

# Gaseous argon

Gaseous argon is tasteless, colorless, odorless, noncorrosive, and nonflammable. Argon belongs to the family of rare inert gases. It is the most plentiful of the rare gases making up approximately 1% of the earth's atmosphere. It is monatomic and extremely inert, forming no known chemical compounds.

Since argon 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.

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## Manufacture

Argon is produced by an air separation unit (ASU) through the liquefaction of atmospheric air and separation of the argon by continuous cryogenic distillation. The argon is then removed as a cryogenic liquid.

## Uses

Argon serves as a shielding gas to protect metals from oxidation during welding. Inert gas welding is the preferred method of joining several ferrous and nonferrous alloys.

The metals and semiconductor manufacturing industries employ argon as a purge or inerting gas in furnaces, or other processing steps. In some instances, liquid argon is introduced and then vaporized over the surface of volatile or reactive molten metals to significantly reduce oxidation and/or volatility using an inert "blanket" of gas.

High-volume flow rates of argon are introduced via specialized lances or "tuyeres" in a variety of melting and refining processes. The argon typically acts as a "shroud" gas to provide protection to the tuyere. It also promotes removal of impurities and/or dissolved gases in several refining processes.

Argon is also widely used in the lighting industry for filling bulbs and in combination with other rare gases for special color effects.

## Health effects

Since argon is odorless, colorless, tasteless, and nonirritating, it has no warning properties. Argon is non-toxic 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 argon 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 (SCBA) or air-line respirator.**

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

## Containers

Argon 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.

**Table 1: Compressed Argon Physical and Chemical Properties**

Chemical Formula	Ar
Molecular Weight	39.95
Boiling Point @ 1 atm	-302.6°F (-185.9°C)
Freezing Point @ 1 atm	-308.8°F (-189.4°C)
Critical Temperature	-188.4°F (-122.4°C)
Critical Pressure	705.8 psia (48.0 atm)
Density, Liquid, @ BP, 1 atm	87.02 lb/ft <sup>3</sup> (1394 kg/m <sup>3</sup> )
Density, Gas @ 68°F (20°C), 1 atm	0.1034 lb/ft <sup>3</sup> (1.656 kg/m <sup>3</sup> )
Specific Gravity, Gas (air=1) @ 68°F (20°C), 1 atm	1.38
Specific Gravity, Liquid (water=1) @ 68°F (20°C), 1 atm	1.40
Specific Volume @ 68°F (20°C), 1 atm	9.68 ft <sup>3</sup> /lb (0.604 m <sup>3</sup> /kg)
Latent Heat of Vaporization	69.8 Btu/lb (162.3 kJ/kg)
Expansion Ratio, Liquid to Gas, BP to 68°F (20°C)	1 to 840

## Cylinders

Cylinders are manufactured according to Transportation regulations, which specify the material of construction, method of manufacture, testing, and what products they are permitted to be filled with, as well as other details. A cylinder is a hollow tube with a closed concave base that permits it to stand upright. The opposite end is tapered to a small opening, 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 used in groups, the cylinders should be piped together for stationary storage or to form portable banks.

## Tubes

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 a truck-trailer chassis or railcar bed or placed at stationary locations when large amounts of argon are needed. A tube is a pipe that is tapered on both ends. Each end is threaded to allow the installation of valves, connections, or relief devices.

## 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 argon, depending on the pressure of the container. In addition, a high-integrity connection, also known as a Diameter Index Safety System (DISS) connection, has been assigned to argon. Cylinders containing argon at pressures up to 3,000 psig use a CGA 580 connection; cylinders with pressures between 3,001 and 5,500 psig use the CGA 680 connection; and cylinders with pressures between 5,501 and 7,500 psig use a CGA 677 connection. The DISS connection assigned to argon is 718.

## Pressure-relief devices

In North America and Asia, argon containers are equipped with pressure-relief devices to protect from overpressurization. Argon cylinders less than 65" long use a frangible disk device. Cylinders over 65" use a combination device consisting of a frangible disk backed by a fusible alloy. Combination devices require that both the temperature and pressure requirements be reached before the device will relieve. In Europe, pressure relief devices are not commonly used on cylinders.

## Shipment of gaseous argon

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

If oxygen-deficient atmospheres are suspected or can occur, use oxygen monitoring equipment to test for oxygen-deficient atmospheres. Review the appropriate Safety Data Sheet (SDS).

## Buildings

Provide adequate ventilation in areas using argon. 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, argon 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 overheat 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, insure 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 overtightened 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 not allowed.**

## Personal protective equipment (PPE)

Personnel must be thoroughly familiar with properties and safety considerations before being allowed to handle argon and/or its associated equipment. Safety glasses, safety shoes, and leather work gloves are recommended to handle cylinders. In emergency situations, wear a self-contained breathing apparatus (SCBA).

## 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.**

## Fighting fires

Since argon is nonflammable, special fire-fighting equipment and instructions are not needed. However, upon exposure to intense heat or flame, a cylinder containing argon may vent rapidly and/or rupture violently. Most cylinders are designed to vent contents when exposed to elevated temperatures. Pressure in a cylinder or other container can build up due to heat, and it may rupture if the pressure-relief device fails 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

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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