

Industrial Gas Micro Cryogenic Liquid Tank Installation & Operation Manual

工业气体 微型低温液体贮罐安装与操作手册

在您阅读并理解本指南之前不要试图使用或维护这些设备。禁止未经培训的人员使用或维护该设备。若您不懂该指南，请联系您的供货商索取其他信息。

Do not attempt to use or maintain these units until you read and understand these instructions. Do not permit untrained persons to use or maintain this equipment. If you do not understand these instructions, contact your supplier for additional information.

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1. WARNING 警示

The following safety precautions are for your protection. Before installing, operating, or maintaining this unit read and follow all safety precautions in this section and in the reference publications. Failure to observe all safety precautions can result in property damage, personal injury, or possibly 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 stored in it.

下述的安全预防措施是对您的保护。在安装、操作或者维护本设备之前，应阅读并遵守该章节以及有关文件中的全部安全预防措施。不能遵从全部的安全预防措施的将可能造成财产损失，人身伤害，或可能死亡。该设备的购买方有责任充分地使用者警示有关的预防措施，并提供对该设备及其内储存低温液体的实际操作。

CAUTION: When installing field fabricated piping, make certain a suitable safety valve is installed in each section of piping between shut-off valves.

注意：当现场安装管线时，确定在截止阀之间的每节管道上安装合适的安全阀。

1.1 Safety Precautions for Liquid Oxygen 用于液氧的安全预防措施

Oxygen is a colorless, odorless, and tasteless gas. Approximately one-fifth of normal air is oxygen. Oxygen can be condensed into a liquid at the low temperature of 297 degrees below zero Fahrenheit (-183°C) under normal atmospheric pressure. As a liquid, oxygen is pale blue in color. Oxygen is non-flammable; however it vigorously accelerates the burning of combustible materials.

氧气是无色、无嗅、无味的气体。空气中大约五分之一是氧气。在标准大气压、低于华氏零下 297 度(-183°C)的情况下，氧气可以被压缩为液体。在液体状态下，氧是淡蓝色的。氧气是不易燃的，然而它对可燃材料却有着强烈地助燃性。

Keep Combustibles Away from Oxygen and Eliminate Ignition Sources

使可燃物远离氧气并清除点火源

Many substances that do not normally burn in air require only a slight 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.

通常在空气中不燃烧的物质，在高浓度氧气环境里，仅凭小的火星或者适度的热里就可以使它们燃烧起来。其它的物质，即在空气中适度燃烧的物质，在高浓度的氧气环境下可以剧烈的燃烧（爆燃）。

Do not permit smoking or open flame in any area where liquid oxygen is stored, handled, or used. Keep all organic materials and other flammable substances away from possible contact with liquid oxygen. Some of the materials that can react violently with oxygen are oil, grease, kerosene, cloth, wood, paint, tat, and dirt that contains oil or grease. Under certain conditions flammable materials that have become permeated with liquid oxygen are impact sensitive and can detonate if subjected to shock.

在液氧贮存、处理或者使用的任何区域内禁止吸烟或者使用明火。使所有的有机材料及其他易燃物质远离可能接触到液态氧的地方。一些与氧气发生强烈反应的物质有：油、油脂、煤油、布、木材、油漆、粗麻布以及含有油或油脂的污垢。在一定条件下，已渗透液态氧的易燃物质对冲击敏感，并且，若受到冲击则可能爆炸。

Keep Area and Exterior Surfaces Clean to Prevent Ignition 保持区域与外表面清洁以防着火

As normal industrial soot and dirt can constitute a combustion hazard, all equipment surfaces must be kept very clean. Do not place oxygen equipment on asphalt surfaces, or allow grease or oil deposits to remain on benches or concrete surfaces in the vicinity of the oxygen equipment. Use cleaning agents, which will not leave organic deposits, on the cleaned surfaces. Equipment to be used in contact with liquid oxygen should be handled only with clean gloves or hands washed clean of oil.

通常条件下，工业烟尘和灰尘可能会成为引起燃爆的危害根源，所以必须保持所有设备的表面非常清洁。不要把设备放置在煤焦油沥青的表面，并且禁止把油脂或油沉积物遗留在氧气设备附近的工作台或混凝土的表面上。使用清洁剂将不会在清洁过的表面上遗留有机沉淀物。必须使用洁净的手套或者已经清洁去油的手操纵与液态氧接触的设备。

Maintain Adequate Ventilation 保持充分通风

Enclosed areas containing oxygen equipment should be ventilated to prevent accumulations of oxygen and thereby minimize combustion hazards.

必须使包括有氧气设备的封闭区域通风，以便于防止氧气积累，从而减少燃爆危害性。

Extreme Cold - Cover Eyes and Exposed Skin 极冷—遮住眼睛与暴露的皮肤

Accidental contact of liquid oxygen 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 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 outside boots or over the shoes to shed spilled liquid. If clothing should be splashed with liquid oxygen or otherwise saturated with the gas, air out the clothing immediately, removing it if possible. Such clothing will be highly flammable and easily ignited while the concentrated oxygen remains, and should not be considered safe for at least 30 minutes.

皮肤或者眼睛意外接触到液态氧或寒冷流动的气体，可能会导致类似冻伤的冻结性损伤。处理液体以便其不会飞溅或不会溢出。保护眼睛，并把可能与液体、冷管及设备或现存寒冷气体相接触的皮肤遮盖住。如果液体可能发生喷射、飞溅或者寒冷气体可能从设备中喷发出来，就必须配戴防护眼镜或者防护面罩。推荐穿戴清洁、绝缘并且极易摘下的手套及护袖保护手臂。必须穿无袖口长裤并遮盖在靴子或者鞋的外面，以防止飞溅液体进入。如果衣服被液氧飞溅或被气体浸透，应立即把衣服放在通风处。如有可能应尽快脱掉它，因为当高浓度的氧气存在时，此类衣服将会极易燃烧并很容易被点燃，不要认为至少 30 分钟是安全的。

Replacement Parts Must be Suitable for Oxygen Service 备用零部件必须适合于氧气服务

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 "Cleaned For Oxygen Service" in accordance with Compressed Gas Association (CGA) Pamphlet G-4.1 "Cleaning for Oxygen Service" or equivalent industrial cleaning specifications.

很多材料，特别是一些非金属垫片和密封圈，尽管可能适合用于与其他的低温液体一起使用，但是在氧气服务环境下可形成一种燃爆危害源。对于推荐的备用零部件不得使用替代品。按照压缩气体产业协会(CGA)小册子 G-4.1“适用于氧气服务的清洁”或者等效的工业清洗规范，还必须确保对备用零部件实施彻底的“清洁用于氧气服务”。

Observe Safety Codes When Locating Oxygen Equipment 放置氧气设备时应遵守安全规程

Before locating oxygen equipment, become thoroughly familiar with National Fire Protection Association (NFPA) Standard No. 50, "Bulk Oxygen Systems". The NFPA Standard covers the general principles recommended for the installation of bulk Oxygen systems on industrial and institutional consumer premises.

在放置氧气设备前，应全面熟悉美国防火协会(NFPA)标准的第 50 号“大容量氧气系统”。美国防火协会标准包括了推荐的适合于工业上与制度上的消费场所使用的大容量氧气系统的安装一般原则。

1.2 Safety Precautions for Liquid Nitrogen and Liquid Argon 用于液态氮与液态氩的安全预防措施

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

氮气是惰性的、无色、无嗅和无味的气体，并占有空气中五分之四的比例。通过把空气冷却直至变为液体，然后除去氧气即可获得液态氮。液态氮是存在于正常大气压下-320°F 温度(-196°C)。

NOTE:

Argon is an inert gas whose physical properties are very similar to those of Nitrogen. For handling of liquid Argon, follow the safe practices described for the handling and use of liquid Nitrogen.

注：氩气是物理性质与氮气极为相似的惰性气体。对于氩气的处理，应遵从处理与使用液态氮的安全操作说明。

Extreme Cold - Cover Eyes and Exposed Skin 极冷—遮住眼睛与暴露的皮肤

Accidental contact of liquid nitrogen 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 equipment, or the cold gas exists. Safety goggles or a face shield should be worn if liquid ejection or splashing can occur or cold gas can issue forcefully from equipment. Insulated gloves that can be easily removed and long sleeves are recommended for arm protection. Trousers without cuffs should be worn outside boots or over the shoes to shed spilled liquid.

皮肤或者眼睛意外接触到液态氮或寒冷流动的气体，可能导致类似冻伤的冻结性损伤。处理液体以便于使其不会飞溅或不会溢出。保护眼睛，并把可能与液体、冷管及设备、或者现存寒冷气体相接触的皮肤遮盖住。如果液体可能发生喷射、飞溅或者寒冷气体可能从设备中喷发出来，就必须配带防护眼镜或防护面罩。推荐穿戴绝缘的极易摘下的手套以及护袖保护手臂。必须穿无袖口长裤并遮盖在靴子外面或者鞋的外面以防止飞溅液体进入。

Keep Equipment Area Well Ventilated 保持设备区域通风良好

Although nitrogen is non-toxic and non-flammable, it can cause asphyxiation in a confined area without adequate ventilation. Any atmosphere not containing enough oxygen for breathing can cause dizziness, unconsciousness, or even death. Nitrogen, a colorless, odorless, and tasteless gas, cannot be detected by the human senses and will be inhaled normally as if it were air. Without adequate ventilation, the expanding nitrogen will displace the normal air resulting in a non-life-supporting atmosphere.

尽管氮气是无毒的极不易燃的气体，然而在一个没有足够通风的地方，氮气仍会引起窒息。任何不含足够氧气的空气都可能引起头晕、意识不清，甚至死亡。人的感觉器官无法检测出氮气，因为它是一种无色无嗅无味的气体。并且，氮气如同空气一般会被人体吸入。若没有足够的通风，膨胀的氮气就会替代氧气使空气成为不适合任何生命生存的环境。

Dispose of Waste Liquid Nitrogen Safely 安全处理废液态氮

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

处理废液态氮的地点要在其不会损坏地板和车道并能迅速蒸发的户外区域。充满洁净沙子或碎石的户外坑能够使液态氮安全迅速地蒸发。

NOTE: Argon is an inert gas whose physical properties are very similar to those of nitrogen. For handling of liquid argon, follow the safe practices described for the handling and use of liquid nitrogen.

注：氩气是物理性质与氮气极为相似的惰性气体。对于氩气的处理，应参照遵守对液态氮的处理与安全使用的操作说明。

1.3 Safety Precautions for Liquid Carbon Dioxide 用于液态二氧化碳的安全预防措施

WARNING: CARBON DIOXIDE CAN CAUSE ASPHYXIATION AND DEATH IN CONFINED, POORLY VENTILATED AREAS.

警告：在通风不好的空间内，二氧化碳可以导致窒息和死亡。

COLD GAS CARBON DIOXIDE CAN CAUSE SEVERE FROSTBITE TO THE EYES OR SKIN. DO NOT TOUCH FROSTED PIPES OR VALVES. IF ACCIDENTAL EXPOSURE TO THESE GASES OCCURS, CONSULT A PHYSICIAN AT ONCE. IF A PHYSICIAN IS NOT READILY AVAILABLE, WARM THE AREAS AFFECTED BY FROSTBITE WITH WATER THAT IS NEAR BODY TEMPERATURE.

寒冷的二氧化碳气体可能导致对眼睛和皮肤的严重冻伤。不要接触结冰管道或阀门。如发生意外暴露在 这类气体中，咨询医生。若没有医生，用接近体温的水对霜冻的区域加热升温。

Keep Equipment Area Well Ventilated. 保持设备区域通风良好

Carbon dioxide affects the important acid-base balance in the body. Carbon dioxide is formed in normal functioning within the body, but the body can tolerate increased amounts of carbon dioxide only in limited concentration. This is recognized in OSHA standards where a Threshold Limit Value of 5,000 parts per million by volume (0.5 percent concentration) has been adopted. 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.

二氧化碳会影响人身体内重要的酸碱平衡。二氧化碳是在人身体内的器官正常运行状态下形成的，但是人的身体仅仅能够承受有限增加的二氧化碳浓度。在美国职业安全与卫生条例（OSHA）标准中认定的按照被采用的体积比（浓度为0.5%）容许的（二氧化碳）最高浓度5000ppm。为保证安全，禁止浓度高于该水平，浓度的提升可能导致人身体受损或死亡。另外，由于二氧化碳取代了氧气，可能导致窒息，造成头晕、无意识或死亡。

Ten percent carbon dioxide in air can be endured for only a few minutes; twelve to fifteen percent soon cause unconsciousness; twenty five percent may cause death if exposure lasts for several hours. Carbon dioxide cannot

be detected by the human senses and will be inhaled like air. Carbon dioxide is heavier than air and will accumulate in low lying areas. Carbon dioxide concentrations will be greater in these areas. If adequate ventilation is not provided, carbon dioxide may displace normal air without warning that a life-depriving atmosphere is developing.

人在二氧化碳浓度达到 10% 的空气中只能忍受几分钟；二氧化碳浓度达到 12%至 15%时会使人产生无意识；如果人暴露在二氧化碳浓度为 25%的空气状态下几个小时可能造成人的死亡。人的身体对二氧化碳浓度无法做出反应,并且人体吸收二氧化碳就如同空气一样。二氧化碳的比重大于空气并在地势低的地区积聚,致使二氧化碳浓度远大于该区域的浓度。若不提供充分的通风,二氧化碳就可能悄无声息地取代正常的空气,即逐步形成导致人失去生命的空气。

COVER EYES AND SKIN. 遮盖眼睛和皮肤

If released to atmosphere, liquid carbon dioxide will turn to carbon dioxide snow. Accidental contact of carbon dioxide snow or 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 a face shield, and cover the skin to prevent contact with snow or cold gas, or with cold pipes and equipment. Protective gloves can be quickly and easily removed and long sleeves are recommended for protection.

若释放大气中,液态二氧化碳将会转化为二氧化碳雪。眼睛或皮肤意外地接触二氧化碳雪或寒冷气体可能导致严重的冻伤,所以应处理液体以防止泄漏或者飞溅出来,配戴防护眼镜或者防护面罩以保护眼睛,并遮盖皮肤避免接触二氧化碳雪、寒冷气体或寒冷的管路及设备。推荐穿戴容易快速脱下的防护手套和长护袖,以便于防护。

The rapid discharge of liquid carbon dioxide through a line which is not electrically grounded will result 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.

通过一条没有电绝缘的管线快速排放液态二氧化碳,就会导致静电积聚。接触该电荷可能对操作人员造成惊人和潜在的危險。因此在这些管线投入使用前必须接地。

2. INTRODUCTION 介绍

This manual provides information for the operation and maintenance of industrial gas micro cryogenic liquid tank cryogenic gas supply systems. These products store cryogenic liquid and dispense it as a warm pressurized gas. Additional product specifications, flow diagram, views, and important dimensions are shown on the general arrangement drawing provided in the appendix of this manual.

该手册规定的操作和维护资料，是针对工业气体微型低温液体贮罐。该类产品储存低温液体并对气体升温加压后分配输出。本手册的附录中提供的总体布置图标明了其他的产品规格，流程图，视图和重要尺寸。

2.1 System Description 系统说明

The Industrial Gas micro cryogenic liquid tank consists of a cryogenic liquid vessel, piping, external vaporizer, and external pressure builder.

工业气体 微型低温液体贮罐是由低温液体容器、管线、外汽化器和外增压器构成。

The vessel consists of a pressure vessel suspended inside a jacket. The space between the pressure vessel and the jacket is evacuated and insulated with a micro-fiberglass / aluminum foil radiation shield. Both the inner pressure vessel and vacuum jacket are constructed of type S30408 stainless steel. All models are designed and constructed in accordance with TSG 21-2016、GB 150.1~150.4-2011 and GB/T 18442-2011.

该容器由一悬在夹套内的压力容器构成。把压力容器与夹套之间的空间抽成真空并用超细玻璃纤维/铝箔辐射防护层绝缘。内压力容器与真空夹套是由 S30408 型不锈钢制成的。所有型号都是按照 TSG 21-2016、GB 150.1~150.4-2011 和 GB/T 18442-2011 设计及制造。

Piping circuits allow the vessel to vent, fill, pressurize, and provide pressurized gas. Piping is type-304 and 316L stainless steel. Valves are brass or stainless steel. Fittings are machined from forged brass and stainless steel.

管道线路允许容器排放、充装、加压，并提供加压的气体。管线是用 304 型和 316L 型不锈钢制成的。阀门是铜或不锈钢制的。配件是由加工的锻造黄铜与不锈钢制成的。

Instrumentation consists of a pressure gauge and a differential pressure gauge. The pressure gauge allows the vessel pressure to be monitored. Accurate measurement of the vessel contents is provided by the differential pressure gauge.

仪表包括压力表和差压液位计。压力表可提供检测容器压力。差压液位计为容器内部提供精确的测量数据。

The Industrial Gas micro cryogenic liquid tank system automatically maintains pressure by vaporizing cryogenic liquid in a controlled fashion. All energy for building pressure and vaporizing liquid is provided by heat from ambient air.

工业气体微型低温液体贮罐可以通过控制使汽化的低温液体自动保持压力。从周围的空气中提取热量为加压和汽化液体提供能量。

2.2 Specifications 规格

Specifications is shown on the Appendix 规格型号见附录

3. PIPING CIRCUITS 管线回路

The following paragraphs describe the operation of the piping circuits of the system. The descriptions refer to the main components of each circuit and are grouped by function. Reference the piping schematic below and in the general arrangement drawing for the component designations. These component and circuit descriptions should be understood before attempting operation.

以下各章节阐述了该系统的管道回路的操作。本说明涉及每个回路的主要零部件并依据功能分组。参考下面的管线示意图和总布置图中的零部件名称。在开始操作前必须理解零部件与回路的说明。

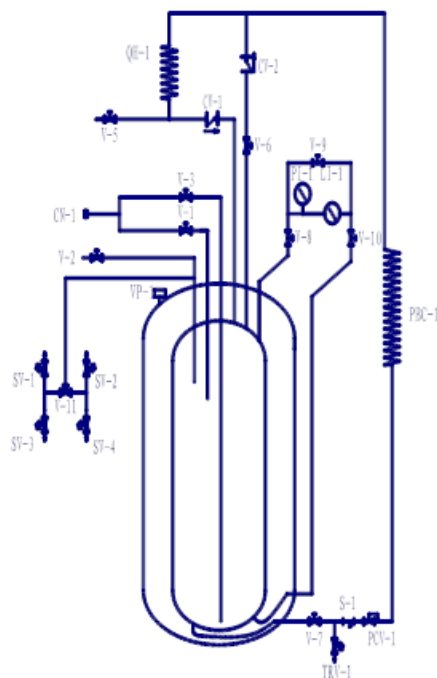


Figure 1: System Piping Schematic

图 1: 系统的管线示意图