Taylor-Wharton
Harsco

SAFETY FIRST

Bulk Tank Safety Data

Special Notice

This booklet is intended for personnel who are familiar with cryogenic liquefied gases and the handling of cryogenic fluids. If you are not familiar with the principles of operation and safe practices for this equipment, we urge you to read and fully understand the Safety Precautions and reference publications and reference publications in this manual before attempting operation or maintenance.

Table of Contents

Special Notice:
Failure to use and operate this equipment in accordance with the manufacturer's instructions and industry standards can lead to serious injury or death.

Principles of Safe Operation

Cryogenic systems present potential hazards which the users must understand and consider when operating such systems. Thorough understanding of the potential hazards and the safety precautions necessary to prevent accidents is absolutely essential. All persons involved in the operation and maintenance of the system must read and understand the safety precautions contained in this booklet and the reference publications listed herein. Complete familiarity with the equipment of the system is also necessary. All operators must carefully read and understand the pertinent instructions before proceeding with their work.

To protect personnel and equipment, observe the following points:

1. Operate the equipment with competent operators, adequately trained and properly supervised. Never allow unqualified persons to attempt to operate or repair the system

2. Keep the equipment in good operating condition. Schedule regular inspections and correct any discrepancies promptly. Keep a record of all inspections and repairs as described in the Maintenance Section of this booklet.

3. Establish and maintain an effective program for handling possible emergency situations. Conduct simulated emergency drills to ensure that operating personnel are familiar with the emergency action plan.

4. When field installed options are incorporated with the tank installation, full consideration must be given to providing adequate safety relief devices.

Safety Precautions - Liquid Gases

The following safety precautions are for your protection. Before performing installation, operating, or maintenance procedures, read and follow all safety precautions in this booklet and in reference publications. Failure to observe all safety precautions can result in property damage, personal injury, or possible death. It is the responsibility of the purchaser of this equipment to adequately warn the user of the precautions and safe practices for the use of this equipment and the cryogenic fluid being used.

Extreme cold can cause frostbite injury. Accidental contact with cryogenic liquid or cold issuing gas may cause a freezing injury similar to frostbite. Handle the liquid so that it won't splash or spill. Protect your eyes and cover the skin where the possibility of contact with the liquid, cold pipes and cold equipment or the cold

gas exists. Safety goggles or a face shield should be worn around cryogenic equipment. Ejection or splashing may occur, or cold gas may be released from equipment. Clean insulated gloves that can be easily removed and long sleeves are recommended for arm protection. Cuffless trousers should be worn outside boots or over the shoes to shed spilled liquid. If clothing should be splashed with liquid oxygen or otherwise saturated, the clothing will be highly flammable and easily ignited. While the concentrated oxygen remains, air out the clothing immediately, removing it if possible. Do not consider saturated clothing safe for at least 30 minutes.

For more detailed information concerning safety precautions and safe practices to be observed when handling cryogenic liquids, consult CGA pamphlet P-12 “Handling Cryogenic Liquids” (see page 15).

Liquid Oxygen

Oxygen is a colorless, odorless, and tasteless gas that can be condensed into a liquid at the low temperature of -297°F (-183°C) under normal atmospheric pressure. Approximately one-fifth of normal air is oxygen. As a liquid, oxygen is a pale blue color.

Oxygen causes fire to burn rapidly. Oxygen is non-flammable but vigorously accelerates the burning of combustible materials. Keep combustibles away from oxygen and eliminate ignition sources. Many substances which do not burn normally in air require only a quick spark or moderate heat to set them aflame in the presence of concentrated oxygen. Other substances which are only moderately combustible in air can burn violently when a high percentage of oxygen is present.

Do not permit smoking or open flame in any area where liquid oxygen is present. Keep all organic materials including hydrocarbons and other flammable substances away from contact with liquid nitrogen. Some of the materials that can react violently with oxygen are oil, grease, kerosene, cloth, wood, paint, tar and dirt which contains oil or grease. Under certain conditions, flammable materials which have been permeated with liquid oxygen are impact sensitive and can detonate if subject to shock.
Keep area surfaces clean to prevent ignition. As normal industrial soot and dirt can constitute a combustion hazard, all equipment surfaces must be kept very clean. Do not install oxygen equipment on asphalt surfaces or allow grease or oil deposits on concrete surfaces in the vicinity of the oxygen equipment. Equipment to be used in contact with liquid nitrogen should be handled only with clean gloves or hands washed clean of oil.

Replacement parts must be suitable for oxygen service. Many materials, especially some non-metallic gaskets and seals constitute a combustion hazard when in oxygen service, although they may be acceptable for use with other cryogenic liquids. Make no substitutions for recommended spare parts. Also, be sure all replacement parts are thoroughly “*Clean for Oxygen Service”* (see page 15).

Observe safety codes when locating oxygen equipment. Prior to installation, become thoroughly familiar with the National Fire Protection Association (NFPA) Standard No. 50, "*Bulk Oxygen Systems"* (see page 15), and with all local safety codes. The NFPA Standard covers the general principles recommended for installation of bulk oxygen systems on industrial and institutional consumer premises.

Liquid Nitrogen and Liquid Argon

Nitrogen is an inert, colorless, odorless and tasteless gas which makes up four-fifths of the air you breathe. Liquid nitrogen is obtained by cooling air until it becomes a liquid and the removing the oxygen which makes up most of the other fifth of air. Liquid nitrogen is at a temperature of -320°F (-196°C) under normal atmospheric pressure.

Liquid argon is an inert gas whose physical properties are very similar to nitrogen and represents about 1% of the air you breathe.

Keep equipment area well ventilated. Although nitrogen and argon are non-toxic and non-flammable, they can cause asphyxiation in a confined area without adequate ventilation. Any atmosphere which does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Nitrogen and argon are colorless, odorless, and tasteless and cannot be detected by the human senses. They will be inhaled normally as if gas were air. Without adequate ventilation, the expanding gas will displace the normal air without warning that a non life-supporting atmosphere is present. Store liquid containers outdoors or in other well-ventilated areas.

Dispose of waste liquid and argon safely. Dispose of waste liquefied gases out-of-doors where cold temperature cannot damage floors or driveways and where they will evaporate rapidly. An outdoor pit filled with clean sand or gravel will evaporate liquid nitrogen and argon safely and quickly.

Liquid Hydrogen

Hydrogen is a flammable, colorless, odorless and tasteless gas which may be condensed into a liquid at the very low temperature of -423°F (-253°C) under normal atmospheric pressure. Gaseous hydrogen is always present where there is liquid hydrogen. Hydrogen gas burns with a pale blue, almost invisible flame when mixed with air or other oxidizers, and is explosive over a wide range of mixture.

Eliminate hydrogen accumulation and ignition sources.
Concentrations of hydrogen between 4% and 75% by volume in air are relatively easy to ignite by a low-energy spark. Smoking, open flames, unapproved electrical equipment, and other ignition sources must not be permitted in hydrogen areas. Possible ignition by electrostatic sparks must be prevented by earthgrounding all hydrogen storage and handling equipment. Hydrogen containers should be stored outdoors in well-ventilated areas.

Keep air and other gases away from liquid hydrogen. The low temperature of liquid hydrogen can solidify any gas except helium. Solidified gases and liquids allowed to form and collect can plug pressure-relief passages and foul relief valves. Plugged passages are hazardous because of the continual need to relieve excess pressure produced as heat leaks into the continually evaporating liquid. Air, being 21% oxygen, must be kept out of contact with liquid hydrogen to prevent accumulation of potentially explosive oxygen concentrations. Therefore, always store and handle liquid hydrogen under positive pressure and in closed systems to prevent the infiltration and solidification of air or other gases.

Keep exterior surfaces clean to prevent combustion. Atmospheric air will condense on exposed liquid hydrogen-cooled surfaces, such as vaporizers and piping. Nitrogen, having a lower boiling point than oxygen, will evaporate first from condensed air, leaving oxygen enriched liquid. To prevent the possible ignition of grease, oil or other combustible materials which could come into contact with the air-condensing surfaces, such areas must be cleaned to oxygen-clean standards. Consult CGA pamphlet G-4.1 "*Cleaning Equipment for Oxygen Service"* (see page 15).

Extreme cold – Cover eyes and exposed skin. Accidental contact with liquid hydrogen or cold issuing gas with the skin or eyes may cause a freezing injury similar to frostbite. Handle the liquid so that it won't splash or spill. Protect your eyes and cover the skin where the possibility of contact with the liquid, cold pipes and cold equipment, or the cold gas exists. Safety goggles or a face shield should be worn if liquid ejection or splashing may occur or cold gas may issue forcefully from equipment. Clean, insulated gloves that can be easily removed and long sleeves are recommended for arm protection. Cuffless trousers should be worn or over the shoes to she spilled liquid.

Keep equipment area well ventilated. Although hydrogen is non-toxic, it can cause asphyxiation in a confined area without adequate ventilation. Any atmosphere which does not contain enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Hydrogen being colorless, odorless, and tasteless and cannot be detected by the human senses. They will be inhaled normally as if gas were air. Without adequate ventilation, the expanding gas will displace the normal air without warning that a non life-supporting atmosphere is present. Store liquid containers outdoors or in other well-ventilated areas.

Observe safety codes when locating hydrogen equipment. Before locating liquid hydrogen equipment, refer to National Fire Protection Association (NFPA) Standard No. 50B, *"Liquefied Hydrogen Systems at Consumer Sites"* (see page 15).

Carbon dioxide

Carbon dioxide cannot be detected by the human senses and will be inhaled like air. If adequate ventilation is not provided, carbon dioxide may displace normal air without warning that a life-depriving atmosphere is developing. Store and use containers outdoors in well-ventilated areas.

Keep equipment area well ventilated. Carbon dioxide can cause asphyxiation or death. Carbon dioxide effects the important acid-base balance in the body. The gas is formed in normal functioning within the body, but the body can tolerate increased amounts of carbon dioxide only in limited concentration. For safety, concentrations above this level should not be permitted; increased concentrations can cause bodily harm or death. Additionally, carbon dioxide can cause asphyxiation by displacing oxygen resulting in dizziness, unconsciousness or death.

Extreme cold – cover eyes and skin. If released to atmosphere, liquid carbon dioxide will turn to carbon dioxide snow (or dry ice). Accidental contact of carbon dioxide snow and cold gas with the eyes or skin may cause severe frostbite. Handle liquid so that it will not vent or spill. Protect your eyes with safety goggles or face shield, and cover the skin to prevent contact with snow and cold gas, or with cold pipes and equipment. Protective gloves that can be quickly and easily removed and long sleeves are recommended for protection. If you are accidentally exposed to cold snow or gas, consult a physician at once. Warm affected areas with water that is near body temperature.

Static electricity – Ground all piping. The rapid discharge of liquid carbon dioxide through a line which is not electrically grounded results in a buildup of static electricity. Contact with this electrical charge could be startling and potentially dangerous to operating personnel. Such lines should, therefore, be grounded before use.

For additional information on handling of CO_2, refer to a Material Safety Data Sheet for Carbon Dioxide available from your gas supplier. If you are not fully familiar with the principles of operation

and safe practice for Carbon Dioxide equipment, we recommend that you read CGA Pamphlet G-6 available from the Compressed Gas Association, Inc. (see page 15).

Nitrous Oxide

Nitrous oxide has no color, no odor and practically no taste. It is obtained by thermal decomposition of ammonium, which yields nitrous oxide and water. Due to the toxic impurities produced in this process, the water is condensed out and the gas is passed through scrubbing towers to remove impurities.

Keep equipment area well ventilated. Due to the difficulty of detecting nitrous oxide's presence, there is imminent dangers of loss of consciousness and physical inability to function if exposed to medium or high levels. Since nitrous oxide is a non-toxic gas, there are hazards are created when life-supporting oxygen is displaced and diluted. It is imperative to maintain a well-ventilated work environment to minimize the danger from a leaking systems or activated safety relief device.

Nitrous oxide causes fires to burn rapidly. Nitrous oxide is non-flammable but, as with oxygen, ignition of combustible materials may occur more readily in a nitrous oxide-enriched atmosphere than in air with combustion proceeding at a faster rate. Open flame and smoking are strictly prohibited.

For more detailed information concerning safety precautions and safe handling of nitrous oxide, consult CGA pamphlet G-8.2, a *"Standard for Nitrous Oxide"* (see page 15).

Installation Safety

Installation Drawings

Dimension and connection data for this tank can be found on the General Arrangement drawing supplied with each tank. Additional copies of these drawings can be purchased from the factory. Please include information on tank model number, part number, serial number and project number, if known, in drawing requests.

Rigging Instructions

Vertical tanks are shipped in the horizontal position, secure on permanent shipping legs (500,900,1,500, and 3,000 gallon) or on temporary wooden cradles (6,000, 9,000, 11,000 and 13,000 gallon) which must be removed prior to erection of the tank. Make certain that rigging equipment has adequate capacity to safety handle the weights involved. Employ experienced personnel for erection of the tank. Re-use the wooden cradles supplied with the tank if the tank must be stored in the horizontal position.

Caution

To prevent possible tip over, do not leave the tank standing upright unless it is anchor bolted on its specified foundation or other hard surfaces capable of supporting its weight. Loading on the tank legs is great enough to cause them to sink into most surfaces other than reinforced concrete, and a brisk wind may cause the tank to tip over.

Pre-Installation Inspection

Before erecting the tank, inspect it carefully for possible shipping damage.Report any damage to the carrier and the factory. In addition, check thevacuum as follows:

1. These tanks are shipped pressurized with nitrogen gas. Check tank pressure by connecting a 0-30 psig (0-207 kPa/0-2 bar) pressure gauge to the outlet tube of the full trycock valve using welding hose and clamps or using the pressure gauge supplied with the tank. If pressure is below 3 psig (21 kPa/0.2 bar) and no repairable leaks are found, contact the factory in accordance with the warranty.

2. Check insulation space vacuum. If “as received” vacuum (tank at ambient temperature) is above 750 microns, contact the factory.

Note
If the tank is empty and warm, vacuum space pressure will tend to be high because of the release of gasses from the absorbent package inside the vacuum space. Vacuum level should decrease to an acceptable level when the liquid container is filled with cold product.

Note
An abnormally high vacuum reading without other evidence of vacuum loss (excessive pressure, rapid venting, etc.) may be caused by a fault in the gauging equipment or by improper operation of the equipment. Be sure that the vacuum gauge tube are in good condition, and compatible. Follow operating instructions carefully. Always be sure that the gauge tube valve has been open for at least 30 minutes before taking a minute.

Foundation Details

Foundation bolt location dimensions and tank weights are shown on the General Arrangement Drawing. The dimensions of mounting bolt locations are for layout of the foundation only. This information should be used along with tank weights from the General Arrangement drawing, and the seismic zone requirements for your area and service. To determine foundation requirements, local soil characteristics must be considered for foundation construction as well as state and local codes and many other factors. We recommend that you retain the services of a local civil engineer to ensure all requirements of foundation construction are met.

Tank-Mounted Vaporizers

Many tanks, shipped with a vaporizer attached, are ready for service as soon as the tank is installed. If additional vaporizers are ordered with the tank, they are shipped separately with attaching hardware. A shut-off valve should be installed downstream of the vaporizer. A line relief valve with suitable capacity/service must be installed between the shut-off valve and vaporizer.

Note
Installation of a suitable low-temperature shut-off device at the outlet of the product vaporizer is recommended for systems in combustible gas service or any system utilizing carbon steel piping.

Functional Descriptions

Vacuum System

Taylor-Wharton tanks are vacuum-sealed. The space between the casing and the liquid container is filled with high quality insulation, pumped to a high vacuum, and sealed at the factory. An absorbent is factory installed in the vacuum space to help maintain the vacuum by absorbing any outgassing from the materials in the vacuum space. The evacuation valve is sealed at the factory, but may be used for field re-evacuation by qualified personnel if necessary.

A thermocouple type vacuum gauge tube, located on the head of the casing, should be used to check tank vacuum in the field. The casing is protected against internal overpressure by a bursting disc or safety relief life plate device located on the upper head of the tank.

Filling Circuits

The tank is filled with product through the fill connection with two hand valves. The liquid fill valve line extends to the bottom of the liquid container. The gas valve line extends to the top of the liquid container. Filling from the top of the container tends too decrease tank pressures; while filling from the bottom tends to increase tank pressure. The blowdown valve is opened for venting and throttled to maintain desired tank pressure during liquid phase filling. The full trycock valve is used to determine when the tank is full.

Gauge Circuits

Pressure in the liquid container is displayed by the tank pressure gauge. The liquid contents gauge provides an indication of the amount of liquid product in the tank. The contents gauge is calibrated in inches of water column and a gauge chart is used to convert the gauge reading s to pounds and gas equivalent values. The contents gauges indicates the difference in pressure between the top and the bottom of the tank and provides an approximation of the amount of liquid in the tank. It should not be considered accurate enough for precise measurement of the amount of liquid added to or withdrawn from the tank.

Pressure Building Circuit

The pressure building system provides a means of maintaining tank pressure at a preset value during product withdrawal. This system operates when the pressure building isolation valves are opened. Liquid flows through the pressure regulator to the pressure building vaporizer. The resulting gas flows to the top of the liquid container, increasing tank pressure. When the pressure reaches the setting of the regulator, it closes to prevent further flow of liquid into the systems. When product withdrawal lowers tank pressure below the regulator setting, more liquid ill be vaporized to maintain tank pressure for continue withdrawal.

Product Withdrawal

Product is normally withdrawn as liquid through a liquid withdrawal line. Liquid flows through the withdrawal valve to an external vaporizer. When the pressure building valves are open and tank pressure exceeds the setting of the economizer valve, gas will flow from the top of the tank through the pressure building system and the economizer valve to the liquid withdrawal line. This action interrupts the flow of liquid, allowing gas to flow through the withdrawal line until tank pressure falls below the setting of the economizer valve. This economizer action reduces product losses by allowing the withdrawal of gas that may otherwise be vented.

Safety Devices

Overpressure protection for the liquid container is provided by pressure relief devices consisting of safety valve and a bursting disk. An optional Dual Safety Relief Manifold with a three-way diverter valve permits the operation of one set of protective devices while the other set is isolated for maintenance. This arrangement prevents all safety devices from being valved out of the circuit at the same time and permits maintenance of these devices without the need to blow-don tank pressure.

Initial Filling Safety

The inner container and plumbing of all Taylor-Wharton tanks have been “Cleaned for Oxygen or Hydrogen Service” (specification GS38 or GS40 respectively. You should take appropriate measures to assure that only clean liquid, free of particulate matter, be placed in your container.

Warning

Once a container is placed into Carbon Dioxide or Nitrous Oxide gas service, it should never be placed into any other gas service.

The tank was pressurized at the factory with nitrogen gas. If the tank is to be filled with any other product, the nitrogen gas must be purged from the tank. Purge with product gas until analysis indicates acceptable purity.

Caution

To avoid injury, do not touch fill hose or connections with bare hands. During filling, these parts are cooled extremely low temperatures. See Safety Precautions for recommended protection.

Nitrogen Purge

Before placing tank in service, determine container contents impurity level with one of the following instruments:

- Meeco Moisture Analyzer
- Alnor Dewpoint Analyzer
- Model 210-S Gow-Mac Gas Master Hydrogen Analyzer
- A Bulb tester for measuring Oxygen in Nitrogen or equivalent

If container contents purity is unacceptable, perform a nitrogen purge to reduce contaminants.

Nitrogen Precool

A large quantity of product is lost due to flash-off when a warm container is filled with liquefied gases. To minimize loses, precool the tank container with nitrogen before filling with highly combustible or more expensive liquefied gases. The residual nitrogen gas should be removed from the container and piping by a pressure purge. The tank may then be filled with service product.

Caution

Do not exceed liquid weight quantity specified for the tank. Container supports could be damaged by the increased weight of the liquid.

Maintenance Safety

Never allow persons that are not adequately trained and properly supervised to attempt maintenance or operation of this equipment.

Follow all safety precautions in this booklet and cited reference publications when making repairs to this cryogenic storage tank. If combustible gases are present, make certain system pressure is relieved and the liquid container and all piping are drained and purged with nitrogen before making any repairs requiring use of welding equipment or other ignition source. If hydrogen is present in any part of the system and repairs require use of an ignition source, isolate piping requiring repairs and provide a continuous purge of nitrogen gas through the isolation section. Use spark free tools made of brass or aluminum if the presence of hydrogen is suspect.

Maintain a permanent record of all inspectors, vacuum measurements and system repairs. If equipment does not operate properly, stop work immediately and investigate cause of malfunction. Field repair to instruments and controls must be made by a qualified instrument specialist. Use only approved replacement parts suitable and cleaned for cryogenic oxygen or hydrogen service.

Warning for O_2 System Users
Residue of leak detectors solutions can be flammable. All surfaces to which the leak detector solutions have been applied must be adequately rinsed with potable water to remove all traces of residue. Reference CGA G-4.4 Section 4.9 (see page 15).

After making repairs requiring disassembly or part replacement, leak test all valves and piping joints that were taken apart and reconnected. Use Sherlock 5-Second Leak Detection Solution, Type CG concentrate, obtainable from Winston Products Company, Inc.

Warning
A small amount of gas may leak from around the adjusting screws while regulator caps are removed. Take precautions to prevent sparks or other sources of ignition in the vicinity of the regulators in combustible gas service while adjustments are being made.

Casing Safety Device
When the safety device has ruptured or leakage is caused by corrosion or other damage, the safety device assembly must be replaced

Warning
Do not start any cutting of welding work until gaseous concentration in the insulation space has been checked for combustibles. If necessary, purge insulation space with dry nitrogen gas until combustible gases have been eliminated. Do not allow pressure in the insulation space to exceed the pressure in the inner container. External overpressure on the inner container could cause permanent damage.

Because re-evacuation is time consuming and usually requires taking the tank out of service, it is not normally attempted until tank performance becomes unacceptable. Even a relatively high degree of deterioration can be tolerated in a tank from which high rates of withdrawal are being made. However, if vacuum deterioration seriously affects tank operation by producing excessive pressure buildup and high loss rates, re-evacuation may be warranted.

Note
Do not use Teflon tape as a sealant on vacuum system fittings

Moving the Tank

When moving a tank from another location after being in cryogenic service, be sure that the tank is empty and warm. If the tank has been in oxygen or hydrogen service, purge it warm filtered nitrogen gas to eliminate any residual combustible gas. To prevent contamination from atmospheric moisture, pressurize the tank to approximately 20 psig (138 kPa/1.4 bar) with filtered nitrogen gas and close all valves to retain pressure.

Vertical tanks should be shipped in the horizontal position on wooden cradles. Shipping drawings may be purchased from the Theodore, Alabama factory. Give tank model and part numbers when requesting drawings.

PAMPHLET INFORMATION

The following pamphlets can be ordered from the Compressed Gas Association

- Pamphlet P-12:"Handling Cryogenic Liquids"
- Pamphlet G-4.1:"Cleaning Equipment for Oxygen Service"
- Pamphlet G-6: "Carbon Dioxide"
- Pamphlet G-8.2: "Standard for Nitrous Oxide"
- Pamphlet G-4.4: "Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems"

Compressed Gas Association, Inc.
1235 Jefferson Davis Highway
Arlington, VA 22202 USA

The following pamphlets can be ordered from the National Fire Protection Association:

- NFPA Standard No. 50: "Bulk Oxygen Systems at Consumer Sites"
- NFPA Standard No. 50B: "Liquefied Hydrogen Systems at Consumer Sites"

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