required.

As soon as a demand for nitrogen is detected while the generator is in economy mode, it will resume gas production.
**Minimal Maintenance**

Both Parker membrane and PSA technology nitrogen generators are designed for maximum reliability with minimum maintenance.

Only occasional calibration of the oxygen analyser is required. This is a simple task that can be carried out by the operator in just a few minutes. The generator can be left on-line producing gas whilst calibration is performed.

Maintenance is generally limited to the replacement of compressed air filter media and basic operational checks every 12 months.

Over the longer term the oxygen cell will need replacing along with some of the control valves on the PSA models.

A range of standard service kits are available through Parker authorised outlets to ensure quick and easy scheduled maintenance.

The CMS used with PSA models is not a consumable component and is installed for the life of the generator.

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**Flexible multi-bank option**

Both Membrane and PSA technologies are modular in design to provide flexibility as they can be multi-banked and configured to suit greater flow rate applications, or can be added to installations as and when the nitrogen demand increases.

Additional modules can provide extra capacity on standby or service backup for peace of mind.

**Fits through a standard doorway**

The compact design also means the units can fit through standard doorways, eliminating the need for special access or facility structural dismantling during installation.