FACT SHEET

Berkeley UNIVERSITY OF CALIFORNIA EH&S OFFICE OF ENVIRONMENT, HEALTH AND SAFETY

Cryogenic Liquids - Precautions and Safe Handling Procedures

Cryogenic liquids are extremely cold liquids that at normal temperature and pressure would be a gas. These very cold liquids provide a fluid media that is useful for researchers to preserve their sample materials and for laboratory experimental processes. This fact sheet provides a summary of the hazards and safe work practices for users of cryogens and can be referenced in the laboratory Chemical Hygiene Plan. The most common cryogens are nitrogen and helium.

Physical Properties

Cryogenic liquids boil well below temperatures that we normally consider “cold”, and may boil violently in containers at room temperature. They are odorless and colorless when vaporized to a gas, but as the gas boils off, it condenses moisture in surrounding air creating a highly visible fog that is often mistaken for cryogenic gas (which is invisible).

Hazards of Cryogenic Liquids

Burns - Direct contact of skin and cryogenic liquids can cause cold burns and frostbite. Prolonged contact may result in blood clots.

Adhesion - The cold surface of equipment and piping containing cryogenic liquid can cause the skin to stick to the surface, which will then tear as you attempt to remove it. Even non-metallic materials are dangerous to touch at such low temperatures.

Boiling and Splashing - Cryogenic liquids can boil and splash when first added to a warm container.

Oxygen Deficiency and Asphyxiation - Cryogenic liquids have the potential to create an oxygen deficient environment because of their large liquid-to-gas volume displacement ratios, typically about 700:1.

Pressure and Explosions - Large liquid-to-gas ratios can lead to rapid pressure changes as cryogenic liquids vaporize. All cryogens can condense sufficient moisture from the air subsequently freezing and blocking the opening of storage vessels. This can lead to an explosion from the buildup of trapped gases in the container; for instance, cryotubes stored in liquid nitrogen may explode when removed from the Dewar.

Flammability and Explosions - Nitrogen and helium are considered non-reactive and non-flammable; however, liquid nitrogen and liquid helium can condense oxygen out of air. Liquid oxygen is VERY reactive and hazardous. Combustible substances exposed to liquid oxygen become more likely to ignite, will burn more vigorously, and may potentially explode. Materials usually considered non-flammable can burn vigorously in an oxygen enriched environment. Organic materials that can react violently with liquid oxygen include oil, grease, kerosene, tar, cloth, and asphalt. Any planned use with liquid oxygen must be reviewed by the EH&S Campus Fire Marshal.

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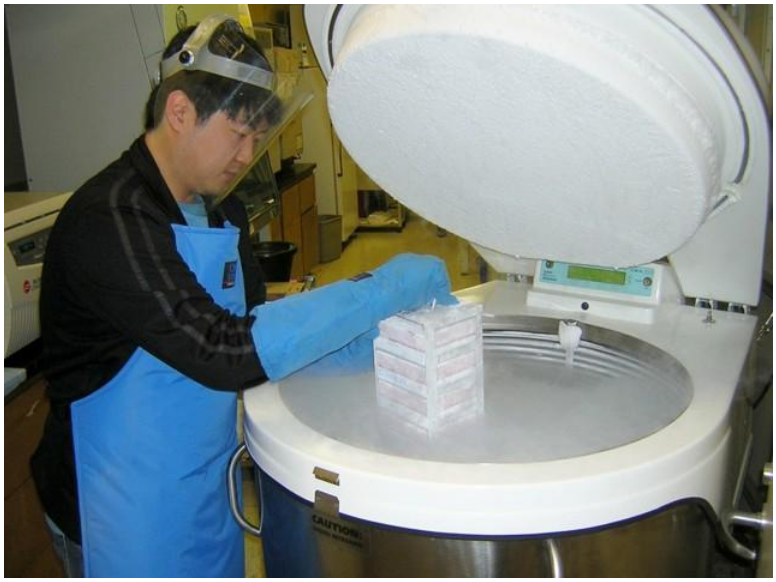
Safe Handling Procedures

Preparation

1. Be familiar with hazards associated with cryogen use.
2. Work in an open, well-ventilated location. Consider ventilation monitors or oxygen deficient sensors and alarms. Check the monitors and alarms before and during cryogen use.
3. Always wear safety goggles and/or face shield.
4. Always wear appropriate cryogen gloves; do not leave skin exposed. Do not wear metal jewelry or watches.
5. Examine containers and pressure relief valves for signs of defect. Never use a container that has defects. Ask cryogen vendor for assistance with questions on cryogenic equipment and pressure relief valves.
6. Ensure that all equipment and containers are free of oil, grease, dirt, or other materials which may lead to flammability hazard upon contact with liquid oxygen.



7. Select working materials carefully. Cold cryogenic liquids may alter the physical characteristics of many materials, make them brittle and fail.
8. Verify there is pressure relief for any place that there can be a pressure build-up.
9. Schedule large dewar fills during normal business hours, when staff are available to assist. If after-hours access is needed, it is **required** that there be others nearby to assist moving the cryogenic containers, especially if the individual is not experienced at handling cryogenic material.
10. Sometimes the dewar pressure relief valves fail and allow improper or frequent venting. Safely move the damaged dewar to a well-ventilated area, post a warning sign, and contact the dewar manufacturer or campus cryogen vendor for assistance.

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Transfer and Use

1. All cryogenic systems and Dewars must have pressure relief valves to release excessive pressure, and bursting discs. Dewar flasks must have loose fitting lids. The pressure relief valves should be inspected regularly.
2. Use only fitted transfer tubes designed for use with the Dewar container. Damaged transfer tubes should be replaced. Do not handle transfer tubes with your bare hands as the fitting is not insulated.
3. When transferring to a secondary container, do not fill the secondary container to more than 80% of capacity (60% if the temperature is likely to be above 30°C).
4. Do not lower warm experiments into Dewars of cryogen.
5. Immediately re-cap any container to prevent atmospheric moisture from entering and forming an ice plug in the opening.
6. Provide proper venting for the Dewars used in experiments.

Handling / Moving

1. Wear the proper Personal Protective Equipment (PPE, see below) before handing cryogenic containers.
2. Use care in transporting cryogens; do not use fragile containers. Use a hand truck or the lowest shelf of a cart for transport of cryogens.
3. When available, use service elevators for transferring unsealed containers of cryogens. Do not accompany any containers of cryogenic liquid in elevators.
4. At least two people must be present in order to transport or move cryogen containers.
5. Never roll a cryogen container.
6. When moving large cryogenic dewars (such as those with a capacity of 160 L or greater), make sure to point the pressure relief valve away from your face and the face of others.
7. When moving large containers, keep the load close to the body. Push, do not pull the container.
8. If the container tips over - **let it go**. Do **NOT** try to stop a falling container. The rim at the top of the container acts as a roll cage and should keep the valves safe. Evacuate and call EH&S for assistance immediately.

Storage

1. Store cryogens in well-ventilated areas to prevent oxygen deficiency.
2. Use only approved storage vessels that have pressure relief valves.
3. Never adjust, block, or plug a pressure relief valve. The vendor is required to check the pressure relief valve before filling the Dewar.
4. Avoid contact of moisture with storage containers to prevent ice plugs in relief devices.
5. Periodically check container necks for ice plugs; core out ice plugs if present.
6. Keep all heat sources away from cryogenic liquids.
7. Do not use cryogens or dry ice in walk-in cold rooms, because they may not have sufficient air exchange and could become hazardously oxygen deficient.

Personal Protective Equipment (PPE)

Hand Protection

- Wear loose fitting gloves made for cryogenic work (blue cryogenic gloves) or smooth leather welding type gloves without gauntlets. Loose fitting gloves can be thrown off if some cryogen leaks or is spilled into them.
- Rubber gloves should not be used because they will harden instantly - if your hand is bent, you may not be able to remove your hand.
- A thin gas barrier forms between the skin and the cryogenic liquid when it is spilled on the skin. This will protect you unless the liquid hits you under force. This gas barrier is very cold and can also burn you.
- Use non-metallic tongs to add or remove materials from cryogenic liquids.

Eye Protection

- Face shields and goggles provide the best protection for the eyes and face. Safety glasses will not protect your face, and cold liquids can hit your face and run under the glasses into your eyes. Safety goggles will keep liquid out of eyes but leave face exposed.
- When filling Dewars or transferring cryogenic liquids from one container to another, face shields must be worn.
- Avoid working with cryogens overhead, as a spill can more likely result in serious injury. Extra care should be taken when working with cryogens overhead, such as when filling lab equipment. If necessary use a ladder and work from above with no one below.

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Clothing

- Closed toe shoes are required when handling cryogenic liquids. Leather will shed the spilled liquid. Cuffless pants should cover the shoe top. Sneakers are typically made with absorbent materials which could draw liquid toward your skin.
- Long sleeve shirts made of non-absorbent material are best.
- An apron made of leather or other non-absorbent material should be used when working with liquid cryogens. Most clothing material will absorb spilled liquid cryogens, bringing the liquid close to the skin.
- Wear a lab coat when working with cryogenic liquids.

Injuries

- If skin comes into contact with a cryogen, run the area under room temperature or warm water for fifteen minutes. Never use hot or cold water. The re-warming, or thawing, of affected area(s) should be done gradually. It may take up to 60 minutes to thaw the affected area(s) and bring back the natural color of the skin.
- If your finger is burned, do not put it in your mouth. This could burn your mouth or tongue.
- Do not rub a burned area: rubbing can cause further tissue damage.
- Always seek medical attention for frostbite injuries. You should obtain medical assistance as soon as possible when cryogens contact your skin. Immediately upon exposure, the frozen skin appears waxy and yellow and the burn usually is not painful. Then it painfully swells and blisters while the skin defrosts.
- Always push Dewars if they need to be moved. Never pull on Dewars - they are very heavy and can tip and crush you. Large Dewars can lead to ergonomic injuries (back injuries, crushed foot, crushed hand).
- Be careful with cryogenic materials.

Training

Take a short on-line training (approximately 20 minutes) for the **Safe Use of Cryogenic Materials** on the UC Learning Center.