

Gaseous helium

Gaseous helium is inert, colorless, odorless, noncorrosive, and nonflammable. Helium is the lightest rare gas. Helium is a monatomic chemically inert gas. It will not react with other elements or compounds under ordinary conditions.

Since helium is noncorrosive, 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.

Manufacture

Most commercial helium is recovered from natural gas through a cryogenic separation process. Normally, helium is present in less than 1% by volume in natural gas. Helium is recovered, refined, and liquefied. Liquid helium is typically shipped from production sources to storage and transfill facilities. Gaseous helium is then compressed into cylinders.

Uses

Gaseous helium is used as an inert shielding gas in metal arc and laser welding. Being both lighter than air and nonflammable, helium is used to inflate balloons and airships. Helium can provide a protective atmosphere in the production of reactive metals, such as titanium and zirconium. Gaseous helium is used as a coolant during the drawing of optical fibers, as a carrier gas for chromatography, and as a leak detection gas in a variety of industries.

Health effects

Being odorless, colorless, tasteless, and non-irritating, helium has no warning properties. Although helium is nontoxic and inert, it can act as a simple asphyxiant by displacing the oxygen in air to levels below that required to support life. Inhalation of helium 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 that 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 helium 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. Cylinders are manufactured to Transportation regulations, which specify the material of construction, method of manufacture, testing, and with what products they are permitted to be filled, as well as other details. The quantity of product a container can hold is determined by its pressure rating and internal volume. Generally, the higher the pressure, the more helium is contained in a cylinder.

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 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 tapered at both ends. Each end is threaded to allow the installation of valves, connections, or relief devices. 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, railroad car beds, or placed at stationary locations when large amounts of helium are needed.

Table 1: Gaseous Helium Physical and Chemical Properties

Molecular Symbol	He
Molecular Weight	4.003
Boiling Point @ 1 atm	-452.1°F (-268.9°C)
Freezing Point @ 367 psia	-459.7°F (-272.2°C)
Critical Temperature	-450.3°F (-268.0°C)
Critical Pressure	33.0 psia (2.26 atm)
Density, Liquid @ B.P, 1 atm	7.802 lb/ft ³ (124.98 kg/m ³)
Density, Gas at 70°F (21.1°C), 1 atm	0.0103 lb/ft ³ (0.165 kg/m ³)
Specific Gravity, Gas (air=1) @ 32°F (0°C), 1 atm	0.138
Specific Gravity, Liquid @ B.P, 1 atm	0.125
Specific Volume @ 32°F (0°C), 1 atm	89.77 ft ³ /lb (5.604 m ³ /kg)
Specific Volume @ 68°F (20°C), 1 atm	96.67 ft ³ /lb (6.035 m ³ /kg)
Latent Heat of Vaporization	8.72 Btu/lb (20.28 kJ/kg)
Expansion Ratio, Liquid to Gas, B.P. to 32°F (0°C)	1 to 754

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 helium, 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 helium. Cylinders containing helium at pressures up to 3,000 psig use a CGA 580; cylinders containing pressure between 3,001 psig and 5,500 psig use a CGA 680; and pressures between 5,501 psig and 7,500 psig use a CGA 677. The DISS connection assigned to helium is the DISS 718. For detailed drawings of these connections, consult Compressed Gas Association Pamphlet V-1.

WARNING: NEVER use adapters to make cylinder connections!

Pressure-relief devices

In North America and Asia, helium containers are equipped with pressure relief devices to protect from overpressurization. Helium 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 not commonly used on cylinders.

Table 2: Helium Service Connections

Cylinder Service	CGA Connection
Helium < 3,000 psig	580
Helium at 3,001 to 5,500 psig	680
Helium at 5,501 to 7,500 psig	677
Semiconductor	718

Shipment of gaseous helium

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 helium are asphyxiation and the high pressure of the gas in containers and systems.

Buildings

Provide adequate ventilation where helium is being used.

Provide monitoring for areas where oxygen displacement may occur.

A 19.5% oxygen concentration in the air is the minimum recommended for working without special breathing equipment.

Remember, helium has no warning properties!

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. Never deliberately over-heat a cylinder to increase the pressure or discharge rate.
- Cylinders should be stored away from heavily traveled areas and emergency exits.
- Avoid areas where salt and other corrosive materials are present.
- 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. Replace any valve outlet and protective caps originally shipped with the container and label the cylinder as "Empty." Do not store full and empty containers together.

Handling

- Never drop, drag, roll or slide cylinders. Use a specifically designed hand truck for cylinder movement.
- Never attempt to lift a cylinder by its cap.
- Wrenches should never be used to open or close a valve equipped with a handwheel. If the valve is faulty, contact the gas supplier.

- 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!**
- Always open a compressed gas cylinder valve slowly to avoid rapid system pressurization.
- 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 over-tightened or rusted caps.
- Never tamper with the safety devices on valves or cylinders.
- 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.
- 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

Personnel must be thoroughly familiar with properties and safety considerations before being allowed to handle helium and/or its associated equipment. The use of safety glasses, safety shoes, and leather work gloves is recommended when handling cylinders. Only trained and certified emergency responders should respond to emergency situations. In emergency situations, self-contained breathing apparatus (SCBA) must be used.

First aid

Persons suffering from 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 helium is nonflammable, special firefighting equipment and instructions are not needed. However, upon exposure to intense heat or flame, cylinders may vent rapidly and/or rupture violently. Most cylinders are designed to vent contents when exposed to elevated temperatures. Pressure in a container can build up due to heat, and it may rupture if 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

Technical Information Center

T 800-752-1597 (U.S.)

T +1-610-481-8565 (other locations)

Monday–Friday, 8:00 a.m.–5:00 p.m. EST

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