LIQUID NITROGEN

CRYOGENIC LIQUID CYLINDERS

Liquid nitrogen is inert, colorless, odorless, noncorrosive, nonflammable, and extremely cold. Nitrogen makes up the major portion of the atmosphere (78.03% by volume, 75.5% by weight). Nitrogen is inert and will not support combustion; however, it is not life supporting. Nitrogen is inert except when heated to very high temperatures where it combines with some of the more active metals, such as lithium and magnesium, to form nitrides. It will also combine with oxygen to form oxides of nitrogen and, when combined with hydrogen in the presence of catalysts, will form ammonia.

Nitrogen is noncorrosive and special materials of construction are not required to prevent corrosion. However, materials of construction must be selected to withstand the low temperature of liquid nitrogen.

Vessels and piping should be designed to American Society of Mechanical Engineers (ASME) specifications. Although used more commonly in the gaseous state, nitrogen is commonly stored and transported as a liquid, affording a more cost-effective way of providing product supply. When nitrogen is converted to liquid form it becomes a cryogenic liquid. Cryogenic liquids are liquefied gases that have a normal boiling point below –238°F (–150°C). Liquid nitrogen has a boiling point of –320.5°F (–195.8°C). The temperature difference between the product and the surrounding environment, even in winter, is substantial. Keeping this surrounding heat from the product requires special equipment to store and handle cryogenic liquids. A typical system consists of the following components: a cryogenic storage tank, one or more vaporizers, a pressure and temperature control system. The cryogenic tank is constructed like, in principle, a vacuum bottle. It is designed to keep heat away from the liquid that is contained in the inner vessel. Vaporizers convert the liquid nitrogen to its gaseous state. A pressure control manifold controls the pressure at which the gas is fed to the process. Processes that use nitrogen as a liquid do not require the vaporizers and pressure control manifold. Physical and chemical properties are listed in Table 1.

MANUFACTURE

Nitrogen is produced at air separation plants by liquefaction of atmospheric air and separation of the nitrogen by continuous cryogenic distillation. The nitrogen is then recovered as a cryogenic liquid.

Table 1

Liquid Nitrogen Physical and Chemical Properties

Chemical Formula	N2
Molecular Weight	28.01
Boiling Point @ 1 atm	–320.5°F (–195.8°C)
Freezing Point @ 1 atm	–346.0°F (–210.0°C)
Critical Temperature	–232.5°F (–146.9°C)
Critical Pressure	492.3 psia (33.5 atm)
Density, Liquid @ BP, 1 atm	50.45 lb/scf
Density, Gas @ 68°F (20°C), 1 atm	0.0725 lb/scf
Specific Gravity, Gas (air=1) @ 68°F (20°C), 1 atm	0.967
Specific Gravity, Liquid (water=1) @ 68°F (20°C), 1 atm	0.808
Specific Volume @ 68°F (20°C), 1 atm	13.80 scf/lb
Latent Heat of Vaporization	2,399 Btu/lb mole
Expansion Ratio, Liquid to Gas, BP to 68°F (20°C)	1 to 694

APPLICATIONS

Nitrogen is the largest volume inorganic chemical sold in the world, supporting a multitude of commercial and technical applications. In its liquid state, nitrogen is used for food freezing, cooling, metal treating, biological sample preservation, pulverization, and other temperature-related applications.

HEALTH EFFECTS

Being odorless, colorless, tasteless, and nonirritating, nitrogen has no warning properties. Humans possess no senses that can detect the presence of nitrogen. Although nitrogen is nontoxic and inert, it can act as a simple asphyxiant by displacing the oxygen in air to levels below that required to support life. Inhalation of nitrogen in excessive amounts can cause dizziness, nausea, vomiting, loss of consciousness, and death. Death may result from errors in judgment, confusion, or loss of consciousness that prevents self-rescue. At low oxygen concentrations, unconsciousness and death may occur in seconds and without warning.

WARNING: Personnel, including rescue workers, should not enter areas where the oxygen concentration is below 19.5%, unless provided with a self-contained breathing apparatus or air-line respirator.

Contact your Drew Marine representative for more information

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CRYOGENIC LIQUID CYLINDERS

Figure 2a & 2b show a typical cryogenic liquid cylinder. Cryogenic liquid cylinders are insulated, vacuum-jacketed pressure vessels. They come equipped with safety relief valves and rupture discs to protect the cylinders from pressure buildup. A liquid transfer line is used to safely remove liquid product from cryogenic liquid cylinders, con-sult your Drew Marine representative for more information.These containers can operate at pressures up to 350 psig and have capacities between 80 and 265 liters of liquid. Nitrogen may be withdrawn as a gas by passing liquid through an internal vaporizer or withdrawn directly as a liquid under its own vapor pressure.

Figure 2a

Typical Cryogenic Liquid Cylinder, side view

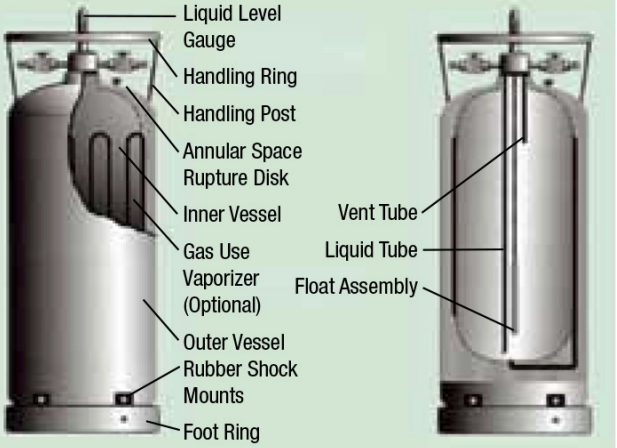
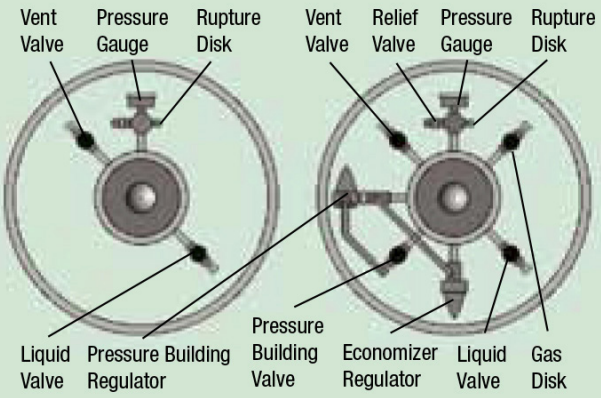


Figure 2b

Typical Cryogenic Liquid Cylinder, top view



SAFETY CONSIDERATIONS

The hazards associated with liquid nitrogen are exposure to cold temperatures, which can cause severe burns; over-pressurization due to expansion of small amounts of liquid into large volumes of gas in inadequately vented equipment; and asphyxiation due to displacement of oxygen in the air in confined work areas. If oxygen-deficient atmospheres are suspected or can occur, use oxygen monitoring equipment to test for oxygen-deficient atmospheres. Review the liquid nitrogen Safety Data Sheet (SDS).

CONFINED SPACE CONSIDERATIONS

Because of the large expansion ratio of liquid to gas, it is very important to provide adequate ventilation in areas using liquid nitrogen. A minimum of six air changes per hour are suggested in these areas. Provide monitoring for areas where oxygen displacement may occur. OSHA has established 19.5% oxygen concentration as the minimum for working without supplied air.

REMEMBER, NITROGEN HAS NO WARNING PROPERTIES!

STORAGE AND HANDLING

Always store and use liquid containers with adequate ven-tilation. Do not store containers in a confined area or in area unprotected from the extremes of weather. Cryogenic containers are equipped with pressure relief devices designed to control the internal pressure. Under normal conditions these containers will periodically vent product. Do not plug, remove or tamper with any pressure relief device. Cryogenic containers must be stored, handled and transported in the upright position. When moving never tip, slide or roll con-tainers on their side. Use a suitable hand truck for moving smaller containers. Move larger containers by pushing, not pulling. Avoid mechanical and thermal shock. Never allow any unprotected part of the body to come in contact with un-insulated pipes or equipment containing cryogenic product. The extreme cold will cause flesh to stick fast and potentially tear on withdrawal. If there is any difficulty in operating the container valve or container connections discontinue use and contact the vendor. Do not remove or interchange connections. Use only the properly assigned connections. **DO NOT USE ADAPTORS.**

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Drew Marine maintains Safety Data Sheets on all of its products. These documents contain health and safety information for the development of appropriate product handling procedures to protect your employees. Safety Data Sheets should be read and understood by all of your supervisory personnel and employees before using Drew Marine products.

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