BRITISH COMPRESSED AIR SOCIETY

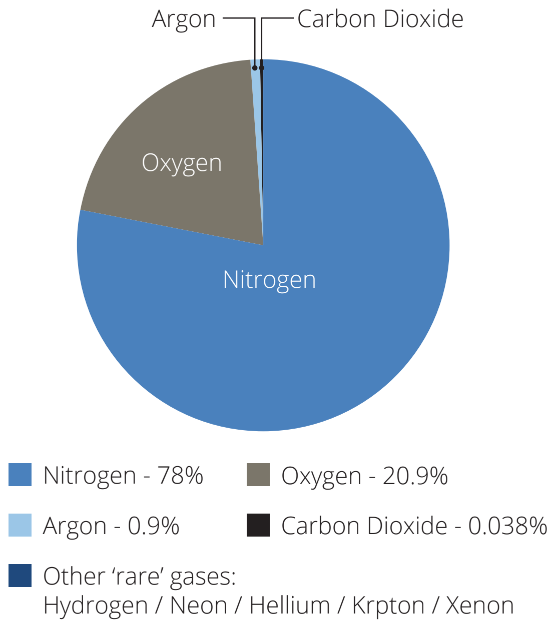
What is Nitrogen?

Nitrogen, N2, is a colourless, odourless inert gas that forms approximately 78% of the Earth's atmosphere. Therefore, it is the main constituent of air drawn into a typical compressor intake.

Nitrogen should be considered in the same manner as compressed air with regards to pressure systems legislation, equipment, flow characteristics and compressed gas safety; with the added hazard that the oxygen has been removed and it cannot support life. All equipment, pipework, vessels, processes and machines should be labelled clearly to warn that they contain nitrogen and it is a potential asphyxiant.

Commercially available nitrogen can be manufactured in several different ways. Each of these processes starts with the readily available feedstock of ambient air that contains 78% nitrogen. It is estimated that currently 85% of the global supply of nitrogen is produced from cryogenic fractional distillation. In very simple terms ambient air is compressed, cleaned and dried then cooled to very low levels.

The main three elements of air – Nitrogen, Oxygen and Argon, liquefy at different temperatures allowing them to be separated at each stage in a distillation column.



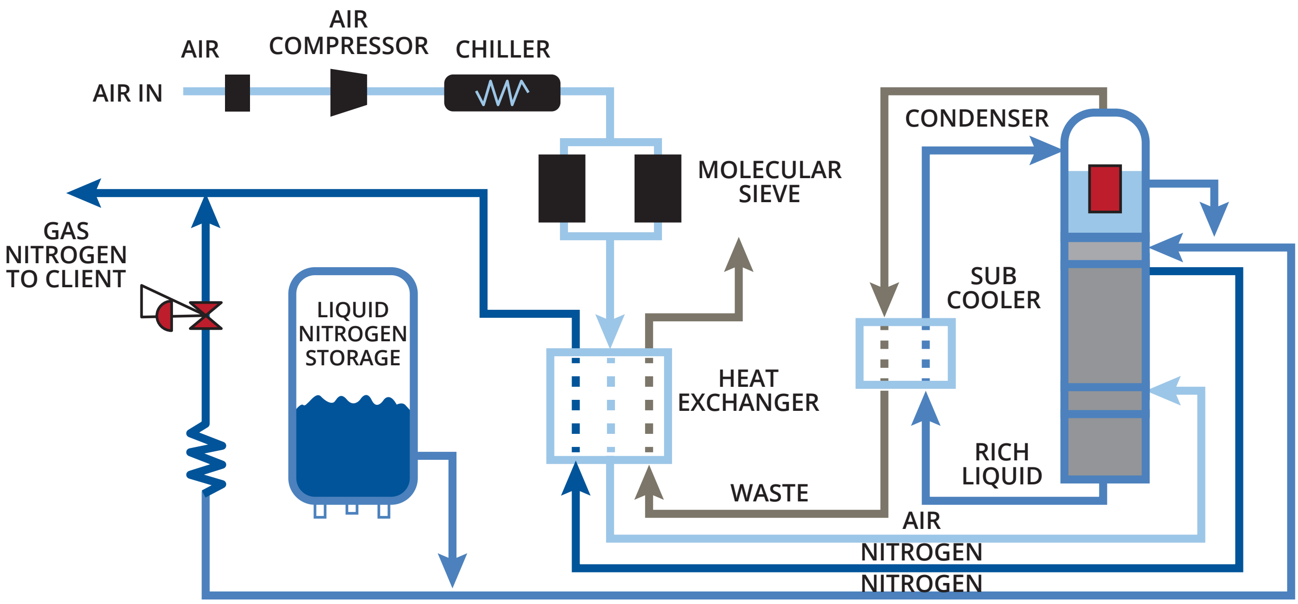


Figure 9: Typical cryogenic nitrogen generator flow diagram

- Oxygen liquefies at -183°C or 90 Kelvin
- Argon liquefies at -186°C or 87 Kelvin
- Nitrogen liquefies at -196°C or 77 Kelvin

The liquefied elements are then stored in bulk vessels ready to be transported by purpose built cryogenic tanker trucks to the customer.

Cylinder gas is produced by evaporating the liquid back to its gaseous phase at typical storage pressures up to 300 barg.

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Making Nitrogen Gas On-Site

An alternative method to obtaining nitrogen gas is for users to make it themselves on site.

All types of standard factory produced compressors are suitable sources of the required compressed air input.

Two main technologies are used to separate the nitrogen gas from ambient air – These are

- Pressure Swing Adsorption, (PSA), using Carbon Molecular Sieve, (CMS);

And

- Hollow Fibre Membrane

  Pressure Swing Adsorption operates on the same principle as a compressed air desiccant dryer. The main difference is that a material called carbon molecular sieve, CMS, is used to remove oxygen rather than a desiccant material to remove water vapour

Advantages of PSA and Membrane Nitrogen Generation

The unit gas cost to produce nitrogen is typically up to 90% less than traditional supplies.

- Pay-back compared to gas company supplies is typically 6-24 months.
- No large stored volumes of potentially asphyxiant gas.
- Ambient temperature gas. No risk of cold burns.
- Low pressure gas @ 5-10barg. Not as many safety issues as with 300 barg high pressure cylinders.
- No manual handling of heavy cylinders
- Economically produce as much or as little gas as required.
- No wastage through liquid "boil-off" or gas sent back unused in cylinders.
- Produce the right purity for the application, minimising costs.
- Never run out or have to wait for deliveries. Increasing up time.
- Reduced movement of delivery vehicles on site, increasing safety.
- Complete control of gas supply and costs.
- Sealed system reducing potential contamination from cylinder hook up or delivery vehicles and equipment.
- Abolish danger of incorrect gas species connected to system
- Negate risk of accidental or deliberate contamination of gas through the external supply chain.
- Reduced administration and monitoring costs associated with an outsourced gas supply.
- Reduce CO2 emissions by eliminating truck-based deliveries and on-site gas production technology lower energy demand.

Where Can On-Site Nitrogen Gas Generation be Used?

Nitrogen gas generators have been operated successfully and extremely economically for –

- Modified atmosphere packaging, (MAP), of food and beverages
- Food processing and bulk ingredient storage.
- Beer and wine production.
- Electronics - selective soldering / wave soldering and IC manufacture.
- Heat treatment of metals.
- Truck and aircraft tyre inflation.
- Additive manufacturing (3D Printing).
- Laser cutting, ablation and welding.
- Autoclave pressurisation.
- Chemical blanketing for products such as inks, resins, solvents and oils.
- Pharmaceutical manufacturing.
- Centralised laboratory gas supply for analytical instruments.
- Pipeline purging.
- Inert storage of electronics and chemicals.
- Marine vessel cargo blanketing – LNG carriers.
- Natural resources – mine blanketing, oil well head pressurisation, tank farm blanketing.
- With additional nitrogen gas booster equipment - high pressure cylinder filling.

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Hollow Fibre Membrane - HFM

This technology uses thousands of straw like polymer fibres approximately 0.5mm diameter, housed into a metal tube assembly. It works on the principle that the relative speed of gases, their molecular size and ability to pass through a semi permeable cellular structure; preferentially separates the faster gases such as oxygen, CO_2 and water vapour from the slower nitrogen gas. The fast gases pass through the hollow fibre wall and are exhausted to atmosphere, (called "permeate"), whereas the nitrogen gas held within the fibre at pressure, is fed to the application, (called "retentate").

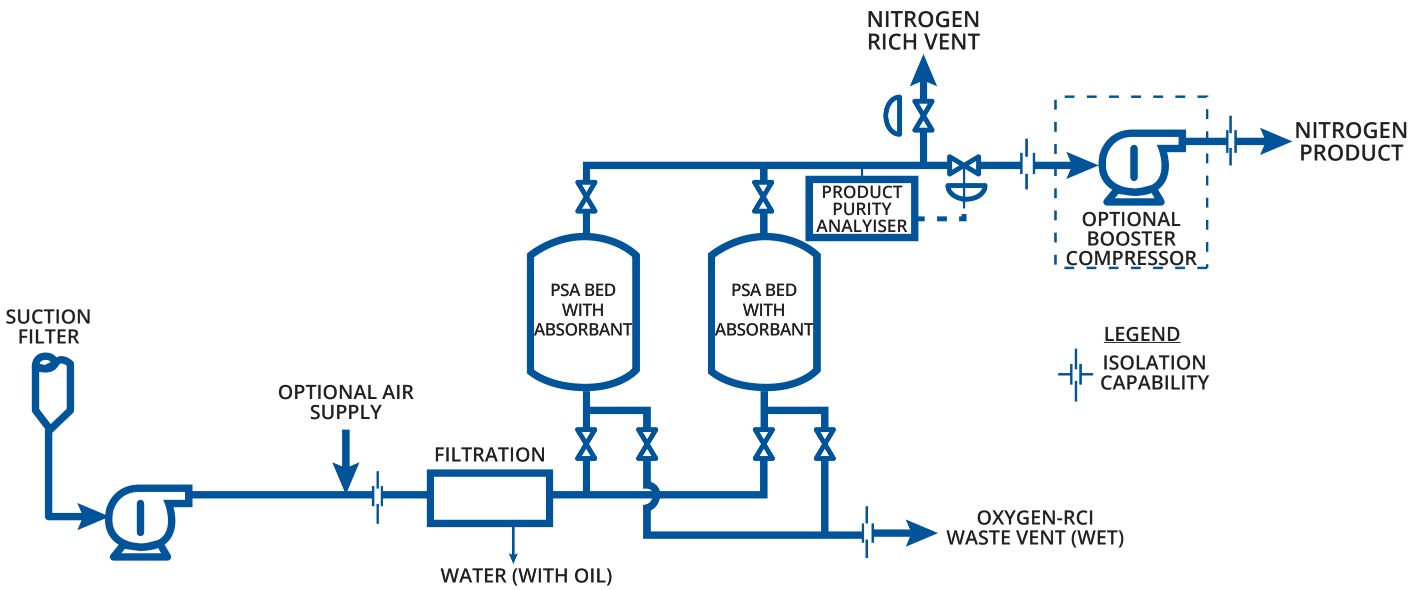

Figure 2: Typical PSA nitrogen generator flow diagram