TRIDENT
engineering quality air and gas

# NITROGEN GENERATION FOR INDUSTRIAL APPLICATIONS

TRIDENT
engineering quality air and gas

## Industry requires nitrogen

*Dozens of gases are used by industry. First among these in terms of quantity consumed is nitrogen. Nitrogen takes pride of place because it is used in a wide range of industries.*

Uses of nitrogen in industries

| Industry | Selected operations |
|---|---|
| Food | Flushing, storing, packing |
| Beverage | Blanketing, transfer, purging, bottling, packing |
| Manufacture | Laser sintering, laser ablation, brazing, carburizing, tempering, annealing, gas quenching, neutral hardening, normalizing, sintering |
| Chemical | Production, storage, packing |
| Electronics | Wave soldering, selective soldering, IC production |
| Oil and gas | Purging, flushing, blanketing |
| Pharmaceutical | Packing |

*In many applications, nitrogen is used as a blanketing gas because of its inert nature. An atmosphere of nitrogen prevents reactive solids and liquids from getting in contact with air, particularly oxygen. Thus it protects explosive or flammable materials and prevents degradation through oxidation or moisture absorption.*

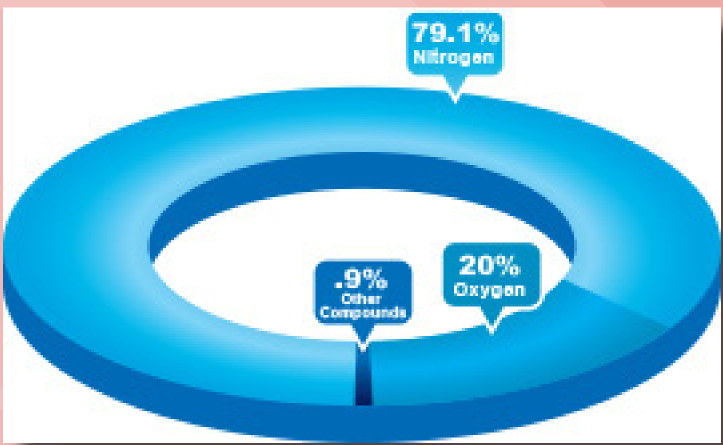
*Nitrogen is used in the food industry in packing operations*
*http://www.southtektalk.com/2012/06/food-packaging-with-nitrogen.html*

*Another use of nitrogen is in a process known as sparging. In this process, nitrogen gas is bubbled through a liquid to expel volatile organic compounds (VOCs) and other unwanted volatile substances. This may be required by regulations to reduce pollution. Sparging of food items such as vegetable oil to remove entrained air protects it against oxidation and loss of quality.*

*There are other uses of nitrogen in industry. For example, it is used as a coolant in some applications.*

## Nitrogen is found in air

*The most commonly used source of nitrogen for industrial requirements is the air around us. Air consists mostly of nitrogen.*




*Air contains mostly nitrogen*

*Air also contains a significant proportion of oxygen. There are smaller proportions of other gases also. As seen in this breakup, the 'other gases' make up a very small proportion of air:*

| Constituent | Chemical symbol | Mole percent |
|---|---|---|
| Nitrogen | $N_2$ | 78.084 |
| Oxygen | $O_2$ | 20.947 |
| Argon | Ar | 0.934 |
| Carbon dioxide | $CO_2$ | 0.0350 |
| Neon | Ne | 0.001818 |
| Helium | He | 0.000524 |
| Methane | $CH_4$ | 0.00017 |
| Krypton | Kr | 0.000114 |
| Hydrogen | $H_2$ | 0.000053 |
| Nitrous oxide | $N_2O$ | 0.000031 |
| Xenon | Xe | 0.0000087 |
| Ozone* | $O_3$ | trace to 0.0008 |
| Carbon monoxide | CO | trace to 0.000025 |
| Sulfur dioxide | $SO_2$ | trace to 0.00001 |
| Nitrogen dioxide | $NO_2$ | trace to 0.000002 |
| Ammonia | $NH_3$ | trace to 0.0000003 |

*Low concentrations in troposphere; ozone maximum in the 30- to 40-km regime of the equatorial region.

## Separating nitrogen from air

*Large-scale production of nitrogen from air involves cryogenic distillation. This process yields very pure nitrogen in the gaseous or liquid form.*

*Liquid nitrogen is produced using a cryogenic distillation process*

*Because of the size of distillation units and the investment they require, cryogenic production of nitrogen is impractical for smaller-volume industrial users. Such users can purchase high-pressure nitrogen gas in cylinders or liquid nitrogen for their requirements. However, nitrogen of the purity obtained by cryogenic distillation is not required for most industrial applications.*

***Nitrogen users may meet their requirements by purchasing high-pressure nitrogen cylinders***

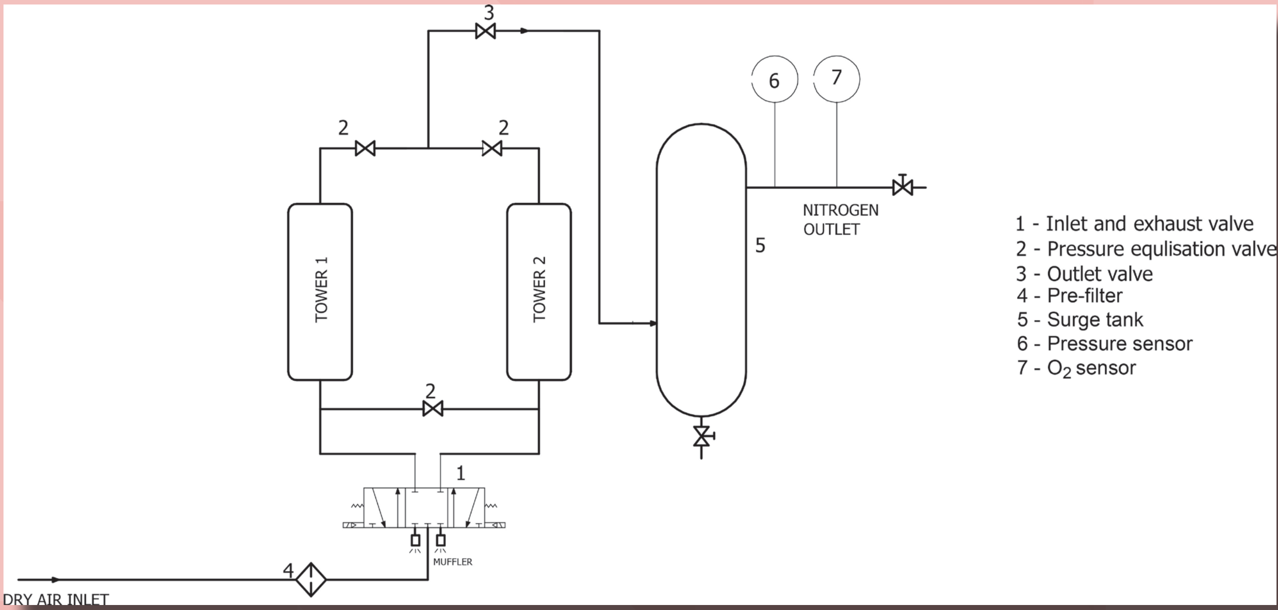
*It is a less expensive and more feasible option for a user to produce nitrogen on-site using certain non-cryogenic processes: adsorption and diffusion processes. These processes can be used to generate nitrogen of the volume and quality required by most industrial users.*

*A diffusion separation process entails the use of hollow fibres through which gases permeate. Adsorption processes, on the other hand, use materials that have large surface area, known as molecular sieves.*

*A widely used adsorption process known as pressure swing adsorption (PSA) is described in the following section.*

## The PSA process

*The steps in the PSA process of nitrogen generation involve passing compressed air through a tower containing an adsorbent material such as a carbon molecular sieve that adsorbs oxygen in preference to nitrogen. The oxygen in the compressed air is removed by the adsorbent material, leaving behind nitrogen. When the adsorbent material is saturated, the oxygen in it is desorbed. In practice, two towers with adsorbent material are used alternately so that the production of nitrogen is continuous:*




***Nitrogen production using a pressure swing adsorption process***

**Step 1**

*Air drawn from the atmosphere is compressed using an air compressor. The compressed air is dried and filtered.*

**Step 2**

*The compressed, filtered air is sent through one of the towers. As it flows through the tower, the adsorbent material adsorbs the oxygen. The nitrogen emerging from the tower is collected in a receiver tank.*

**Step 3**

*Just before the adsorbent material becomes saturated with oxygen, the adsorption process is interrupted by diverting the input air to the second tower. At this point the second tower starts to adsorb oxygen and produce nitrogen.*

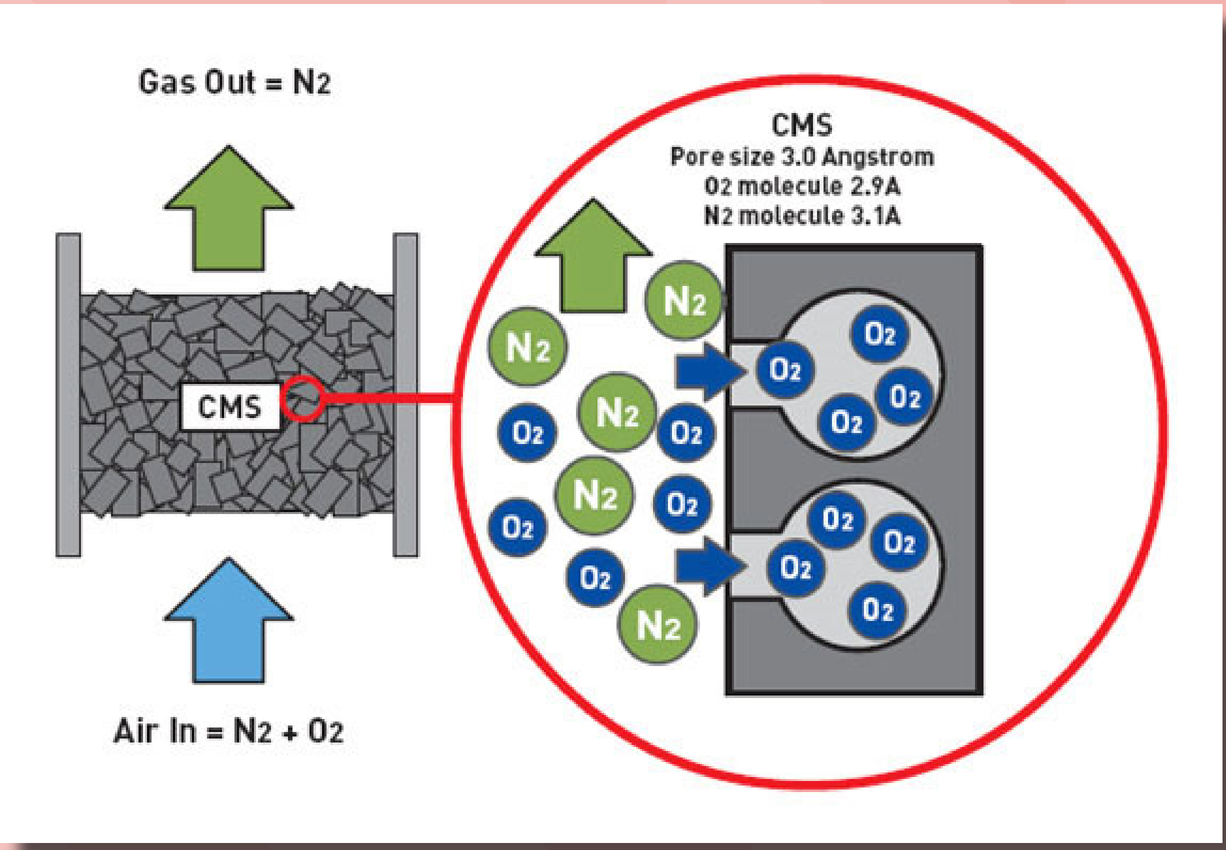
**Step 4**
*Next, the pressures of the two towers are equalised. The adsorbent material in the first tower (almost saturated with oxygen) desorbs the oxygen (the adsorbent material is 'regenerated') as a result of the reduction in pressure. The desorbed oxygen is vented out of the system.*

**Step 5**
*The regenerated adsorbent is now maintained at atmospheric pressure, which marks the end of this cycle. The next cycle starts from Step 1.*

*Typically, the pressure of the nitrogen in the receiver tank goes up to 6–8 bar (g).*

*The purity of the nitrogen is in the range from 95% to 99.999%.*

**Adsorption of nitrogen in the carbon molecular sieve**
The molecular sieve in the towers of a PSA system has fine pores passing all through it. As a result, the surface area of the adsorbent material is high. The pores are all of uniform size, and this size is specifically chosen such that oxygen molecules will be trapped within whereas the slightly larger nitrogen molecules will not. The trapped oxygen molecules adhere to the surface of the molecular sieve, forming layers there.



TRIDENT
engineering quality air and gas

Purity of nitrogen used in industrial applications: Typical values

## High Purity
## 10 ppm to 1000ppm (99.999% to 99.9%)

**Laser cutting**
50ppm to 500ppm

**Heat Treatment**
10ppm to 1000ppm

**Electronics Soldering**
50ppm to 500ppm

**Pharmaceutical**
10ppm to 5000ppm

## Mid Purity
## 0.1% to 1% (99.9% to 99%)

**Food MAP**
0.1% to 1%

**Food processing**
0.1% to 1%

**Beer dispense**
0.5%

**Wine blanketing**
0.5%

**Oil sparging**
0.5%

**Brazing**
0.5%

**Injection molding**
0.5% to 1%

**Wire annealing**
0.5%

**Aluminium sparging**
0.5%

## Low Purity
## 1% to 5% (99% to 95%)

**Fire prevention**
5%

**Explosion prevention**
2% to 5%

**Pressure testing**
5%

**Gas seal blanketing**
5%

**Pigging**
5%

**Chemical blanketing**
1% to 5%

**Autoclaves**
5%

**Laser Sintering**
2%

**Dry boxes**
2%


**Trident Pneumatics Pvt Ltd.**
5/232, KNG Pudur Road,
Somayampalayam P.O.
Coimbatore-641 108. India.
Phone: +91 422 - 2400492 Extn. 234
Fax: +91-422-2401376
e-mail: sales@tridentpneumatics.com
www.tridentpneumatics.com


Trident Pneumatics manufactures a wide range of equipment to treat compressed air for every possible use, for pressures up to 16 bar and flow rates up to 2000 cfm.