How to Work Safely with – Cryogenic Liquids – Fact Sheets

WHY SHOULD I TRY TO USE SUBSTITUTION AS A CONTROL METHOD?

Substitution is often the best way to avoid or reduce a hazard. But it is not always easy or even possible to find a less hazardous substitute for a particular cryogenic liquid used for a specific job. Chemical suppliers may be able to suggest possible safer substitutes to meet the specific needs of your workplace.

Obtain MSDSs for all possible substitutes. Find out about all of the hazards (health, fire, chemical reactivity) of these materials before making any substitutions. Choose the least hazardous material.

Why is proper ventilation important?

Well-designed and maintained ventilation systems remove gases from the workplace and reduce their hazards. To reduce the risk of fire, explosion or asphyxiation, ensure proper ventilation where cryogens are stored or used.

The amount and type of ventilation needed depends on such factors as the type of job, the kind and amount of materials used, and the size and layout of the work area. Some workplaces may need a complete system of hoods and ducts to provide acceptable ventilation. Others may require a single, well-placed exhaust fan. No special ventilation system may be needed where small amounts of inert gases are used. Assess the specific ways cryogenic liquids are stored, handled, used and disposed of in the workplace to find out if existing ventilation controls (and other hazard control methods) are adequate.

Make sure ventilation systems are designed and built so they do not result in an unintended hazard. Ensure hoods, ducts, air cleaners and fans are made from materials compatible with the gas used. Explosion-proof equipment may be required.

Separate ventilation systems may be needed to keep some cryogenic liquids away from systems exhausting incompatible substances.

What should I know about storing cryogenic liquids?

Inspect all incoming containers before storing to ensure they are not damaged and are properly labelled. Do not accept delivery of defective containers. Always use the correct name for all materials. For example, never call liquid oxygen “liquid air”. If the oxygen is available in a mixture, refer to it as “medium purity liquid oxygen” or “oxygen mixture”. Handle any mixtures with an oxygen concentration greater than air with the same precautions as pure liquid oxygen.

Keep dewar flasks covered with a loose fitting cap. This method prevents air or moisture from entering the container yet allows pressure to escape. Use only the stopper or plug supplied with the container. Glass dewar flasks are available but never use them to store combustible or oxidizing cryogenic liquids. Put tape on glass dewar flasks. The tape will minimize any hazards from flying glass should the flask fracture when a cryogenic liquid is poured into it.

Ensure that ice does not form in the neck of flasks. Liquids such as helium and hydrogen can freeze the water vapour in the surrounding air which can create a pressure hazard. Dewar flasks are not pressure vessels so if the opening is blocked pressure can slowly build up. Eventually, the pressure may cause a violent rupture. If the neck of the dewar flask is blocked by ice or “frozen” air, follow the manufacturer’s instruction for removing it. Ice can also cause pressure relief valves to malfunction or become blocked.

Do not store containers where they may come into contact with moisture. Moving parts, such as valves or pressure relief devices, can malfunction due to external ice formation.

Ensure that ignition sources and combustible materials are kept far away from liquified oxygen and other flammable material storage and handling areas. Ensure that vessels are insulated from any sources of heat.

Do not store liquid oxygen containers on wood, asphalt or oil soaked gravel. When saturated with liquid oxygen, these materials have exploded after an impact as slight as a footstep. Use concrete or clean gravel under storage areas.

Store all cryogenic liquid containers upright in well-ventilated areas. Handle them carefully, and avoid dropping, rolling or tipping them on their sides. Take the same precautions for storing liquid cryogens as are needed for storing these materials in their gas form.

Use care when loading or unloading by forklift, crane or other power assist devices. Always ensure the container is secure to pallet or a similar device.

Restrict access to storage areas. Allow only authorized people into the storage areas. Clearly post warning signs and emergency instructions.

What should I know about transporting cryogenic liquids?

Move cryogenic liquid containers carefully. Do not move a container by rolling it on its lower rim. Always use a hand truck, cart, or other proper handling device. Use a strap to secure the container to the handcart. Keep the cryogenic liquid containers upright at all times except for the minor tilting on the cart during transport. Always push the container (don’t pull) as pushing reduces the chance of the container falling on you or a co-worker. If cryogens must be transported by elevator, take adequate precautions to prevent possible injury.

Send cryogenic liquids in elevators without any passengers and ensure that no passengers get on the elevator while the cryogen is being transported. If a power failure occurred, a passenger would be trapped in the confined space of an elevator with the cryogen. Excessive amounts of the cryogen could vapourize and displace the oxygen.

How should I handle and use cryogenic liquids?

Only handle cryogenic liquids if you are fully aware of the properties of the materials and the equipment. Written procedures and checklists should be developed. Changes in procedures should only be allowed after a proper review and if necessary, consultation with the supplier. For particularly hazardous operations, a work permit system should be put into place. A competent person should examine all the equipment and review the proposed procedures before the work begins.

Selecting Materials for Use with Cryogens

At the extremely low temperatures of cryogenic liquids, many common materials such as carbon steel, plastics and rubber become brittle and can crack. This process is called “embrittlement” (e.g. Do not pour cryogenics down the drain). Many materials also shrink at cryogenic temperatures, potentially causing leaks at hose connections. Therefore, take care when selecting materials to be used with cryogens. Regardless of the materials chosen do not allow water to contaminate equipment. Freezing ice will expand and can crack equipment.

Cooling Operations

When using cryogenic liquids to cool an object, insert the object SLOWLY using tongs. This procedure minimizes any boiling and splashing which occurs when warm objects are added rapidly. Never wear watches, rings, bracelets or other jewellery, because if splashed by a cryogen, they can freeze to exposed skin.

What should I know about transferring cryogenic liquids?

When transferring cryogenic liquids from one container to another, cool the receiving dewar flask before filling it. Always start filling slowly to allow the vaporization to chill the receiving container. After the vaporization and liquid boiling has decreased, fill the container at the normal rate. Devices which reduce turbulence while filling are available for attachment to your transfer hose. These attachments will significantly reduce the release of gas. Contact your gas supplier for information.

When pouring cryogenic liquids, use an appropriate filling device. For wide mouthed containers this may be a funnel. When it is not safe or convenient to tilt the container, use a discharge tube to remove the liquid. Insert the discharge tube through the neck of the container and well down into the liquid. The packing material or stopper on the discharge tube should form a seal in the neck of the container. Normal evaporation usually produces enough pressure to push liquid out. If necessary, the container may be pressurized with the same gas as the liquid or with an oil-free inert gas. Use just enough pressure to force liquid out. Never fill containers higher than the indicated level.

Fill containers only with liquids they are designed to hold. Mixing flammable cryogens and liquid oxygen produces a fire hazard. If liquid oxygen is used in a

liquid nitrogen refrigerator, any organic materials in the refrigerator could burst into flames.

How should I handle liquid oxygen?

Prevent all organic substances including oils and greases from contacting liquid oxygen. Thoroughly clean any equipment or container used with liquid oxygen to the degree required for use with oxidizing materials. Some common materials (such as asphalt kerosene, cloth, wood, paint, tar, and dirt containing oil or grease) can react violently with liquid oxygen at certain pressures and temperatures.

Remove clothing that is splashed with liquid oxygen immediately and air it out for at least one hour. If a fire starts in an area where liquid oxygen is flowing, stop the flow of oxygen. Do not allow smoking or open flames in any area where liquid oxygen is stored, handled or used.

How should I handle liquid hydrogen?

Liquid hydrogen is a severe fire hazard because it is easily ignited, has a wide flammable temperature range, and produces a colourless flame that is difficult to see. Therefore, limit the amount of liquid hydrogen used indoors.

Simply opening a hydrogen container can produce enough energy to start the gas burning. In fighting a hydrogen fire, it is important to first stop or turn off the flow of hydrogen gas. Simply smothering or blowing out the flame without shutting off the hydrogen supply can create an explosion hazard. If the hydrogen supply cannot be turned off, it may be best to let the fire burn. Control the spread of the fire until the fuel is used up.

Is special training needed?

Anyone who handles, stores or transfers cryogenic liquids requires instruction on safe handling practices. Specific areas of instruction should include:

- Properties of the cryogen both as a liquid and a gas.
- Specific instructions on the equipment being used, including safety devices.
- Approved materials that are compatible with the cryogen.
- Selection, use and care of protective equipment and clothing.
- First aid, including self-treatment.
- Dealing with emergencies such as fires, leaks and spills.
- Good housekeeping practices.

Is good housekeeping important?

Maintain good housekeeping at all times in the workplace.

- Do not contaminate cryogenic liquids or their containers.
- Never allow combustible organic materials near liquid oxygen.
- Prevent mixing of flammable and oxidizing cryogens.
- Never allow any absorbent materials to be exposed to flammable or oxidizing cryogens.
- When venting storage containers, proper consideration must be given to all the properties of the gas being vented. Venting should be to the outdoors

with appropriate environmental considerations. This prevents the accumulation of flammable, toxic, oxidizing or inert gases in the work area.

Is personal cleanliness important?

Personal cleanliness helps protect people working with hazardous materials. (This is particularly important with liquid oxygen).

- Remove contaminated clothing since it may be a severe fire or health hazard.
- Do not wear or carry items contaminated with oxidizing or flammable cryogens into areas with ignition sources or where smoking is allowed.
- Do not store food and tobacco products in work areas.
- Wash hands before eating, drinking, smoking or going to the toilet.
- Wash yourself thoroughly at the end of the workday.

Is equipment maintenance important?

- Regular equipment maintenance can prevent hazardous conditions in the workplace.
- Always follow all the manufacturer’s procedures for operating and maintaining equipment used with cryogens.
- Comply with applicable regulations and follow the advice of the cryogenic liquid supplier.
- Repair equipment properly using tools and procedures suitable for the contents of the cryogenic liquid container.
- Avoid forcing connections, using homemade adaptors, or tampering with containers in any way.
- When doing maintenance work on oxygen handling systems, cleanliness is required. Grease or oil must not be allowed to contaminate any parts.

Regular workplace inspections can help to spot situations in which cryogenic liquids are stored, handled or used in potentially hazardous ways.

What should I know about Personal Protective Equipment for cryogenic liquids?

It is essential to choose the right personal protective equipment (PPE) for a particular job. MSDSs should provide general guidance. Also obtain advice from someone who knows how to evaluate the hazards of the job and how to select the proper PPE.

Avoid Skin Contact

Cryogenic liquids flow very freely and can penetrate woven or other porous clothing much faster than water. Wear a non-porous, knee length laboratory coat, without pockets or cuffs which could catch the liquid. If using larger quantities of cryogenic liquids, wear an apron of a non-woven material such as leather. Wear boots with tops high enough to be covered by pants without cuffs. Wear loose fitting, insulated gloves when handling anything that may have been in contact with a cryogenic liquid. The gloves must be loose so they can be thrown off quickly if liquid spills into them. Insulated welding gloves are one type of glove that has been found useful.

Use tongs or proper gloves to handle objects that are in contact with cryogenic

liquids.

Protect Your Eyes and Face

Wear safety glasses whenever you are near a cryogenic liquid. Protect the eyes with a full-face shield (with safety glasses or goggles) if a cryogenic liquid is poured or if an open container of the cryogen may bubble. The CSA Standard Z94.3 “Eye and Face Protectors”, provides advice on selection and use of eye and face protectors.

Avoid Breathing Harmful Gases

If respirators must be used for breathing protection, develop and follow a written respiratory protection program. The CSA Standard Z94.4, “Selection, Care and Use of Respirators,” gives guidance for developing a program. Follow all legal requirements for respirator use and approvals. These requirements may vary between jurisdictions in Canada.

Remember, air-purifying respirators do not protect against oxygen-deficient environments. In situations where low oxygen levels occur, use supplied air or self-contained breathing apparatus.

Be familiar with the right PPE for use in emergencies as well as during normal operations.

Wear the PPE needed for doing a particular job. It cannot provide protection if it is not worn.

What First Aid measures should I take?

Avoid contact with cryogenic liquids, their vapours and any cooled surfaces. If contact does occur, immediately flush the area with large quantities of warm (not hot) water. If the skin is blistered or the eyes have been exposed, obtain medical attention immediately. Locate emergency eyewash stations and safety showers wherever there may be accidental exposures to cryogens.

What emergency procedures should I take?

Prepare for emergencies. Planning, training and practicing, help people to know what they must do. The MSDSs are a starting point for drawing up an emergency plan. MSDSs have specific sections on spill and leak procedures, first aid instructions, and fire and explosion hazards. If the directions in each MSDS section are not clear or seem incomplete, contact the cryogen supplier or manufacturer for help.

Many other sources can also help develop emergency plans. Local fire departments can assist with fire emergency plans and training.

Act quickly in emergencies such as chemical fires or cryogenic vessel leaks.

- Evacuate the area at once if you are not trained to handle the problem or if it is clearly beyond your control.
- Alert other people in the area to the emergency.
- Call the fire department immediately.
- Report the problem to the people responsible for handling emergencies where you work.

- Obtain first aid if you have been exposed to harmful chemicals.

Remove all contaminated clothes.

Only specially trained and properly equipped people should handle emergencies. Nobody else should go near the area until it is safe.

If a liquid oxygen container falls over, evacuate the area and observe the container from a safe position for 30 minutes. If the inner vessel is damaged, a leak could cause an ignition in the insulation space when the vessel is moved. Contact your supplier immediately if the inner vessel of a liquid oxygen container is damaged.

Cryogens can be particularly dangerous during fires. Cryogenic liquids can freeze water very rapidly. Careless use of water can lead to heavy icing, possibly blocking pressure relief valves. The relatively warm water can also cause a flammable cryogenic liquid to vapourize more rapidly. This rapid evaporation produces more flammable gas to feed the fire.

What are basic safe practices when working with cryogenic liquids?

Following these basic general safe practices will help protect you from the hazards of cryogenic liquids:

- Read the MSDSs and labels for all of the materials you work with.
- Know all of the hazards (fire/explosion, health, chemical reactivity, pressure) of the materials you work with.
- Store cryogen containers in cool, dry, well-ventilated areas, away from incompatible materials and ignition sources.
- Store, handle and use cryogen containers securely fastened in place in the upright position.
- Ensure that pressure relief valves are working properly.
- Never tamper with safety devices on vessels, valves or equipment.
- Never roll, drag, or drop vessels or permit them to strike each other.
- Move containers in handcarts or other devices designed for moving cryogenic liquid vessels.
- Ensure proper ventilation in areas where cryogens are stored or used to reduce the risk of fire, explosion or asphyxiation.
- Fill containers only with the liquids for which they were designed. Label each container. Fill vessels to the indicated level only. Do not overfill.
- Proceed slowly when filling a container or inserting objects into a cryogen to minimize boiling and splashing.
- Prevent frostbite by never allowing cryogenic liquids to touch your skin.
- Never wear watches, rings, bracelets, or other jewellery that could freeze to your skin.
- Always wear loose fitting insulated gloves when handling anything that may have been in contact with a cryogen.
- Wear safety glasses whenever you are near a cryogen, and a face shield when pouring a cryogen.
- Wear the proper personal protective equipment for each of the jobs you do.
- Know the location of eyewash stations and safety showers.
- Obtain proper training on how to use all of the materials and equipment you are using.
- Know how to deal with emergencies (fires, leaks, personal injury).
- Follow the health and safety rules that apply to your job.