Membrane modules for nitrogen and oxygen generator systems

Technology Overview

ENGINEERING YOUR SUCCESS.

Parker modules the heart of OEM tailor-made nitrogen generators

OEM (Original Equipment Manufacturer) customers use Parker membrane modules to manufacture custom-made and turnkey nitrogen and oxygen systems. These systems are installed at end-users; therefore Parker membrane modules need to provide the best solution for both the OEM and end-user customer.

Parker has identified the most important needs for both customers, show why Parker membrane modules are the best solution for custom-made nitrogen and oxygen generators.

Parker's value to OEM customers

Parker understands that the number one priority of an OEM customer is to purchase membranes at the best size, price and performance and to meet the specified compressor capacity.

Due to the high product gas flow per module and its relatively small dimensions, the Parker membrane modules allow OEM customers to reduce module investment while meeting both nitrogen gas and feed-air specifications and simultaneously reducing the number of modules and interconnections within the system. This not only results in a smaller investment cost, but also allows for a lightweight system with a small system footprint.

Parker value to end-users

Not only is great importance attached by the end-user to reliability of the complete system including the air compressors and associated equipment within the membrane generator, but also maintenance and availability of user serviceable parts.

Parker membrane modules are the most robust in the world and when provided with the correct pre-treatment, life expectancy can exceed 10 years. Additionally, SmartFluxx membrane modules allow compressors to operate at their optimum working pressure of 100 to 115 psig, which increases reliability of the complete system.

Air compressor choice is influenced by the membranes selected. Parker membranes operate at an optimum pressure of 100 to 115 psig while competitive membranes prefer a higher inlet pressure of 145 to 180 psig. A lower operating pressure provides the following benefits:

1. **The optimal working pressure of industrial compressors is 100-115 psig because the fact that oil in oil lubricated compressors reduces their life-time by 50% at every 10 degrees temperature increase when they are operated on a higher pressure. Therefore compressor availability is optimum at these pressures**
2. **Investment costs are lower for low pressure compressors**
3. **Increased life-time of an air compressor**
4. **Less noise and heat production (the more the air is compressed, the more the outlet compressed air temperature)**
5. **Less condensate formed during compression which results in less wear and tear of drain traps and prefiltration**
6. **With every 15 psig pressure increase, a compressor consumes significant more energy. A general rule of thumb is 7% per 15 psig increase. When a process requires low nitrogen pressure (for instance 2 – 5 psig for blanketing) it is most economic to generate nitrogen at the lowest possible pressure.**
7. **Design pressure of the whole compressed air and nitrogen system can be lower which results in thinner piping- and pressure vessel materials which ultimately results in fewer welding hours. This will reduce the systems costs significantly!**

Besides offering the heart of the nitrogen turnkey systems, the Parker membranes, Parker offers the best solutions for feed air treatment packages. Parker has an extensive product range including refrigerant dryers, coalescing filters, dust filters, desiccant dryers, active carbon absorbers, condensate drain traps, instrument manifolds, small valves including actuators, filter regulators, fittings and tubing. Parker Distributors can offer all components and equipment in a single package.

Parker Membrane Modules

Parker offers a comprehensive range of membrane modules which can be used to build custom-made nitrogen or oxygen-enriched air generator systems.

Standard OEM membrane module sets

A complete range of membrane module sets offers the possibility to integrate a nitrogen or oxygen enriched-air source. Requirements can always be met thanks to the different sizes and membrane performances available.

Fluxx versus Oxy modules

Parker distinguishes two types of modules i.e. Fluxx and Oxy modules. The Fluxx modules (HiFluxx® and SmartFluxx®) are designed to produce nitrogen enriched air. The Oxy modules (EnOxy®) are designed to produce oxygen enriched air.

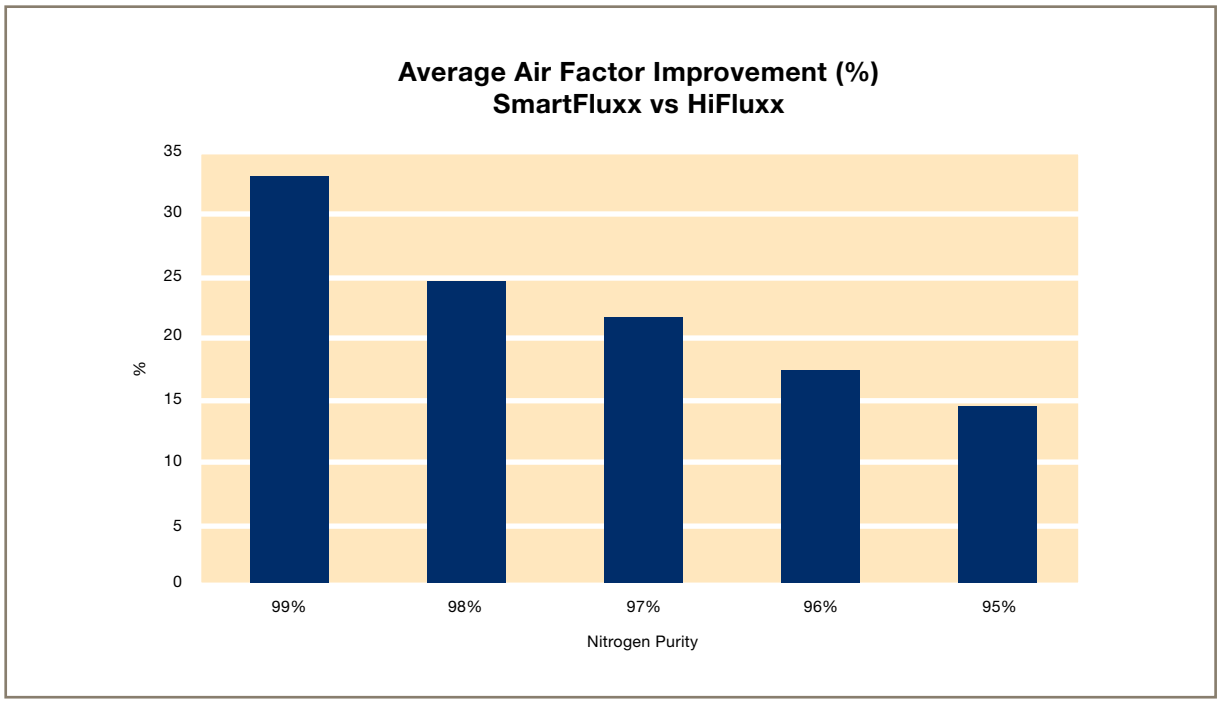
SmartFluxx versus HiFluxx

The market recognizes that Parker HiFluxx modules are the most productive membrane modules available in the world today. Accordingly, investment costs are the lowest, i.e., a system requires fewer modules when compared to competitive membranes. Parker technology is ideal for nitrogen gas at lower purities (95-98%).

SmartFluxx modules have a reduced air factor (=air consumption) when compared to HiFluxx modules.

For technical data, Parker refers to their Product Information Sheets.

To give an indication of the air factor improvement of the SmartFluxx membrane please see below chart:



Membrane Technology

Membrane technology uses bundles of hollow fibers contained within a tube. The fiber walls selectively separate feed-air into a nitrogen (retentate) and an oxygen enriched air stream (permeate).

At its production facility at Etten-Leur in the Netherlands, Parker manufactures so-called hollow fiber gas-separation membranes from Polyphenylene Oxide. The fiber membrane consists of a permeable sponge-like structure with an ultrathin cover layer. To do so, Parker uses the latest know-how and cutting-edge production processes from the field of nanotechnology.

Parker hollow fibers are small, strawlike plastics. In a module, which is a metal or plastic tube, thousands of these fibers are glued in. Only the ends of a bundle of fibers are glued in, in the middle the fibers hang free. As the space between the fiber ends is glued, when compressed air is introduced to the module heads, the air has to go inside the fibers. The plastic fibers behave in such a way that their walls “prefer” the oxygen and water molecules more than the nitrogen molecules. The fibers allow the oxygen and water molecules to pass through the wall (diffusion) easier than the nitrogen molecules. All the water and oxygen molecules are discharged from the module (permeate), the nitrogen molecules however remain inside the fiber and exit at the other glued end of the fiber (retentate).

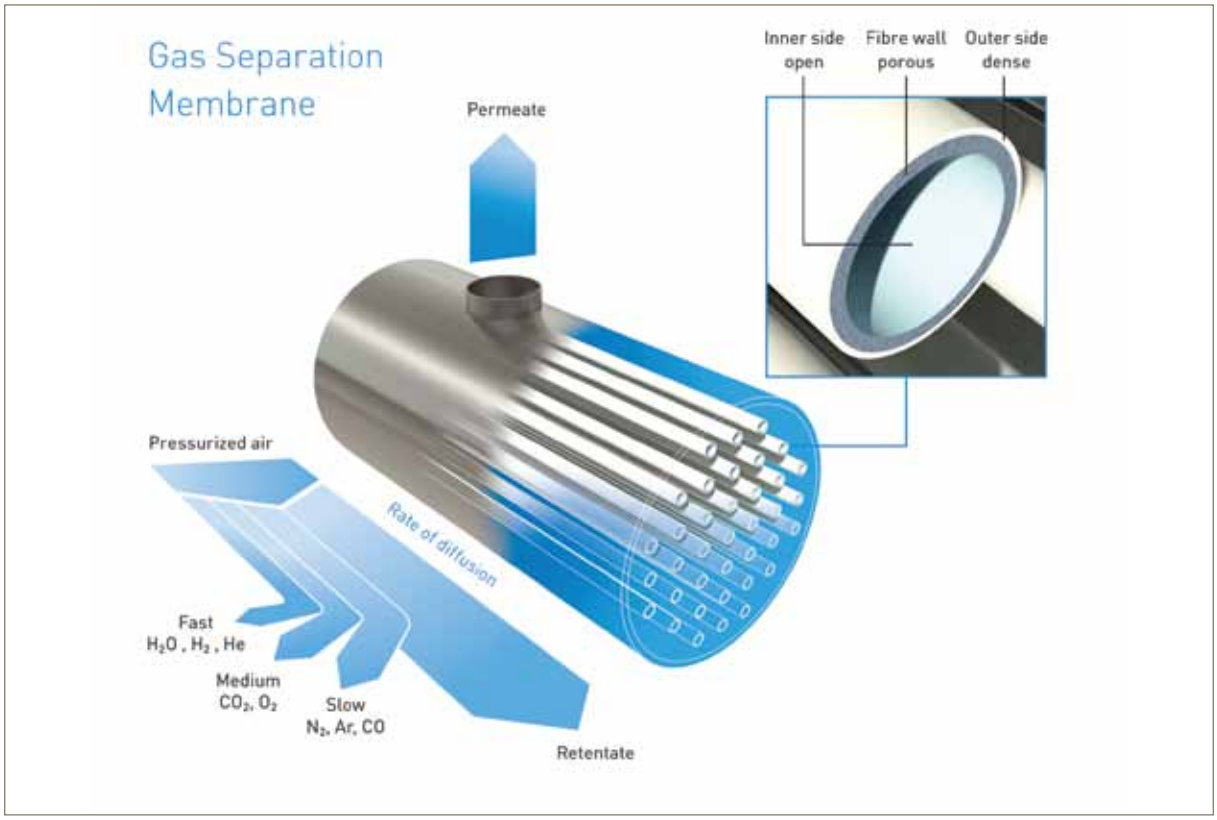
The pressure and temperature at which the compressed air enters the fiber and the time the air has to remain inside the fiber, determines the nitrogen purity (or rather the inert gas purity) at the nitrogen outlet.

Hollow fiber membranes

The Parker membrane is extremely reliable and effective for producing nitrogen and oxygen enriched air, simply because it is the strongest and most permeable membrane in the world. This means that more product can be separated per fiber, resulting in lower cost of ownership, longer membrane life, and very cost-effective systems with short payback times.

Standard membrane modules

Parker has developed a complete range of standard module sets for producing nitrogen or oxygen enriched air from ambient air. These module sets can be integrated into the end products manufactured by OEM (Original Equipment Manufacturer) customers. Requirements can always be met, thanks to the large range of sizes and membrane performance available.



Operating conditions for Parker membranes

Feed-Air Inlet Pressure

Systems based on Parker membrane modules operate at air inlet pressures ranging from 60 psig to 189 psig.
The higher the air inlet pressure, the more nitrogen and oxygen enriched gas that can be produced from a given fiber. Compressed air usage is also one of the main cost factors. To compare the different membranes, it is important to know the optimum working pressure. For every 1 bar pressure needed during nitrogen production, operating costs will increase by 7%, due to compressor energy usage (The CO2 footprint will increase as well).

Feed-Air Usage

The air factor or air to nitrogen ratio is used to calculate how much feed-air is needed to produce the desired nitrogen flow, at certain purity. Different purities result in different air factors and these will influence the size of the compressor to produce the desired nitrogen flow.

Example: Customer requires 1000 scfh of nitrogen. If the air factor is 2.5 this means a compressor has to provide: 100 x 2.5 = 2500 scfh of feed-air to produce the requested nitrogen flow.

Nitrogen and Oxygen Purity

Parker Fluxx membrane modules can provide nitrogen gas with a purity ranging from 95% to 99.9%*.

The Parker Oxy membrane modules can supply an oxygen content ranging from 28% up to 40%.

*Depending on selected membrane module

Aging

Parker membranes are made from Polyphenylene Oxide (PPO) which is a polymer (plastic). After production the plastics' molecules need to settle themselves in the membrane structure. During the settlement, the performance decreases. Critically, Parker fibers are pre-aged during production which means that performance of the membrane modules will not deteriorate over time.

*Parker membranes separate oxygen from pressurized air. The composition of the product is determined by measuring the residual oxygen content. The nitrogen content is calculated by subtracting the residual oxygen content from 100 %. Air is composed of nitrogen (78.1%), oxygen (20.9 %), Argon (0.9 %), CO2 (0.03 %), and some trace inert gases. Remember that the value that is normally called the nitrogen content is actually the inert gas content.

Robustness

Robustness of the membrane depends on:

- **Diameter of the membrane fiber**
- **Strength of material**
- **Related pressure drop**

The smaller the membrane diameter, the higher the risk of clogging due to poor quality air/particulates. Parker membranes have the largest membrane diameter and therefore are less sensitive to contamination.

Another consequence of a small membrane diameter is a high pressure drop. Pressure drop is the difference between the inlet feed-air pressure and the outlet nitrogen pressure. Pressure drop equates to waste of energy and Parker membrane modules have the lowest pressure drop of all.

Robustness will also influence life-time.

Life-time

Parker membranes have the longest life expectancy of any membranes.

Overview modules

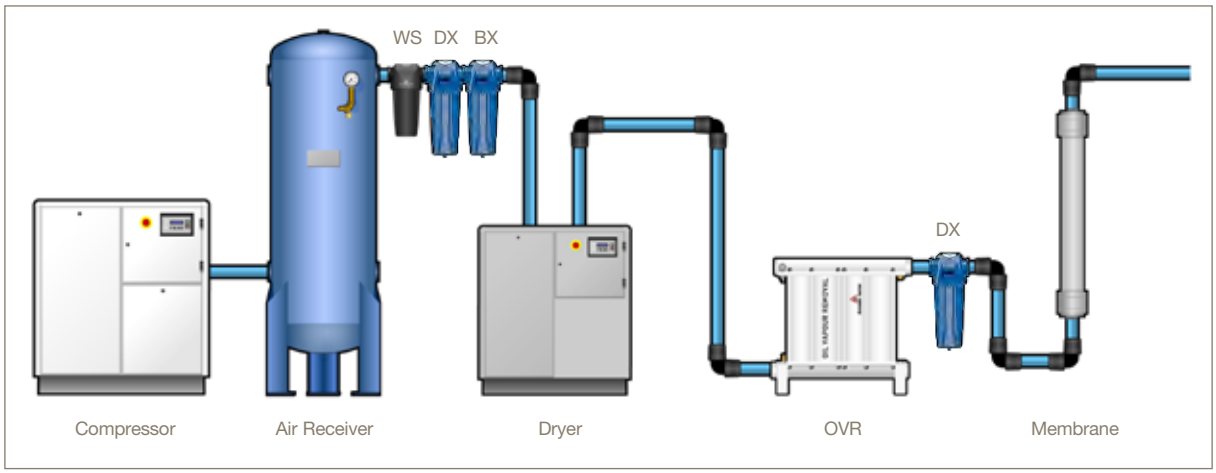
NM-ST15020, NM-1508, NM-ST604, NM-ST6010, NM-ST304, NM-P243

Simple Installation

Parker membrane modules can be mounted both horizontally and vertically. Independently from the type of gas (nitrogen or oxygen) the application requires, the membrane always needs to be fed with compressed air.

To guarantee the life-time of the membrane, the feed-air has to meet the specified quality as explained in section compressed air pre-treatment.

Membrane typical installation



KEY

WS	Water Separator	**OVR**	Oil Vapor Removal
DX	Coalescing Filter	**DX**	Dry particulate Filter
BX	Coalescing Filter		

Feed-Air Pre-treatment

The quality of the compressed air used is important to maintaining the purity and efficiency of the system based on Parker membrane modules. The main contaminants that need to be removed include oil, particulate and water.

Feed-air Conditions

Maximum operating pressure	189 psig / 13.0 bar g*
Min. / Max. operating temperature	33°F / +2°C / 122°F +50°C
Maximum oil vapor content	<0.01 mg/m^3
Particles	filtered at 0.01 µm
Relative humidity	<100% (non condensing)

*Depending on selected membrane module

Minimal Maintenance

Parker membrane modules are designed for maximum reliability with minimum maintenance.

The modules themselves do not have any parts that need to be maintained. And when used appropriately the membranes have an expected life-time of over 10 years.

Benefits:

- **Fewer membrane modules needed per system**
  More nitrogen and oxygen enriched air per fiber is produced from Parker hollow-fiber membranes than any other in the world
- **Use of low pressure standard industrial compressor**
  No high pressure compressor needed to obtain required flow
- **Low air consumption (air factor or air to nitrogen ratio)**
  Use a small compressor and reduce investment costs
- **Energy savings**
  Operation at a low pressure requires less energy
- **Reduced CO2 emissions**
  No heater required to open polymer membrane structure, thus reducing the energy consumption
- **Robust fiber**
  Most tolerant fiber to particle contamination
- **Large membrane diameter**
  Lowest membrane module pressure drop
- **Strong engineering plastic**
  Life-expectancy of more than 10 years
- **Factory membrane aging, pre-delivery**
  No performance decrease over time due to fiber aging
- **Quick start-up time**
  Required purity is produced instantly, no heating up time
- **Flexible mounting arrangements**
  Can be mounted horizontal or vertical
- **Low noise operation**
  Radiated noise generated by membrane technology is extremely low
- **No maintenance required**
  No user serviceable parts
- **Small system footprint**
  Fewer modules needed to produce nitrogen or oxygen enriched-air requirements.
- **Reduce system component costs**
  The need for fewer membrane modules results in less work to produce a nitrogen generator, less pipe work and less block or isolation valves, fewer chances for leaks

Let Parker support your OEM team and offer you:

- **Application knowledge and support**
- **Knowledge of membrane technology**
- **Expertise in integrated system design**
- **The value you are looking for**

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