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Praxair Canada Inc.

User Guidance

Cryogenic Liquid Containers

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Cryogenic Liquid Containers

An Introduction

This document presents an overview of the operational features of cryogenic liquid containers; provides answers to a few common questions; and offers some simple tips to address issues that customers tend to experience with liquid containers.

Understanding the applications and operational features of cryogenic liquid containers is critical to the safe, reliable, and optimal use of liquefied gases.

What are Cryogenic Liquid Containers?

Cryogenic liquid containers are double-walled, vacuum vessels with insulation that fills the inner-wall space.

These containers are specifically designed to help ensure safe, reliable, and economic transportation and storage of liquefied gases at cryogenic temperatures, typically colder than -130°F (-90°C).

Liquid containers not only provide a large volume of gas at a relatively low pressure when compared to a compressed gas cylinder, but they also provide a source of cryogenic liquids that can be easily used.

Despite being well insulated, heat continuously leaks into the liquid container due to the temperature differences between the cryogenic liquid and the ambient environment, resulting in the vaporization of product.

Vaporized product collects at the top of the container, which is sometimes referred to as the head space (or vapor space), above the liquid, building pressure in the container that is occasionally vented through the container's safety relief devices.

This common periodic venting process is part of the normal and safe functioning of the cryogenic container.

Rates of vaporization will vary between 0.4% and 3% based on the storage conditions and other environmental factors.

Safety Information

NOTE: This document assumes previous training and knowledge for safe practices and proper cryogenic liquid container handling.

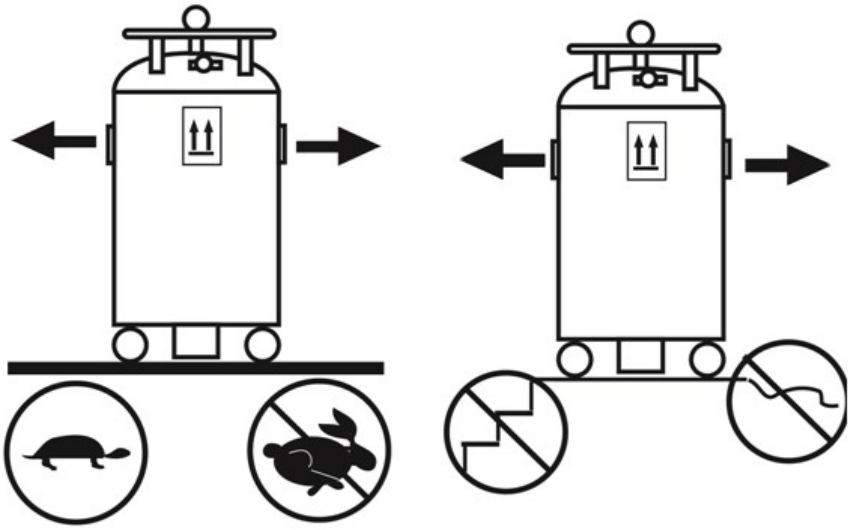
Praxair Canada distributes a number of cryogenic liquids in containers including both industrial and specialty gas grades of carbon dioxide (LCO_2), liquid helium (LHE), liquid nitrogen (LIN or LN_2), nitrous oxide, and liquid oxygen (LOX). Liquid argon (LAR) is also available as a refrigerated liquid in similar containers. Some cryogenic liquids are available in medical grades.

DANGER: Cryogenic liquid and cold gas cause severe frostbite on contact with the skin. Avoid body contact with the liquid and with equipment chilled to liquid temperatures.

Safety Data Sheets (SDSs) for materials should be reviewed before any procedure that involves those materials is executed. Each SDS must be reviewed for material properties and hazards, precautions necessary to prevent exposure, recommended personal protective equipment, and control measures if physical contact or airborne release occurs.

When moving cryogenic liquid containers, it is important to be aware of the hazards that might cause the container to fall:

- Always push the liquid container slowly when moving on a level surface.
- Never push a liquid container up an incline; always pull to avoid injury.
- Do not roll a liquid container down stairs or over rough surfaces.



Operational Information

Figure 1: Valve/Gauge/Safety

1. Vent Valve
2. Safety Relief Valve
3. Pressure Gauge
4. Burst Disc
5. Gas Use Valve
6. Sight Gauge
7. Liquid Use Valve
8. Pressure Building Regulator
9. Pressure Building Valve

The following information is for specific components of cryogenic liquid containers and discusses the functions they perform. Cryogenic liquid containers are often incorrectly referred to as Dewars. Dewars are open-top, non-pressurized vessels used for short-term transport and holding of cryogenic liquids. Refer to Figure 1 for Valve/Gauge/Safety descriptions of Cryogenic Liquid Containers.

Liquid Contents Gauge or Sight Gauge

The contents gauge is a float-type liquid level gauge and indicates an "approximate" amount of product within the cryogenic liquid container. Refer to Figures 2 and 3 for a sight gauge comparison.

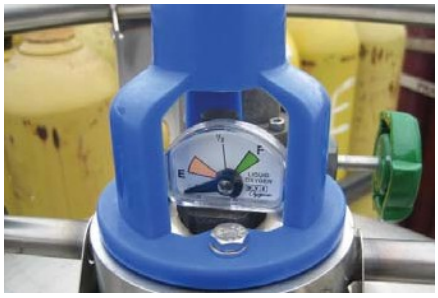


Figure 2: Newer Style Sight Gauge (Typical)

Figure 3: Older Style Sight Gauge (Typical)

Pressure Gauge

The pressure gauge displays the internal container pressure and does not indicate the volume of liquid product in the container.

Pressure Relief Devices

To protect from over-pressurization, cryogenic liquid containers are equipped with two relief devices: the safety relief valve and the rupture disc (refer to Figure 6).

- **Safety Relief Valve:** A spring-loaded pressure relief device that opens and closes as needed to relieve excess pressure at the marked rating on the device (for example: 22 psig, 230 psig, 350 psig).

  The relief rating is used for indication purposes only and not intended for exact measurements. The pressure setting is based on the liquid container's Department of Transportation (DOT) rating, and often selected based on the end-user's application.

- **Rupture Disc:** A non-resetting "bursting" or "rupture" disc is used as an emergency relief to add a second layer of over-pressurization protection. Once the rupture disc operates, all of the product will vent from the container.

  Bursting discs are rated at 1½ to 2 times the stamped service pressure of the container as set by the DOT.

Liquid Valve

The liquid valve is a wheel valve located on top of the container. The liquid valve can be opened or closed to allow filling into or withdrawing liquid product from the container. The liquid valve has a Compressed Gas Association (CGA) connection specified for a liquid line connection, and matches the product service for which the container is configured.

WARNING: The use of adapters is not permitted. The outlet connections should not be tampered with or removed.

Vent Valve

The vent valve is a wheel valve located on top of the container primarily used to maintain a 10–15 PSI pressure differential during container filling. The vent valve can also be used to manually vent excess vaporized product during use or to withdraw gas for specific applications.

Gas Use Valve

The gas use valve is a wheel valve located on top of the container used to control the flow of gas product withdrawn through the container's internal vaporizer. The gas use valve has the required CGA connection that matches the product service for which the container is configured.

Pressure Building Valve

The pressure building valve is a wheel valve located on top of the container and is used to adjust the container pressure. The pressure building valve is opened to increase the gaseous pressure within the container. The valve is closed to stop the pressure building process. Refer to Figures 4 and 5 for pressure building valve examples.

CAUTION: Remember to close the pressure building valve when the desired pressure level is achieved or the container will begin to relieve excess pressure when it reaches the set pressure rating on the safety relief valve.

Pressure Building Regulator

The pressure building regulator is located on top of the container and is factory set. The pressure building regulator creates and maintains sufficient operating pressure as part of the pressure building system. The pressure building regulator should always remain closed when the container is used in low-pressure operations (for example: 22 PSI). Refer to Figures 4 and 5 for pressure building regulator examples.

WARNING: Never make adjustments to the pressure building regulator. Always use the pressure building valve to adjust the container pressure.

Figure 4:

Newer Style Pressure Building Regulator

Pressure Building Valve (on/off)

Figure 5:

Pressure Building Valve (on/off)

Older Style Pressure Building Regulator

Economizer Circuit

The economizer circuit is controlled by a regulator which withdraws vaporized gas preferentially from the head space. This is the vaporized gas that would otherwise be lost to venting.

Excess pressure in the head space of the container is relieved by allowing gas to flow from the head space directly to the gas use valve outlet while gas is being withdrawn from the container. At the same time, normal operating pressure is preserved during this process to ensure uninterrupted liquid product delivery.

The economizer circuit is automatic and requires no operator attention. However, if the circuit is set too high, or stuck closed, it will cause the safety relief valve to vent more frequently.

Internal Vaporizer

This is an internal heat exchanger that functions as a gas vaporizing coil to convert liquid product to gas product.

WARNING: Both the economizer and pressure building regulator are preset by the manufacturer or reset by the filling facility during servicing. They are not intended to be adjusted by the end user. Do not tamper with the economizer or pressure building regulator.

Frequently Asked Questions

Why is there frost on the top or head of the container?

Frost on the head or top of the container is normal (see Figure 7). Ice or frost may remain on the container for days after it has been filled, after heavy use, or when it is in cooler or more humid environments.

Why is the container frosting around the circumference of the shell? Why does frost spiral up the shell?

Frosting appearing around the circumference of the shell is normal.

The internal vaporizer converts cryogenic liquid product into gas. This occurs because the pressure building valve is open. Refer to Figure 8.

A ring of ice or an oval-shaped ice ball often remains on the cryogenic liquid container for days after its last use or fill.

Why is product venting from the safety relief valve?

Product venting from the safety relief valve is normal.

When the container is not in use, it is normal for 0.4% to 3% of its contents to be relieved daily.

The container is designed to vent excess pressure from the safety relief valve to help ensure that the actual container, itself, does not over-pressurize.

Because the safety relief valve opens and closes as needed, check to ensure that the correct safety relief valve is installed for your application. Common safety ratings that are equipped on Praxair supplied containers include: 22 PSI, 50 PSI, 235 PSI, and 350 PSI.

Check the location of the container and the temperature of the storage area, as product venting occurs more frequently in warmer environments.

Why won't my regulator attach to the valve without leaking?

Threads on the regulator's fittings or on the container's connections may be dirty or damaged.

Clean the external threads with a small, dry, and clean wire brush or clean toothbrush. Then try to connect again.

Regulator fittings can wear out. They may not create a tight seal with the container's connections. Ensure that you are using a regulator with brass fittings.

The use of stainless steel or other hard metals can damage the outlet connection threads on the container.

In addition, periodic replacement of the regulator fittings may be necessary to ensure a tight seal.

How does the Pressure Building Regulator function?

The pressure building regulator is factory set and must not be adjusted by the end user. Use of the pressure building regulator is controlled by the pressure building valve.

The pressure building valve is used for adjustments and controls the container's pressure. When opened, the pressure building valve allows liquid product to flow from the bottom of the container through an internal vaporizer.

The vaporizer converts liquid to gas at a high rate. The gas is then returned to the headspace at the top of the container. This vaporization of liquid creates gaseous pressure.

Scenarios and Explanations

What should be done if the cryogenic liquid container is full (the sight gauge indicates container is full), but no product is coming out?

Open the pressure building valve. If there is liquid product in the container, a frost ring will begin to form on the bottom of the container within five minutes (see Figure 8). The container pressure will slowly build. It may take an hour or longer for pressure to build up to a usable level.

Sometimes, liquid content gauges may become stuck and indicate a false liquid level. Tapping lightly on the gauge face with a gloved finger may loosen a liquid contents gauge that is stuck. If none of these solutions work, call Customer Service for a return authorization.

⚠ **WARNING:** Both the economizer and pressure building regulator are preset by the manufacturer or reset by the filling facility during servicing. They are not to be adjusted by the end user. Do not tamper with the economizer circuit (not shown) or pressure building regulator.

Figure 6:

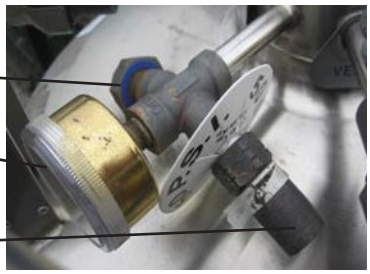


Figure 7:
Frost on a Cryogenic Liquid Container Frosting is normal during use or when in cooler or more humid environments.

Figure 8:
Internal Vaporization Pressure Building Valve is open and cryogenic liquid is flowing through the internal vaporizer.

What should be done if a cryogenic liquid container makes a very loud hissing noise?

Liquid containers are designed to periodically vent excess gas product through the safety relief valve and some noise is normal. Excess noise can be checked in the following ways:

Is the container located near a warm piece of equipment?
Ensure that it is not next to a heat source (such as a radiator or other equipment) or in a room located in direct sunlight where the temperature is not controlled.

Is the Pressure Building Valve open?
Check to see if the pressure building valve is open. Close the pressure building valve if the valve is open. Users may choose to manually vent any excess pressure through the vent valve to reduce the frequency of venting.

Is the Safety Relief Valve frozen?
Check the pressure gauge reading. If the container is hissing and the container pressure (in PSI) is below the pressure rating of the safety relief valve, the safety relief valve may be frozen open (refer to Figure 6).

Pour warm water over the safety relief valve (about 1 to 2 gallons). If this does not correct the problem, lightly tap on the safety relief valve with a gloved finger to reset the spring inside the safety.
If the safety fails to reset, call Customer Service for a return authorization.

Is the Sight Gauge leaking?
A less probable reason for a hissing noise could be that a leak exists at the sight glass area at the top of the container. This results in a loss of product or no pressure.

A leak at the sight glass area can be determined by pouring warm water over the top of the sight glass area and looking for bubbles.
If bubbles appear, call Customer Service for a return authorization.

Other Possible Causes:
A more uncommon cause is that the container has lost or is losing its vacuum, and the liquid product is boiling off. If you suspect that the container is converting liquid to gas quicker than normal, contact Customer Service.

Scenarios and Explanations - continued

The result of continuous venting is that frost will completely cover the container sides. Call Customer Service for a return authorization.

What should be done if a cryogenic liquid container is not reaching full pressure?

Check for leaks at the sight glass or around the wheel valves and piping located on the top of the container. If leaks are detected, call Customer Service for a return authorization.

If no leaks are detected, open the pressure building valve. If there is liquid product in the container, a frost ring will begin to form on the bottom of the container within five minutes (see Figure 8). The container pressure will slowly build. It may take an hour or longer for pressure to build up to a usable level.

Close the pressure building valve when the desired container pressure level is reached. If the valve is not closed, the container will relieve excess pressure when it reaches the pressure rating of the safety relief valve.

When using a high volume of cryogenic liquid the pressure building valve may need to remain open to help maintain the correct pressure while withdrawing product.

It is possible that your liquid product usage is higher than what can be provided and you may need a container with a higher pressure rating, even with the pressure building valve open during use.

If an issue cannot be resolved, contact your Praxair sales representative to discuss your problem and possible solutions.

References

Publication Title	Publication No.	Source
Safety Precautions and Emergency Response Planning Awareness: Oxygen, Nitrogen, Argon, Helium, Carbon Dioxide, Hydrogen, Fuel Gases	P-3499	Contact your Praxair supplier, sales representative, or our order desk. Praxair Canada Inc. http://www.praxair.ca Phone: 1-800-225-8247 Email: specialty_gas_support@praxair.com
Guidelines for Handling Compressed Gas Cylinders and Cryogenic Liquid Containers	P-14-153	
Additional copies of this publication	P-15-760	
Portable Cryogenic Liquid Containers -- Use, Care, and Disposal	CGA P-30	Compressed Gas Association http://www.cganet.com Phone: (703) 778-2700 14501 George Carter Way Suite 103 Chantilly, VA 20151 USA
Characteristics and Safe Handling of Medical Gases	CGA P-2	
Hazards of Oxygen in the Health Care Environment	CGA SB-31	

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