

CRYOGENIC MATERIAL

(For assistance, please contact EHS at (402) 472-4925, or visit our web site at <http://ehs.unl.edu/>)

Definition

Cryogenic liquids have boiling points of less than -90°C (-130°F) at 14.7 psia (1 bar). All cryogenic liquids are gases at normal temperatures and pressures. When cooled and placed under pressure in specially designed systems or storage containers, the gases condense to a liquid state and maintain very cold temperatures.

Types of Cryogens & Hazards

Various gases can be used as cryogenic liquids. The most common cryogens used at UNL are nitrogen and helium, which are odorless and colorless. Both liquid helium and nitrogen are simple asphyxiants. Therefore, they do not have associated permissible exposure limits (PELs) or threshold limit values (TLVs). The hazards associated with these cryogenic liquids are contact with the skin or eyes, which causes frostbite; and displacement of oxygen from the room, which can create an atmosphere that is insufficient to support life. While inert, rapid release of cryogenic liquids can condense oxygen in the air thereby creating a localized oxygen-enriched atmosphere. This localized oxygen-rich atmosphere may pose a fire risk in the presence of organic matter and an ignition source.

Less common cryogens, such as propane, hydrogen, and oxygen, present risk of fire due to their inherent flammability, while others are toxic. Consult the Material Safety Data Sheet (MSDS) for the particular cryogenic liquid being used for a complete discussion of associated hazards.

Cryogen Containers

Cryogenic liquids are generally shipped in low-pressure, vacuum-insulated, multi-walled containers; and may be transferred to non-pressurized containers for everyday use. The vacuum-insulated wall design is intended to keep the surrounding heat away from the liquid contained in the vessel. All containers will "leak" heat which causes the liquid to slowly change to a gas thereby creating pressure. As the gas exits the container (through a pressure release valve or loose fitting lid), a visible fog and/or frosting on the container will be seen. Shipping containers are equipped with pressure relief valves and rupture disks that vent excess pressure. Holding containers such as dewar flasks are equipped with loose fitting lids to allow excess pressure to vent. These pressure venting features are critical to the safe operation of cylinders and containers.

- **Liquid dewar flasks.** Liquid dewar flasks are non-pressurized, vacuum-jacketed vessels. Dewars are equipped with loose fitting caps or plugs. Dewars are available in sizes ranging from 5 to 200 Liters.

- **Liquid cylinders.** Liquid cylinders are low-pressure, stationary or portable, and are specifically designed for cryogenic liquids. Cylinders are available in sizes ranging from 80 to 450 Liters. Cylinders designed for liquid withdrawal generally operate at less than 20 psig. Cylinders designed for gas withdrawal generally operate in the range of 5-150 psig.

Safe Work Practices

- Contact of the skin with cryogenics or items that have been supercooled by a cryogen can cause severe burns or frostbite.
- Wear eye protection and a face shield when opening valves, dispensing cryogenic liquids, or placing items into or removing items from a cryogen. Remove jewelry or other items that could trap spilled liquids against the skin. Use thermal or leather gloves when touching items that have been in contact with cryogenics. Use tongs to remove or place items into cryogenic liquids. Splattering will occur anytime an item is placed into or removed from a cryogenic liquid. Items removed from a cryogen will change temperatures/pressures very rapidly, which can result in container failure sending shards of plastic everywhere. Thus, eye and face protection is critical. Use potholders when opening valves or dispensing cryogenics. If eye or skin contact with frostbite occurs, remove restrictive clothing, flush the affected area with tepid (NOT HOT) water and seek medical attention. Do not rub the affected area or use dry heat to warm.
- Cryogenic gases can cause asphyxiation by displacing oxygen in the air because of their very large expansion ratios (700 – 900). As an example, an abrupt release of only 3 liters of liquid nitrogen in a 12x12x8 room would result in an oxygen deficient atmosphere (< 19.5% oxygen)¹. Indoor use, storage, and dispensing areas should be mechanically ventilated (minimum of six air changes per hour). Passive ventilation is not recommended. An oxygen sensor and alarm (or sensor specific to the gas in use) should be used in areas where the size of the largest container exceeds the available room capacity to the extent that an oxygen deficient atmosphere could occur in the event of a release; and in areas equipped with stationary containers that are filled from a delivery truck and the equipment is not vented to the outdoors. Oxygen sensors/alarms are recommended for gases that are simple asphyxiants and that do not have good warning properties (i.e., odor). Specific gas monitors/alarms are recommended for gases that present other hazards (i.e., toxic, flammable).
- Pre-plan for spills.
- Know the maximum amount that can be spilled or released in the area without creating an oxygen deficient atmosphere or other hazard (i.e., fire, toxic atmosphere, etc.). If a spill occurs that exceeds this amount, immediately leave the area, shut doors, and contact the University Operator. If the amount spilled or released is such that it could impact nearby areas or create a secondary hazard of fire or toxicity, initiate building evacuation procedures.
- If the amount is small and does not create a secondary hazard, ensure ventilation of the area, and notify the University Operator. If it is safe to do so and a fume hood is nearby, the cylinder or container can be located in or in front of the operating hood to assist with ventilation.

- Pressure relief valves on cylinders serve an important safety function- they allow gases to escape to prevent over-pressurization. Do not block, seal, or otherwise tamper with the valves. Caps on dewars are designed to be loose-fitting to allow for gases to escape. Never completely seal a dewar.
- Never use a thermos bottle or other device that has not been specifically designed for cryogenic service.
- When working with cryogenic liquids, ensure that equipment is scrupulously clean. Greases, waxes, or other impurities could react with the liquid/gas or condensed room oxygen to cause a fire. Use and store cryogenics away from ignition sources.
- Store and move cylinders only in an upright position. Do not drop, tip, or roll containers. Use mechanical handling devices for safely moving large containers and secure the container during transport.
- Avoid transporting containers or cylinders in a passenger elevator.
- Recognize that many materials can become brittle and prone to failure in contact with the extremely cold temperatures of cryogenics.
- Use only cryogenic storage vials that are designed specifically for this purpose, and visually inspect each vial prior to use to ensure that there are no defects. Do not reuse vials.
- Allow vials and other containers that have been in contact with cryogenics to warm slowly to minimize sudden pressure differentials.
- Label cylinders and dewars with "Cryogenic gas/liquid" and the name of the product (i.e., Liquid Nitrogen).

¹ http://www.oxigraf.com/technical_support.html