CRYOGEN SAFETY

Manage Cryogen Safely:

A cryogenic liquid is defined as a liquid with a normal boiling point below -240°F (-150°C, 123°K). The most commonly used industrial gases that are transported, handled, and stored in the liquid state at cryogenic temperatures are argon, helium, hydrogen, nitrogen, and oxygen. There are a number of general precautions and safe practices that must be observed because of the extremely low temperatures and high rates of conversion into gas of all the cryogenic liquids. There are also specific precautions that must be followed where a particular liquid may react with contaminants or may present other hazards associated with that particular product such as asphyxiation or flammability. As always, end users should have and be thoroughly familiar with the Material Safety Data Sheet (MSDS) for their specific product. All operators must be familiar with the instructions provided with the equipment to be used with the cryogenic liquid.

The vapors and gases released from cryogenic liquids also remain very cold. They often condense the moisture in air, creating a highly visible fog. In poorly insulated containers, some cryogenic liquids actually condense the surrounding air, forming a liquid air mixture.

Properties of cryogenic fluids:

- Extreme low temperatures.
- Large ratio of expansion in volume from liquid to gas.
- Most cryogenic liquids are odourless and colourless when vapourised to gas.
- Boiling points of cryogens
    - Helium - 269.9 0C
    - Hydrogen - 252.7 0C
    - Neon - 245.9 0C
    - Nitrogen - 195.8 0C
    - Oxygen - 183.0 0C
- Liquid to gas expansion ratios of cryogens
    - Helium 1 to 757
    - Hydrogen 1 to 851
    - Neon 1 to 1438
    - Nitrogen 1 to 696
    - Oxygen 1 to 860

Storage:

- Cryogenic fluids are stored in well insulated containers to minimize loss due to boil off.
- The most commonly used container for handling cryogenic fluids is the Dewar flask.
- Dewar flasks are non-pressurized, vacuum jacketed vessels.

Handling:

Always handle cryogenic liquids carefully. Their extremely low temperatures can produce cryogenic burns of the skin and freeze underlying tissue. When spilled on a surface, they tend to spread as far as the quantity of liquid spilled and the physical confines of the area permit. They can cool large areas. The vapors coming from these liquids are also extremely cold and can produce burns. Exposure to these cold gases, which is too brief to affect the skin of the face or hands, may affect delicate tissues, such as the eyes.

Stand clear of boiling and splashing liquid and the cold vapors that are released. Boiling and splashing always occur when filling a warm container or when inserting objects into the liquid. Always perform these operations slowly to minimize the splashing and boiling.

Never allow any unprotected part of your body to touch uninsulated pipes or vessels containing cryogenic liquids. The extremely cold material may stick fast to skin and tear the flesh when you attempt to withdraw it. Even nonmetallic materials are dangerous to touch at these low temperatures. Use tongs to immerse and remove objects from cryogenic liquids. In addition to the hazards of frostbite or flesh sticking to cold materials, objects that are soft and pliable at room temperature, such as rubber or plastics, are easily broken because they turn brittle at low temperatures and may break when stressed.

Personal Protective Equipment (PPE):

One must be thoroughly familiar with the properties and safety considerations before handling a cryogenic liquid and its associated equipment. The eyes are the most sensitive body part to the extreme cold of the liquid and vapors of cryogenic liquids. The recommended personal protective equipment for handling cryogens includes a full face shield over safety glasses, loose-fitting thermal insulated or leather gloves, long sleeve shirts, and trousers without cuffs. In addition, safety shoes are recommended for people involved in the handling of containers. Depending on the application, special clothing suitable for that application may be advisable.

A special note on insulated gloves: Gloves should be loose-fitting so they are able to be quickly removed if cryogenic liquid is spilled on them. Insulated gloves are not made to permit the hands to be put into a cryogenic liquid. They will only provide short-term protection from accidental contact with the liquid. In emergency situations, self-contained breathing apparatus (SCBA) may be required.

Special Inert Gas Precautions:

The potential for asphyxiation must be recognized when handling inert cryogenic liquids. Because of the high expansion ratios of cryogenic liquids, air can quickly be displaced. Oxygen monitors are recommended whenever cryogenic liquids are handled in enclosed areas. People should not be permitted in atmospheres containing less than 19.5% oxygen without supplied air. Liquid helium has the potential to solidify air, which can block pressure-relief devices and other container openings. This can result in pressure buildup that may rupture the container.

Special Oxygen Precautions:

There can be no open flames in any areas where liquid oxygen is stored or handled. Do not permit liquid oxygen or oxygen-enriched air to come in contact with organic materials or flammable or combustible substances of any kind. Some of the organic materials that can react violently with oxygen when ignited by a spark or even a mechanical shock are oil, grease, asphalt, kerosene, cloth, tar, and dirt that may contain oil or grease. If liquid oxygen spills on asphalt or other surfaces contaminated with combustibles, do not walk on or roll equipment over the spill area. Keep sources of ignition away for 30 minutes after all frost or fog has disappeared. Any clothing that has been splashed or soaked with liquid oxygen or exposed to high oxygen concentrations should preferably be removed immediately and aired for at least an hour. Personnel should stay in a well-ventilated area and avoid any source of ignition until their clothing is completely free of any excess oxygen. Clothing saturated with oxygen is readily ignitable and will burn vigorously.

Special Hydrogen Precautions:

No ignition of any kind in any area where liquid hydrogen is stored or handled. All major pieces equipment should be properly grounded. All electrical equipment and wiring should be in accordance with National Fire Protection Association Pamphlet 50B and/or National Electrical Code, Article 500. Boil-off gas from closed liquid hydrogen containers used or stored inside buildings must be vented to a safe location. Liquid hydrogen should not be poured from one container to another, or transferred in an atmosphere of air. If this is done, the oxygen in the air will condense in the liquid hydrogen, presenting a possible explosion hazard. Liquid hydrogen also has the potential of solidifying air which can block safety relief devices and other openings, which may lead to rupture of the container. Dewars and other containers made of glass are not recommended for liquid hydrogen service. Breakage makes the possibility of explosion too hazardous to risk. Every effort must be made to avoid spills, regardless of the rate of ventilation, because it is impossible to avoid creating a flammable vapor cloud.

About Venting From Cryogenic Liquid Containers:

All cryogenic containers vent to atmosphere to prevent hazardous pressure buildup inside the container. Typically, there are two levels relatively low pressure vent valves plus a frangible disk that will blow out and vent the entire container if the internal pressure goes beyond a certain point. In order to prevent total evacuation of the container DO NOT VALVE OFF the low pressure poppet valves. While they can be noisy, they are also necessary.

Continuous venting is not normal, this could mean that there is dirt in the vent valve or that it is otherwise damaged. If this occurs, CALL THE VENDOR and ask them to pick up and exchange the container ASAP.

While frost around the top of a venting container is just indicative that the cold, venting vapors are condensing the moisture in the air, frost at the bottom or on the sides of the cylinder indicate that the container is faulty and damaged. Again, CALL THE VENDOR and ask them to pick up and exchange the container ASAP. If the container is dented or otherwise physically damaged, it should not be accepted from the vendor.

First Aid:

People 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.

For skin contact with cryogenic liquid nitrogen, remove any clothing that may restrict circulation to the frozen area. Do not rub frozen parts, as tissue damage may result. As soon as practical, place the affected area in a warm water bath that has a temperature not in excess of 105°F (40°C). Never use dry heat. Call a physician as soon as possible.

Frozen tissue is painless and appears waxy with a possible yellow color. It will become swollen, painful, and prone to infection when thawed. If the frozen part of the body has been thawed, cover the area with a dry sterile dressing with a large bulky protective covering, pending medical care. In the case of massive exposure, remove clothing while showering the victim with warm water. Call a physician immediately.

If the eyes are exposed to the extreme cold of the liquid nitrogen or its vapors, immediately warm the frostbite area with warm water not exceeding 105°F (40°C) and seek immediate medical attention.