

# Gaseous nitrogen

Nitrogen makes up the major portion of the atmosphere (78.03% by volume, 75.5% by weight). Gaseous nitrogen is inert, colorless, odorless, tasteless, nontoxic, noncorrosive, and nonflammable. Nitrogen is inert and will not support combustion; however, it is not life supporting.

Nitrogen is inert except when heated to very high temperatures, where it combines with some of the more active metals, such as lithium and magnesium, to form nitrides. It will also combine with oxygen to form oxides of nitrogen and when combined with hydrogen in the presence of catalysts, will form ammonia.

Since gaseous nitrogen is inert, special materials of construction are not normally required. Vessels and piping must be selected and designed to withstand the pressure and temperatures involved and comply with applicable codes and regulations.

Nitrogen may be compressed into cylinders using water- or oil-lubricated compressors or by dry compression systems.

Physical and chemical properties are listed in Table 1.

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## Manufacture

Nitrogen is produced at air separation plants, either by liquefaction of atmospheric air and separation of the nitrogen by distillation or by adsorption processes.

## Uses

Nitrogen is the largest volume inorganic chemical sold in the world and has a multitude of commercial and technical applications. Nitrogen's properties benefit applications such as heat treating atmospheres, blanketing atmospheres, propellants, pneumatics, purging and pressurizing, and analytical carrier gases.

## Health effects

Being odorless, colorless, tasteless, and nonirritating, nitrogen has no warning properties. Although nitrogen is nontoxic and largely inert, it can act as a simple asphyxiant by displacing the oxygen in air to levels below that required to support life. Inhalation of nitrogen in excessive amounts can cause dizziness, nausea, vomiting, loss of consciousness, and death. Death may result from errors in judgment, confusion, or loss of consciousness, which prevents self-rescue. At low oxygen concentrations, unconsciousness and death may occur in seconds and without warning. **Personnel, including rescue workers, should not enter areas where the oxygen concentration is below 19.5%, unless provided with a self-contained breathing apparatus or air-line respirator.**

For more information on oxygen-deficient atmospheres, consult Air Products' Safetygram #17, "Dangers of Oxygen-Deficient Atmospheres."

## Containers

Gaseous nitrogen is shipped and stored in high-pressure cylinders, tubes, or tube trailers depending upon the quantity required by the user. Containers are designed and manufactured according to applicable codes and specifications for the pressures and temperatures involved. The quantity of product a container can hold is determined by its water capacity and pressure rating.

### Cylinders

A cylinder is a hollow tube with a closed concave base that permits the cylinder to stand upright. The opposite end is tapered to a small opening, which is threaded to accommodate the installation of a valve. A threaded neck ring is attached to the tapered end to allow a protective cylinder cap to be installed.

Cylinders are manufactured according to Transportation regulations. These regulations specify the material of construction, method of manufacture, method of testing, what products they are permitted to be filled with, as well as other details.

Cylinders may be used individually or in groups. When in groups, the cylinders should be piped together for stationary storage or to form portable banks.

### Tubes

A tube is a pipe that is tapered on both ends. Each end is then threaded to allow the installation of valves, connections, or relief devices.

**Table 1: Gaseous Nitrogen Physical and Chemical Properties**

Chemical Formula	N <sub>2</sub>
Molecular Weight	28.01
Boiling Point @ 1 atm	320.5°F (-195.8°C)
Freezing Point @ 1 atm	-346.0°F (-210°C)
Critical Temperature	-232.5°F (-146.9°C)
Critical Pressure	492.3 psia (33.5 atm)
Density, Liquid, @ BP, 1 atm	50.47 lb/ft <sup>3</sup> (808.5 kg/m <sup>3</sup> )
Density, Gas @ 68°F (20°C), 1 atm	0.0725 lb/ft <sup>3</sup> (1.16 kg/m <sup>3</sup> )
Specific Gravity, Gas (air=1) @ 68°F (20°C), 1 atm	0.967
Specific Gravity, Liquid (water=1) @ 68°F (20°C), 1 atm	0.808
Specific Volume @ 68°F (20°C), 1 atm	13.80 ft <sup>3</sup> /lb (0.861 m <sup>3</sup> /kg)
Latent Heat of Vaporization	85.6 Btu/lb (199.1 kJ/kg)
Expansion Ratio, Liquid to Gas, BP to 68°F (20°C)	1 to 694

Tubes are manufactured according to varying regional standards and regulations, depending on whether they are used for transportation or mounted permanently at a site. Tubes are generally mounted on truck-trailer chassis or railroad car beds, or placed at stationary locations when large amounts of nitrogen are needed.

### Valve connections

Different valve outlet connections are used based on national or regional standards. In North America, the Compressed Gas Association (CGA) recommends three different connections for nitrogen, depending on the pressure of the container. In addition, a high-integrity connection known also as a Diameter Index Safety System (DISS) connection has also been assigned to nitrogen. Cylinders containing nitrogen at pressures up to 3,000 psig use a CGA 580 connection; cylinders containing pressures between 3,001 and 4,700 psig use a CGA 680 connection; and cylinders containing pressures between 4,701 and 6,400 psig use a CGA 677 connection. The DISS connection assigned to nitrogen is DISS 718.

### Pressure-relief devices

In North America and Asia, nitrogen containers are equipped with pressure relief devices to protect from overpressurization. Nitrogen cylinders less than 65 inches long use a frangible disc device. Cylinders over 65 inches use a combination device consisting of a frangible disc backed by a fusible alloy. Combination devices require that both the temperature and pressure requirements be reached before the device will relieve. For more information on pressure relief devices, consult Air Products' Safetygram-15, "Cylinder Pressure Relief Devices." In Europe, pressure relief devices are mainly used for cylinders containing liquified gases such as CO<sub>2</sub> and N<sub>2</sub>O. Pressure relief devices are not used for cylinders containing compressed gases.

## Shipment of gaseous nitrogen

Compliance with applicable Dangerous Goods regulations is required for all shipments by motor freight, rail, air and water. These regulations describe the marking, labeling, placarding, and shipping papers required. International shipments by air must comply with International Air Transport Association/International Civil Air Organization (IATA/ICAO) Dangerous Goods regulations. Final acceptance for air transport is at the discretion of the airline. International shipments by water must comply with International Maritime Organization (IMO) regulations.

## Safety considerations

The hazards associated with nitrogen are asphyxiation and the high pressure of the gas in containers and systems..

## Buildings

Provide adequate ventilation where nitrogen is being used. Test the atmosphere in confined work areas for oxygen content. A 19.5% oxygen concentration in the air is the minimum recommended for working without special breathing equipment.

**Remember: nitrogen has no warning properties!**

## Handling and storage

Cylinders should be stored upright in a well ventilated, dry, cool, secure area that is protected from the weather and preferably fire-resistant. No part of a cylinder should ever be allowed to exceed 125°F (52°C) and areas should be free of combustible materials. Cylinders should be stored away from heavily traveled areas and emergency exits. Avoid areas where salt and other corrosive materials are present.

Do not store full and empty containers together. The valve outlet seal and valve protective cap should be left in place until the cylinder has been secured against a wall or bench, or placed in a cylinder stand and is ready for use. When returning empty cylinders, ensure the valve is closed and that some positive pressure remains in the cylinder. Some valves may be equipped with an RPD (residual pressure device) that will ensure residual pressure stays in the cylinder. Do not manipulate with an RPD.

Some cylinders may be equipped with VIPRs with pressure indicators (valves integrated with pressure regulator) or with cylinder valves with pressure indicators. Do not judge if a cylinder is empty just by the pressure indicator showing zero (there is always probability that the gauge is damaged). Double check by opening and closing the shut-off mechanism.

Replace any valve outlet and protective caps originally shipped with the container and label the cylinder as "Empty." Never tamper with the

safety devices on valves or cylinders.

Never drop, drag, roll or slide cylinders. Use a specifically designed hand-truck for cylinder movement. Wrenches should never be used to open or close a valve equipped with a handwheel. If difficulty is experienced operating the container valve or using the container connections, discontinue use and contact the gas supplier. Use only the proper connections on the container.

### **DO NOT USE ADAPTERS!**

Never attempt to lift a cylinder by its cap. **NEVER** insert an object (e.g., wrench, screwdriver, pry bar, etc.) into the opening of the cylinder cap. Doing so may damage or inadvertently open the valve. Use only a specially designed strap-wrench to remove overtightened or rusted caps. Always open a compressed gas cylinder valve slowly to avoid rapid system pressurization.

Use piping and equipment designed to withstand the maximum pressures encountered. Use a pressure reducing regulator or separate control valve along with properly designed pressure relief devices to safely discharge gas to working systems. Use a check valve to prevent reverse gas flow into the containers. Never deliberately overheat a cylinder to increase the pressure or discharge rate. It is recommended that all vents be piped to the exterior of the building and are in accordance with local regulations.

Refilling or shipping a compressed gas cylinder without the consent of the owner is forbidden.

## Personal protective equipment (PPE)

Personnel must be trained in the properties and safety considerations before being allowed to handle nitrogen and/or its associated equipment. The use of safety glasses, safety shoes, and leather work gloves is recommended when handling cylinders. In emergency situations, self-contained breathing apparatus (SCBA) must be worn.

## First aid

Persons suffering from a lack of oxygen should be moved to fresh air. If the victim is not breathing, administer artificial respiration. If breathing is difficult, administer oxygen. Obtain immediate medical attention.

**Self-contained breathing apparatus (SCBA) may be required to prevent asphyxiation of rescue personnel.**

## Firefighting

Since nitrogen is nonflammable, special firefighting equipment and instructions are not needed. However, upon exposure to intense heat or flame, a nitrogen cylinder may vent rapidly and/or rupture violently. Although most cylinders are designed to vent contents when exposed to elevated temperatures, note that pressure in a container can build up due to heat, and it may rupture if a pressure relief device should fail to function.

## Emergency Response System

T 800-523-9374 (Continental U.S. and Puerto Rico)

T +1-610-481-7711 (other locations)

For regional ER telephone numbers, please refer to the local SDS 24 hours a day, 7 days a week for assistance involving Air Products and Chemicals, Inc. products

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## Technical Information Center

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