

Safetygram-24

Hydrogen Chloride

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Warning: Improper storage, handling, or use of hydrogen chloride can result in serious injury and/or property damage. Use this product in accordance with the Air Products Material Safety Data Sheet (MSDS).

General

Anhydrous hydrogen chloride is a toxic, colorless, liquefied compressed gas that will fume strongly upon exposure to air. The fuming is a result of hydrogen chloride's reaction with moisture in the air. The amount of fuming will increase as the humidity in the air increases. It exhibits a vapor pressure of 613 psig at 70°F. It has a repulsive acidic odor that can usually be detected at or below a concentration of 5 ppm. It is noncorrosive in the anhydrous state. It has a great affinity for water and will react with it to yield highly corrosive hydrochloric acid. Systems that use hydrogen chloride should be kept free of moisture.

Manufacture

Hydrogen chloride is produced as a by-product from the chlorination of benzene and other hydrocarbons and by burning hydrogen, methane, or water gas in a chlorine atmosphere.

Uses

Hydrogen chloride has many uses, including the hydro-chlorination of rubber, the manufacture of pharmaceuticals, in metals manufacturing as a babbitting flux, in the textiles industry for delinting of cotton seeds and the reclamation of wool, gasoline refining, the manufacture of organic and inorganic chlorinated compounds, and in the manufacture of semiconductors as an etchant.

Health

Hydrogen chloride is toxic, causing severe irritation of the upper respiratory tract upon inhalation, and irritation of the eyes and the skin on contact. Inhalation of high concentrations can cause fluid buildup in the lungs (pulmonary edema) or spasm of the larynx that may result in death. Contact with liquid can cause frostbite or cold burns.

Exposure Limits:

OSHA: PEL = 5 ppm Ceiling

ACGIH: TLV = 5 ppm Ceiling

NIOSH: IDLH = 50 ppm

The lethal concentration for hydrogen chloride:

LC50 = 3120 ppm (1 hr. rat)

Symptoms of exposure include coughing, irritation in the throat and nasal tract; irritation and/or burns of exposed areas. Concentrations of 5 ppm are usually sufficient to produce one or more of these symptoms.

Physical Properties

Appearance	Colorless gas that fumes white
Odor	Sharp, suffocating, acidic
Molecular Weight	36.465
Gas Density @ 70°F	0.095 lbs/ft ³
Specific Gravity @ 70°F (air=1)	1.266
Specific Volume @ 70°F	10.55 ft ³ /lb
Vapor Pressure @ 70°F	613 psig
Boiling Point	-121.1°F
Freezing Point	-173.6°F

Containers

Hydrogen chloride is shipped and stored in high-pressure cylinders 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 Department of Transportation (DOT) 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.

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 that 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.

Hydrogen chloride is also available in large skid-mounted cylinders (referred to as “Y” cylinders) that contain 600 pounds of product. The cylinder valve is equipped with a dip tube that, depending on orientation, will allow either gas or liquid withdrawal. When the valve outlet faces up, vapor can be withdrawn. When the valve outlet is oriented down, liquid will be available. (See Figure 1.)

Tube Trailers

If large amounts of product are necessary, hydrogen chloride can also be obtained in tube trailers that contain six or seven tubes. A typical tube trailer contains 21,000 pounds of hydrogen chloride. The tubes are manifolded together on the gas end to allow for a single connection point. (See Figure 2.) When withdrawing product from a tube trailer, open only the number of tubes required to provide adequate flow to the process. If adequate flow can be achieved with one tube, then only one tube should be open. The idea is to open only the minimum number of tubes required to provide sufficient flow so as to limit the amount of product available to the process in case of a release. The incorporation of an excess flow valve in the withdrawal system is highly recommended to minimize the release of product from failed system components.

Valves and Connections

Valves

Cylinders are usually supplied with a wrench-operated packed valve (Figure 3). This valve is also used on Y cylinders. It has a large one-piece stem

Figure 1

HCl Y Cylinder

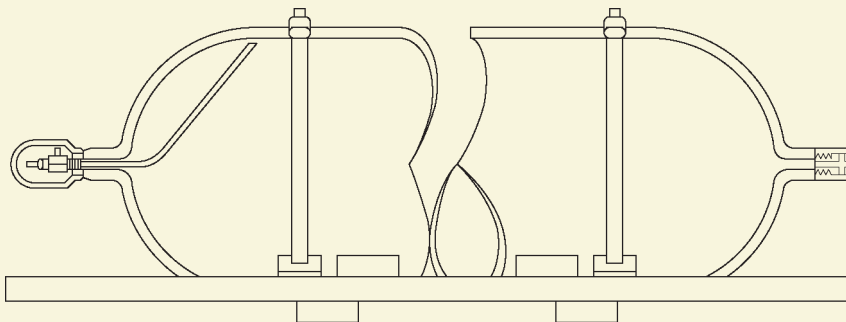
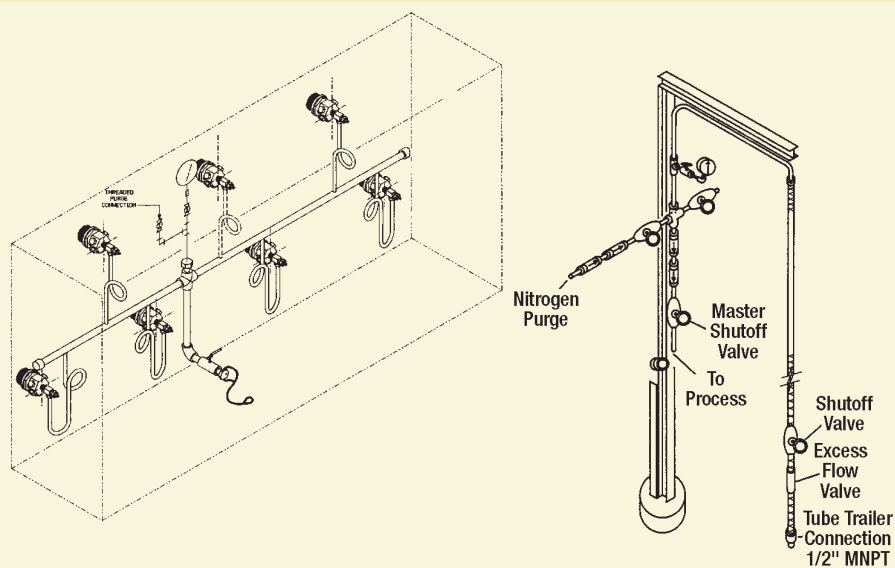


Figure 2

Tube Trailer Manifold and Stanchion



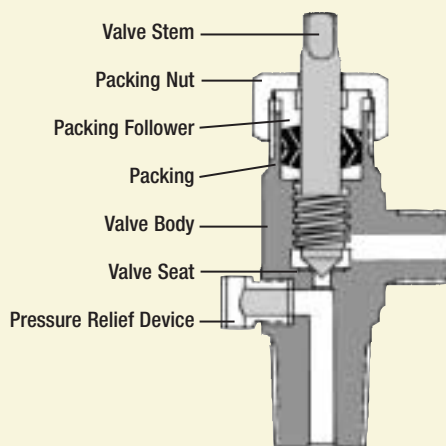
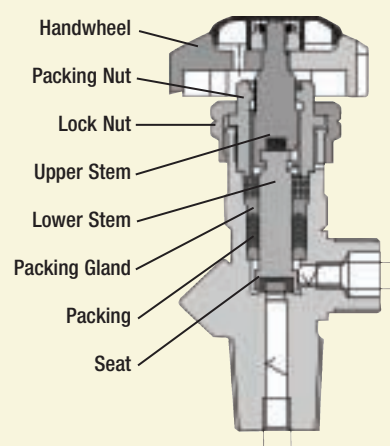
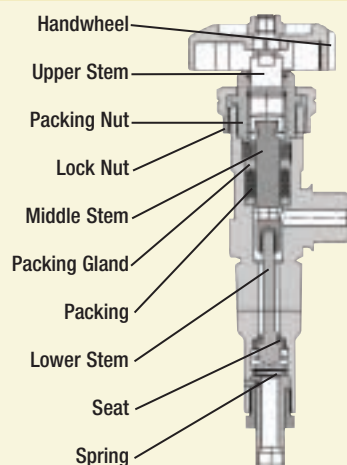
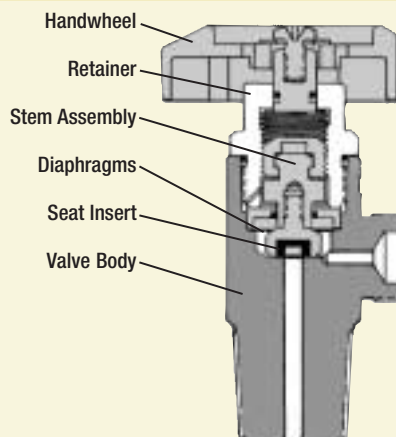
that requires at least 35 foot-pounds of torque to close. It has a metal-to-metal seat and can only be operated with an appropriate wrench. This valve has a large internal opening and flow capacity (Cv). It allows full flow when open $\frac{1}{4}$ to $\frac{1}{2}$ turn. It is not necessary or recommended to open this valve to the full open position. Always keep the valve wrench on or near the valve to facilitate rapid shut-down in case of problems. When using hydrogen chloride in processes that require continuous flow for long periods of time, the valve should be cycled on a weekly basis. This can be accomplished by further opening the valve $\frac{1}{4}$ to $\frac{1}{2}$ turn and then returning the valve to its original position. This keeps the threads free and will allow continued smooth valve operation. If the valve is opened the proper $\frac{1}{4}$ to $\frac{1}{2}$ turn and the threads become jammed by corrosion products, the upper threads usually remain clear. The operator can then further open the valve and free the lower threads.

Another valve that is currently available on hydrogen chloride cylinders is a handwheel-operated

packed valve. (See Figure 4) The valve stem has an elastomeric seat insert that allows the valve to be closed with a handwheel. The stem consists of upper and lower pieces connected by a slip joint. The packing surrounds the lower stem, sealing the top of the valve, and the stem threads are located on the upper stem, isolating the threads from the gas stream. The packing is made of several chevron rings of alternating Teflon® and metal. This helps minimize cold flow, reducing packing leaks.

One of the greatest vulnerabilities of hydrogen chloride tube trailers is the involvement in a transportation accident. The tube valves are enclosed in a steel frame cabinet that provides some protection. However, the valves could still be compromised in a serious accident. To minimize this possibility, Air Products has developed a valve that has the seat internal to the tube. In the event the valve is sheared, an internal spring forces the stem into the seat, thus sealing the valve (Figure 5).

Hydrogen chloride cylinders used in the semiconductor industry are equipped with tied diaphragm

Figure 3**Packed Valve (Wrench-Operated)****Figure 4****Packed Valve (Handwheel-Operated)****Figure 5****Tube Trailer Valve****Figure 6****Tied Diaphragm Valve**

valves. These valves may be either handwheel-operated or pneumatic. These valves eliminate the need of elastomeric packing by sealing the upper valve with a series of metal diaphragms. The lower stem pierces the diaphragms and is sealed to the diaphragms by e-beam welding. The upper stem mechanically connects to the lower stem, providing positive lift without the use of a spring. (See Figure 6.)

For more information on these and all other cylinder valves, refer to Air Products' Safetygram-23, "Cylinder Valves."

Caution: If user experiences any difficulty operating a cylinder valve, discontinue use and contact supplier.

Connections

The standard connection for hydrogen chloride is the CGA 330. This connection has a left-hand thread (loosens with clockwise rotation) and requires a gasket to seal. The preferred gasket

material is glass-filled Teflon or Teflon. The recommended sealing torque to ensure proper seal of this connection is 25 foot-pounds for the glass-filled Teflon gasket and 15 foot-pounds for the Teflon gasket.

An alternate approved connection for high-purity applications is the CGA 634. This is called a DISS (diameter index safety system) connection and requires a nickel gasket that seals with 35 foot-pounds of torque. This connection has a right-hand thread (loosens counterclockwise).

A new gasket should be installed each time a cylinder is connected. This is absolutely critical with the DISS connection.

For more information on cylinder valve connections, refer to Air Products' Safetygram-31, "Cylinder Valve Connections."

Pressure Relief Devices

The DOT-required pressure relief device for hydrogen chloride is a CG-4. The CG-4 consists of a rupture disk backed by a fusible alloy plug on the atmospheric side of the disk. The pressure rating of the disk must not exceed the test pressure of the cylinder, and the fusible alloy must yield nominally at 165°F. The combination pressure relief device provides protection against container failure caused by high temperature or fire. This relief device will not protect a cylinder from overpressurization if the fusible alloy is not heated to its yield temperature. For more information on pressure relief devices, refer to Air Products' Safetygram-15, "Cylinder Pressure Relief Devices."

Storage and Handling

Always store and handle hydrogen chloride and other compressed gases in accordance with Compressed Gas Association Pamphlet P-1, "Safe Handling of Compressed Gases in Containers." Local regulations may require specific equipment

for storage or use. For more information, refer to Air Products' Safetygram-10, "Handling, Storage, and Use of Compressed Gas Cylinders."

Personnel must know and understand the properties, proper uses, and safety precautions for hydrogen chloride before using the product and/or associated equipment.

Storage:

Cylinders should be secured in an upright position and stored in a well-ventilated area protected from the weather. Storage area temperatures should not exceed 125°F (52°C) and should be free of combustible materials. Storage should be away from heavily traveled areas and emergency exits. 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. When returning a cylinder to storage, the valve outlet seal must be installed leak-tight. Separate full from empty cylinders. Avoid excessive inventory and storage time. Visually inspect stored cylinders on a routine basis, at least weekly, for any indication of leakage or other problems. Use a first-in, first-out system. Keep good inventory records. The use of "FULL," "IN USE," and "EMPTY" tags is highly recommended. This is especially important for tubes on tube trailers.

Handling and Use

Use only in well-ventilated areas. Use a suitable handcart designed for cylinder movement. Do not drag, roll, or slide cylinders. When using a "Y" cylinder, do not remove from its transportation skid. 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 discharge gas from cylinder. Never apply flame or localized heat to any part of the cylinder. Do not allow any part of the cylinder to exceed 125°F (52°C). High temperature may cause damage to cylinder and/or premature failure of the pressure relief device that will result in the venting of the cylinder contents. If user experiences any difficulty operating the cylinder valve, discontinue use and contact supplier. Use an adjustable strap-wrench to remove over-tight or rusted caps.

Rapid withdrawal of product (vapor phase) from a cylinder will cause the temperature of the remaining liquid to drop. This may cause frosting on the outside of the cylinder at the liquid level. The cold temperature of the liquid will decrease the vapor pressure in the cylinder. At this point reverse flow may allow process products to backflow into the cylinder. This is an extremely dangerous situation and must be prevented. This can be accomplished by installing a reverse flow trap or two check valves (in series) between the process and the cylinder. If cylinder does subcool, close valve and allow cylinder to warm up. **DO NOT APPLY HEAT!** (See Figure 7.)

Withdrawal of liquid product requires the container to be oriented to gain access to the liquid phase. Extreme care must be taken when handling the liquid phase. Unlike

gas, the liquid does not compress. Therefore, the liquid must always have a space to expand, especially as it warms. In the cylinder this expansion space is provided by the vapor space or the head space. The DOT filling limits/fill density for liquefied compressed gases were set to prevent the cylinder from becoming liquid full at normal temperatures. If a vessel were to be liquid full, any increase in temperature would cause the liquid to expand with no space to grow, resulting in the rapid building of hydrostatic pressure, which can cause overpressurization of the equipment. Overpressurization of a system takes place when its maximum allowable working pressure is exceeded. This can result in a rupture of the system. Systems using the liquid phase hydrogen chloride should be protected by pressure relief devices, especially where there is a chance to trap liquid between valves.

Ensure that cylinder valve is properly closed, valve outlet seal has been reinstalled leak-tight, and valve protection cap is secured before returning to storage, moving, or shipping cylinder.

Disposal:

Return unused product to supplier. Residual or process hydrogen chloride within the system should be disposed of using a caustic scrubber. This can be accomplished by slowly discharging gas into a scrubber or other suitable vessel containing a 15 percent solution of alkali (e.g., sodium hydroxide) and water. Reverse flow of scrubber solution into cylinder must be prevented.

System Design and Maintenance

Systems that use hydrogen chloride must be kept extremely dry. Moisture will cause hydrochloric acid formation. This acid is very corrosive to most metals, including stainless steel. Purge system with dry inert gas (e.g., nitrogen) before and after use. During idle periods, systems should be maintained under pressure with approximately 10 psig of dry inert gas. During cylinder connect/disconnect, a back purge of inert gas should be maintained to prevent moisture from entering the system.

Visually inspect the system on a daily basis. Check for signs of corrosion or leaks. If a leak or any other problem is discovered, shut down and purge with nitrogen before attempting repairs. Never work on a pressurized system. Make repairs as soon as possible.

Carbon steel, stainless steel, nickel, Monel® and Hastelloy® A or B are commonly used with dry hydrogen chloride. Aluminum, brass, and copper should be avoided. In the presence of moisture, nickel, Monel, Hastelloy A or B, platinum, or gold provide good resistance to attack. Teflon or PCTFE offer good resistance when elastomers are required. Piping used to supply hydrogen chloride into any liquid system must include backflow prevention. Teflon-lined hoses should not be used for hydrogen chloride, especially liquid, to avoid static charge-induced failure.

Safety Considerations

Pressure

Hydrogen chloride is a liquefied compressed gas. The cylinder contains both liquid and gas. Cylinder pressure is directly affected by temperature. The amount of product in a cylinder cannot be determined by a pressure reading. Cylinder content can only be verified by product weight. At 70°F hydrogen chloride has a vapor pressure of 613 psig. (See Figure 7.)

Corrosiveness

Anhydrous hydrogen chloride is considered non-corrosive. In the presence of moisture it will form hydrochloric acid. This acid is very corrosive to most metals; therefore, leaks of hydrogen chloride will tend to escalate with time.

Personal Protective Equipment

Personnel must be thoroughly familiar with the properties and safety precautions before being allowed to handle hydrogen chloride and/or associated equipment.

General: Leather gloves, safety shoes, and safety glasses for handling cylinders. Face shield, acid-resistant gloves, and splash suit when connecting, disconnecting, or opening cylinders.

Emergency: Full-protection chemically-resistant suit and self-contained breathing apparatus (SCBA) should be available. Depending on the concentration of hydrogen chloride, NIOSH-approved respirators may also be used.

Caution: Direct contact with liquid may cause chemically-resistant clothing to freeze, become brittle, and crack.

First Aid

Inhalation: Remove victim to an uncontaminated area. If not breathing, give artificial respiration. If breathing is difficult, administer oxygen. Obtain prompt medical attention and continue the administration of oxygen. If airway obstruction occurs, the placement of an artificial airway by an emergency medical technician may be necessary.

Eye Contact: Flush eyes with large amounts of water. Continue for at least 15 minutes. Seek professional medical attention immediately.

Skin Contact: Immediately flush with large amounts of water. Remove contaminated clothing, including shoes, after flushing has begun. Applications of ice water compresses for 30 minutes after flushing may help limit the extent of burn.

Fire Fighting

Hydrogen chloride is nonflammable; use extinguishing media appropriate for surrounding fire. Evacuate all personnel from the area. If possible without risk, move cylinders away from fire area. Keep cylinders cool with water spray until well after fire is out. Runoff from fire fighting may be contaminated; check pH. Cylinders exposed to high heat or flame may vent or rupture violently.

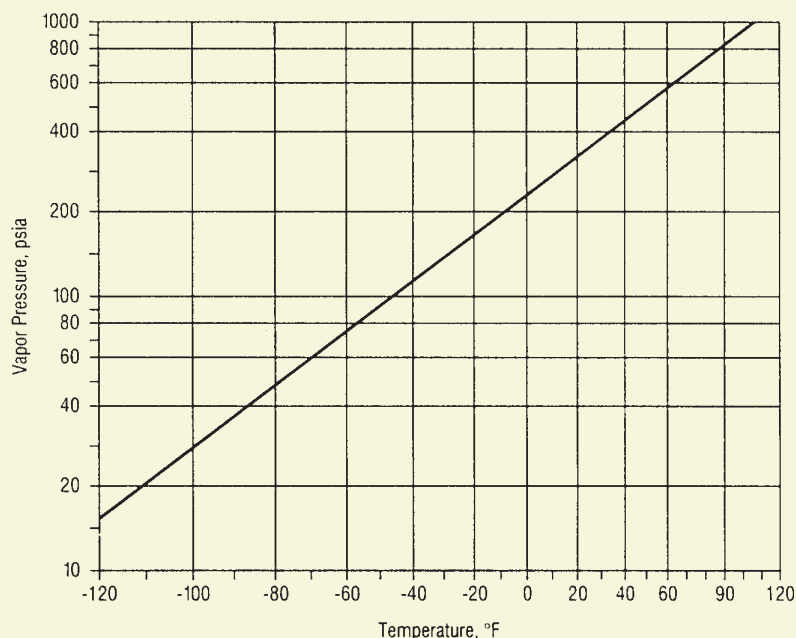
Transportation Information

DOT Hazard Class: 2.3, Hazard Zone C
DOT Shipping Label: Poison Gas, Corrosive
DOT Shipping Name: Hydrogen Chloride, Anhydrous
Identification Number: UN 1050

Special Shipping Information: Cylinders should be transported in a secure upright position in a well-ventilated truck. Never transport in the passenger compartment of a vehicle. Always ensure that cylinder valve is closed, outlet seal is installed gas-tight, and protective cap is in place before shipping.

Figure 7

Vapor Pressure of Anhydrous Hydrogen Chloride



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

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