

Safetygram-3

Gaseous Argon

General

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.

Special materials of construction are not required to prevent corrosion. Vessels and piping should be designed to American Society of Mechanical Engineers (ASME) or Department of Transportation (DOT) codes for the pressures and temperatures involved.

Argon may be compressed into cylinders by water or oil-lubricated compressors or by dry compression systems. To determine the amount of argon in a cylinder, use the appropriate pressure and temperature capacity chart for a specific size cylinder. (The higher the pressure, the larger the amount of argon in the container.)

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.

The ASU manufacturing process begins with a main air compressor and ends at the output of the product storage tanks. Air is compressed and sent through a clean-up system where moisture, carbon dioxide, and hydrocarbons are removed. The air then passes through heat exchangers where it is cooled to cryogenic temperature. The air then enters a high pressure distillation column where it is physically separated into a gaseous form of nitrogen at the top of the column and a liquid form of "crude" oxygen (~90%) at the bottom.

Argon is the major contaminant in this crude oxygen, which is then sent to a low-pressure distillation column where the oxygen is purified. The argon-rich waste stream from the low

pressure column is sent to an argon distillation column. Some argon technologies distill the argon directly to its final manufacturing purity, while others utilize a separate step to purify it, for example, hydrogen deoxo. Purified argon is stored as a liquid in storage tanks at the site.

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 non-irritating, it has no warning properties. Humans possess no senses that can detect the presence of argon. 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, uncon-



sciousness 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.

Cylinders

Cylinders are manufactured according to DOT 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 DOT regulations or to ASME codes 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

The Compressed Gas Association (CGA) recommends three different connections for argon depending on the pressure of the container.

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	87.40 lb/scf
Density, Gas @ 68°F (20°C), 1 atm	0.1034 lb/scf
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 scf/lb
Latent Heat of Vaporization	2804 Btu/lb mole
Expansion Ratio, Liquid to Gas, BP to 68°F (20°C)	1 to 840

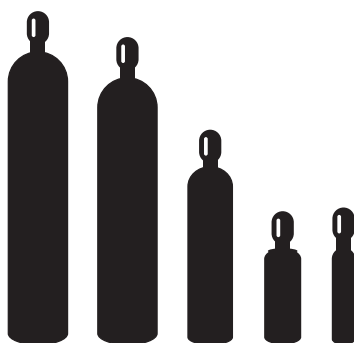


Fig. 1 Typical cylinder shapes and sizes.

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 3000 psig use a CGA 580 connection; cylinders with pressures between 3001 and 5500 psig use the CGA 680 connection; and cylinders with pressures between 5501 and 7500 psig use a CGA 677 connection. The DISS connection assigned to argon is 718. For detailed drawings of these connections, consult CGA's Pamphlet V-1. For general drawings consult the Air Products "Specialty Gases and Equipment Catalog."

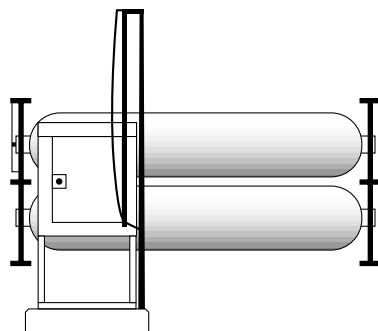


Fig. 2 A typical tube container system for bulk argon.

Pressure-Relief Devices

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. For more on pressure-relief devices, see Air Products' Safetygram-15, "Cylinder Pressure-Relief Devices."

Container Stampings

Each cylinder or tube is identified by stampings in the metal of the shoulder. Fig. 3 shows these stampings and their meanings.

Shipment of Gaseous Argon

All shipments of compressed argon must comply with the DOT Code of Federal Regulations, Title 49. This applies to motor freight, rail, air, and water shipments. For air shipments, all packages must also comply with International Air Transport Association/International Civil Air Organization (IATA/ICAO) Dangerous Goods Regulations. Water vessel shipments must also be prepared in accordance with International Maritime Organization (IMO) regulations. All packaging used to transport argon must be either "UN/DOT Specification" or "UN/DOT Authorized" and in proper condition for transport. DOT Code of Federal Regulations, Title 49, specifies the following labeling and identification requirements:

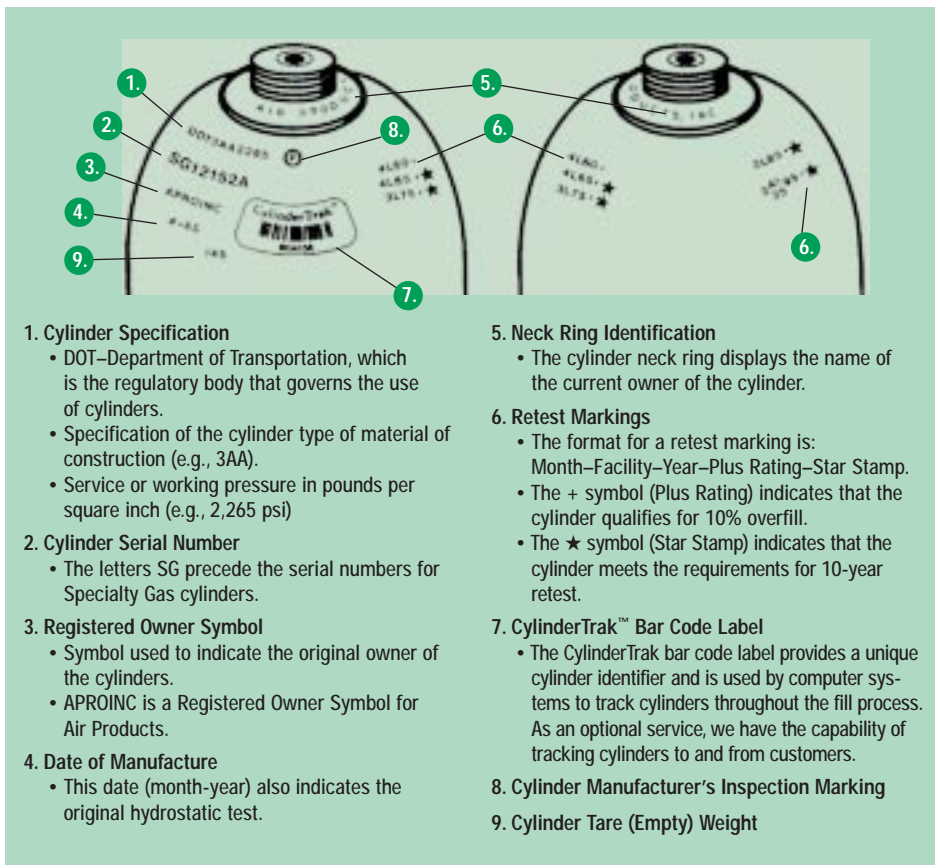


Fig. 3 Key to cylinder stampings.

DOT Hazard Class: 2.2

DOT Shipping Label: Nonflammable Gas

DOT Placard: Nonflammable Gas

Identification Number: UN1006

DOT Shipping Name: Argon, Compressed



Fig. 4 Nonflammable gas shipping label.

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 Material Safety Data Sheet (MSDS).

Buildings

Provide adequate ventilation in areas using argon. Provide monitoring for areas where oxygen displacement may occur. OSHA has established 19.5% oxygen concentration as the minimum for working without supplied air.

Remember, argon has no warning properties!

Storage

- Cylinders should be stored upright in a well-ventilated, dry, cool, and preferably fire-resistant, secure area, which is protected from the weather.
- Storage temperatures should **NEVER** exceed 125°F (52°C) and the area should be free of combustible materials. Storage should be away from heavily traveled areas and emergency exits.
- Oxygen must be separated from flammables and combustibles by 20 feet or a half-hour fire wall.
- Post "No Smoking" and "No Open Flames" signs. Copies of signs may be downloaded from Air Products'

Product Stewardship web site at:
www.airproducts.com/productstewardship.

- Avoid areas where salt or other corrosive materials are present. Valve protection caps and valve outlet seals should remain on cylinders not connected for use.
- Separate full from empty cylinders. Avoid excessive inventory or storage time and keep good inventory records.
- Use a first-in first-out system.

Handling

- If you experience any difficulty operating the container valve or with the container connections, discontinue use and contact the supplier. Use the proper connections.
- **DO NOT USE ADAPTERS!**
- Do not remove or interchange connections.
- Use piping and equipment designed to withstand pressures to be encountered.
- It is recommended that all vents be piped to the exterior of the building.
- Use a suitable handtruck designed for cylinder movement. Do not drag, roll, or slide containers on their sides.
- Never attempt to lift a cylinder by its cap.
- Secure cylinders at all times while in use.
- Use a pressure reducing regulator or separate control valve to safely discharge gas from cylinder.
- Use a check valve to prevent reverse flow into the cylinder.
- Do not overheat cylinder to increase pressure or discharge rate.
- **NEVER** insert an object (e.g., wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage the valve causing it to leak.
- Use a special cap wrench or adjustable strap-wrench to remove overtightened or rusted caps.

Refilling or shipping compressed gas cylinders without the consent of the owner is a violation of Federal Law.

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.

Rescue in Oxygen-Deficient Atmospheres



Fiction: I can hold my breath long enough to rescue a downed co-worker.

Fact: Over 50% of the workers who die in confined spaces are attempting to rescue other workers.

Never enter an oxygen-deficient atmosphere (<19.5% O₂) without self-contained breathing apparatus.

Emergency Response System

- Call: **+1 (800) 523-9374** (Continental U.S. and Puerto Rico)
- Call: **+1 (610) 481-7711** (Other locations)
- 24 hours a day, 7 days a week
- For assistance involving Air Products and Chemicals, Inc. gases and equipment.

Product Safety Information

- For MSDS and Safetygrams:
www.airproducts.com/productstewardship
- Fax-on-Demand:
Call: **+1 (800) 245-2746**
- Enter MSDS Index No. 1000 for a complete list of available safety literature.
- 24 hours a day, 7 days a week

Technical Information Center

- Call: **+1 (800) 752-1597** (U.S.)
- Call: **+1 (610) 481-8565** (Other locations)
- Fax: **+1 (610) 481-8690**
- E-mail: **gasinfo@apci.com**
- Monday–Friday, 8:00 a.m.–5:00 p.m. EST

Information Sources

- Compressed Gas Association
1725 Jefferson Davis Highway, Suite 1004
Arlington, VA 22202-4102
Phone: +1 (703) 412-0900
- National Fire Protection Association
1 Batterymarch Park, P.O. Box 9101
Quincy, MA 02269-9101
Phone: +1 (800) 344-3555