



Vacuum Insulated Pipe



*Ensuring liquid supply capabilities.
Any application - Any time*

Ensuring liquid supply capabilities. Any application - Any time



Innovation. Experience. Performance.™

World Class Facility

Chart is the world's leading manufacturer of vacuum insulated pipe systems. Our industry-leading years of experience cover the spectrum of traditional industrial applications, from heat-leak sensitive helium lines to tightly specified aerospace applications. Our vacuum insulated pipe systems are built in an ISO 9001 approved manufacturing facility with an ASME U-Stamp. This large facility shares manufacturing with our bulk tank product line, giving us the resources and flexibility to adjust our pipe manufacturing capacity to market demands. This enables us to keep our lead times and costs down while maintaining superior product quality. Our wide product line of pipe and accessories allows us to engineer the optimum **system solution** for any liquid application.

From small jobs to large, we can supply the entire system from the bulk tank to the pipe to the application equipment.



Engineering Design

Our site survey crew will document your system specifications and our engineering team will propose the most efficient and economical solution that meets the system's performance requirements.



Quality Manufacturing

Our experience and ISO 9001 certification ensures that your job is completed to high quality standards and on schedule.



Installation & Startup

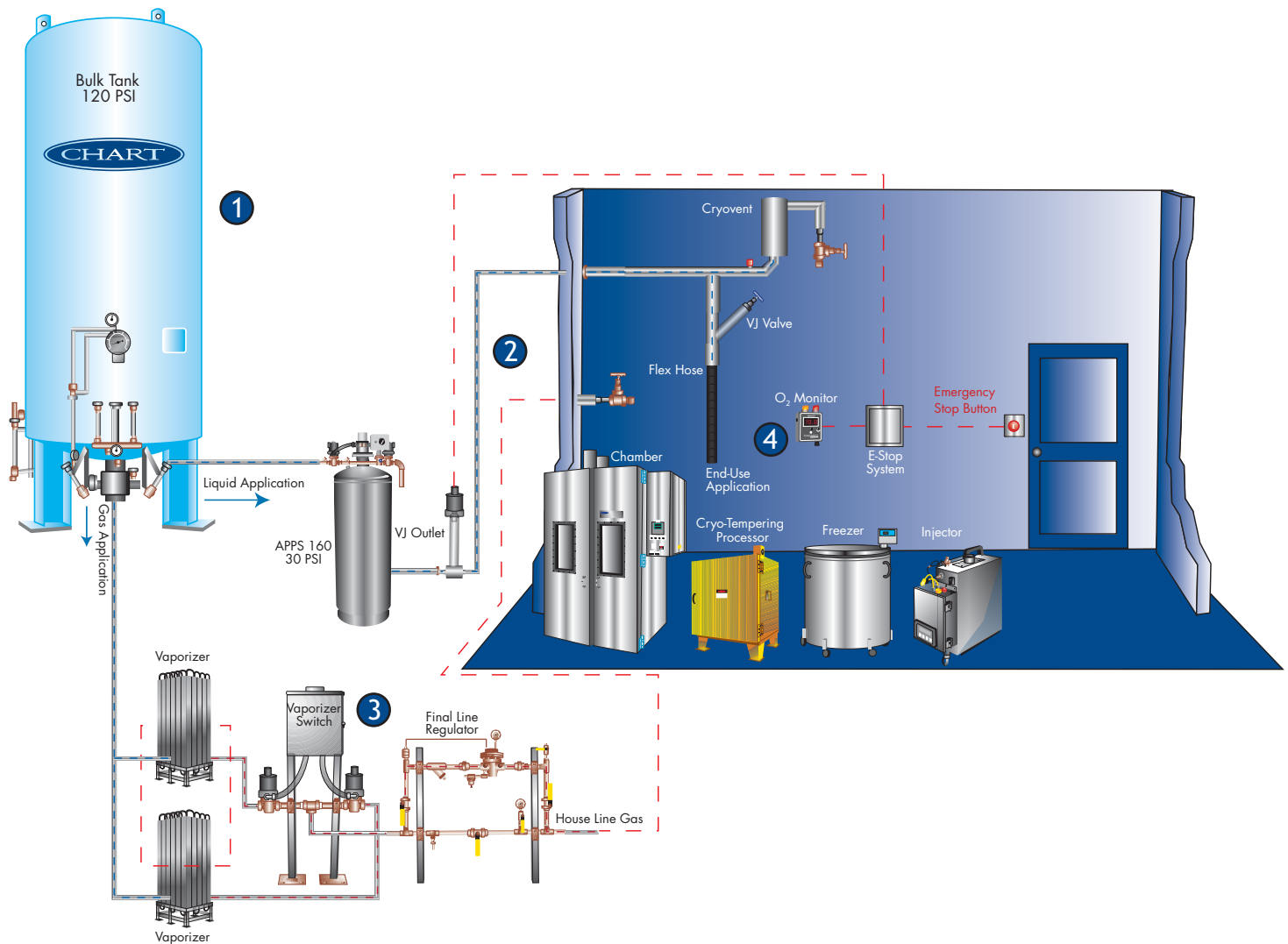
Certified technicians provide installation and training to assure long-term trouble-free operation.

When you choose Chart, you get single-source accountability from the engineered solution through post-installation service.

Vacuum Insulated Pipe

Chart designs, manufactures and installs the complete integrated system.

Chart's vacuum insulated pipe systems are custom engineered to meet your application's specifications. Chart's complete **system solution** package ensures quality liquid to keep your processes operating at their peak efficiency. Built for long-term integrity and industry-leading efficiency, these systems give you the highest performance at the lowest operating cost.



- 1 Liquefied gases are stored at ultra-cold temperatures in a vacuum insulated tank. Controls on the tank keep the pressure of the liquid at optimum levels to assure proper liquid delivery to the application.
- 2 Vacuum insulated pipe connects the tank's liquid withdrawal to the application equipment. The pipe is the foundation for the system's heat-loss efficiency and long-term integrity. It must be engineered to work with the associated controls and accessories.
- 3 Chart manufactures equipment that controls and provides gas to other applications within the facility. Our engineers can help provide proper sizing for vaporizers, control manifolds, etc. to serve both a liquid and gas application from a single bulk tank liquid source.
- 4 The application equipment is designed to utilize liquid at specific properties. The system design must take careful consideration of the application and equipment requirements and specifications.

VIP to Meet the Needs of Any Application



Biological Storage and Research

An efficient supply of high-quality liquid nitrogen is needed to keep valuable biological samples stored indefinitely. Today's top medical research facilities depend on a reliable liquid nitrogen supply to find cures for tomorrow's diseases. Any interruption in supply can result in the loss of many years of research. Chart's experience in the biological container market makes us the first choice in vacuum insulated pipe systems for these applications.



Molecular Beam Epitaxy

MBE is a method of laying down layers of materials with atomic thicknesses on a substrate (epitaxial growth). This is done by creating a "molecular beam" of a material which impinges on the substrate in a high-quality vacuum. A cryogenic screening around the substrate minimizes fluxes of atoms from the walls of the chamber. During this process, it is imperative that the supply of liquid nitrogen be uninterrupted and of good quality (the right pressure and temperature) to prevent contamination of the substrate or interruption of the process.



Food and Beverage Packaging

Using nitrogen to create positive pressure for a rigid container and displace oxygen for a longer shelf-life requires a consistent flow of quality liquid nitrogen to the injector. With Chart's engineered system solutions from the bulk tank to the injector, you get a reliable supply of liquid nitrogen that keeps your equipment operating at peak efficiency for maximum productivity.

Vacuum Insulated Pipe



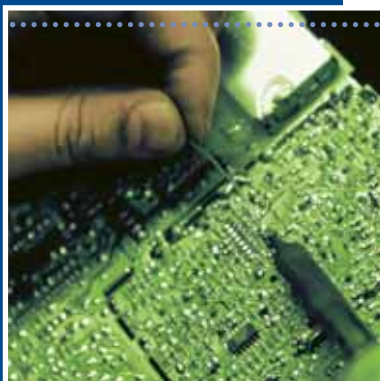
Aerospace

Chart's vacuum insulated pipe is used on launch pads delivering extremely high flow rates of liquid hydrogen and oxygen to fuel today's demanding space programs. Aerospace applications are extremely precise, requiring larger diameters, higher pressures and intense analysis of engineering stress and heat leak. Additionally, Chart is able to meet the precision clean requirements common to these applications.



Food Freezing

Total system cost and efficiency is crucial in food freezing applications. Chart's superior insulation technology delivers liquid nitrogen with more cooling capacity, using less nitrogen per pound of frozen product. With our experience and capabilities in providing complete pipe system solutions, we help maintain the lowest total cost of ownership with the most efficient system.



Electronic Manufacturing and Testing

Silicone manufacturing and cleaning applications require extremely tight tolerances on the control of liquid nitrogen flow. It is critical that the vacuum insulated pipe system deliver the proper amount of liquid at the proper temperature to maximize wafer yield. For electronic component testing, Chart works with today's leading equipment manufacturers to design and manufacture pipe systems that supply the flows demanded by today's thermal stress environmental test chambers. As the leading manufacturer of LN₂ cooled chambers, Chart gets your pipe system right the first time.



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Invar



The ultimate solution for the most demanding applications. Special Invar material is used for the inner pipe, eliminating the need for flexible bellows. Chart's pipe is qualified in all respects to ASME Code, Section B31.3, chemical plant and petroleum refining piping for 150 psi. Invar's extremely low thermal contraction eliminates the need for bellows or convoluted flex hose. All-rigid construction means design simplicity and long-term integrity; no extra weld fatigue from adding items for construction; less stress during over-the-road shipments; and minimal damage during installation. Bayonet or field weld connections.

Internal Bellows



Our most common solution for many industrial applications. Internal bellows eliminate contraction of the outer pipe and give it a clean look. This industrial/commercial grade product is built to the same rigid requirements as ASME piping. The material is very corrosion resistant. Bayonet or field weld connections.

External Bellows



External bellows are a good choice for our customers who need higher pressure ratings or reduced pressure drop, as the flexible bellows material is moved to the outer jacket. This product is qualified in all respects to ASME Code, Section B31.3, chemical plant and petroleum refining piping for 150 psi. The material is very corrosion resistant. Bayonet or field weld connections.

Helium Lines



The solution for helium piping starts with 2 1/2 times more insulation for super-low heat leak. Field joints are also 67% more efficient than standard piping. Chart's helium lines are qualified in all respects to ASME Code, Section B31.3, chemical plant and petroleum refining piping for 150 psi.

Vacuum Insulated Pipe

VIP SYSTEMS

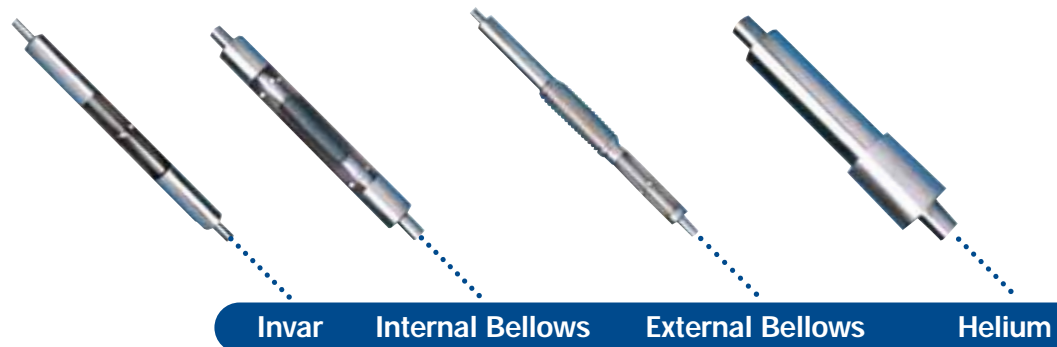
Vacuum insulated pipe systems provide the most efficient method of transferring quality cryogenic liquid, allowing you to focus on operations rather than the liquid supply. Once the system is installed, its maintenance-free design will provide you with many years of trouble-free service.

Serving a variety of markets and usage requirements, Chart's vacuum insulated pipe systems meet the unique demands of every customer. With our industry-leading experience we can help you select the pipe system that best suits your application and installation.



Product Advantages

- ▶ **Stationary, static vacuum system**
100% stainless steel and/or invar construction for a maintenance-free long service life
- ▶ **Maximize limited space**
The smallest diameter outer with the largest diameter inner available today
- ▶ **Sized to match usage needs**
Available in a variety of styles and sizes to meet the unique demands of your application
- ▶ **Built to industry standards**
Qualified to ASME Code, Section B31.1, Chemical Plant and Petroleum Refining



	Invar	Internal Bellows	External Bellows	Helium
FEATURES				
Heat Leak	★★★★	★★★★	★★★★	★★★★
Pressure Drop	★★★★	★★★	★★★★	★★★★
External Durability	★★★★	★★★★	★★★	★★★★
Installation Flexibility	★★★★	★★★★	★★★	★★★
Section Connections	Bayonets or Field Joints			
MATERIALS				
Inner pipe	Invar36	T304 Stainless Steel		
Outer jacket	T304 Stainless Steel; Bright Annealed (1)			
DESIGN CODE	Built in accordance with ASME, Section B31.3 (2)			
MAWP (3)	150 psig			
OUTER JACKET SIZES				
1/2" Inner	2" Nominal Pipe Size			
1" Inner	3" Nominal Pipe Size			
1-1/2" Inner	3-1/2" Nominal Pipe Size			
2" Inner	3-1/2" Nominal Pipe Size			
3" Inner	N/A	5" Nominal Pipe Size		
4" Inner	N/A	6" Nominal Pipe Size		
Larger	N/A	Larger sizes are available - consult factory for details		

(1) Outer jacket for 3-inch inner and larger is not bright annealed

(2) Code required X-ray or pneumatic pressure tests are optional

(3) MAWP = Maximum allowable working pressure

★Poor ★★Good ★★★Better ★★★★Best

VIP Accessories



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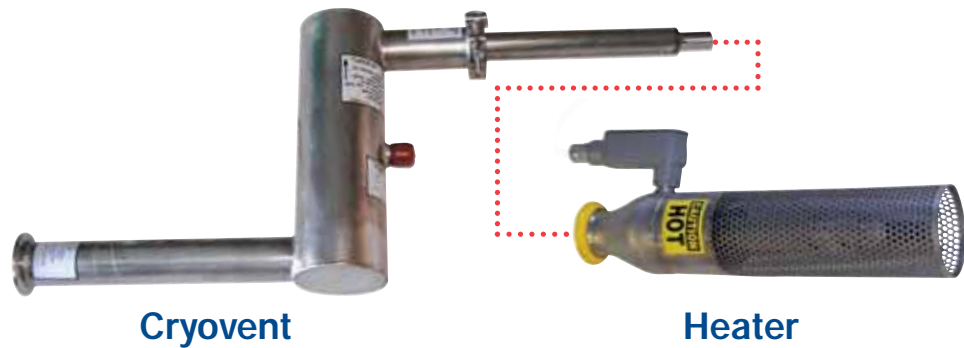
Supplement your vacuum insulated pipe system with Chart's engineered accessories. Our accessories have been field-tested for reliability and durability to give years of trouble-free service.

Cryovents and Heaters

Chart's cryovents are installed to enhance the performance of the pipe system. In normal operation, some liquid is boiled to vapor from the small amount of heat leak into the pipe, and the cryovent allows this gas to escape. Applications requiring continuous up-time of liquid in the piping system must have a cryovent installed to ensure quality liquid availability. The result is more efficient operation of the liquid supply.

Product Advantages

- Available in a wide variety of sizes and configurations, including vacuum insulated exhaust connection to reduce ice build-up from the cold gas
- Electric heater options also available as another solution to eliminate exhaust ice build-up
- Available with pipe thread or bayonet inlets and outlets for system installation flexibility



Cryovent

Heater

Vacuum Jacketed (VJ) Valves

Cryogenic pipe systems often require valves to properly control the liquid flow to the application. Strategically located valves control flow to a branch of the system or into a use-point drop. A vacuum insulated valve has the benefit of extremely low heat leak for minimum gas boil-off, and it eliminates ice build-up and dripping water.

Product Advantages

- Available in many sizes and styles such as T or Y pattern
- The more compact Y-pattern valve is generally used in vertical drops for easier operation, better reliability and higher flow rates.
- Actuators can be installed on valves for control from a remote location or signal. Standard pneumatic actuators are often used to control flow rate or open and close valves based on the state of a switch, control system, or oxygen system E-stop switch.
- Un-insulated economical brass valves are also available for applications that have infrequent use. It is highly recommended to locate the internal liquid trap accessory above the valve to create a gas trap.



T-Pattern Vacuum Insulated Globe Valve

Y-Pattern Vacuum Insulated Globe Valve

T-Pattern Non-Insulated Extended Stem Globe Valve

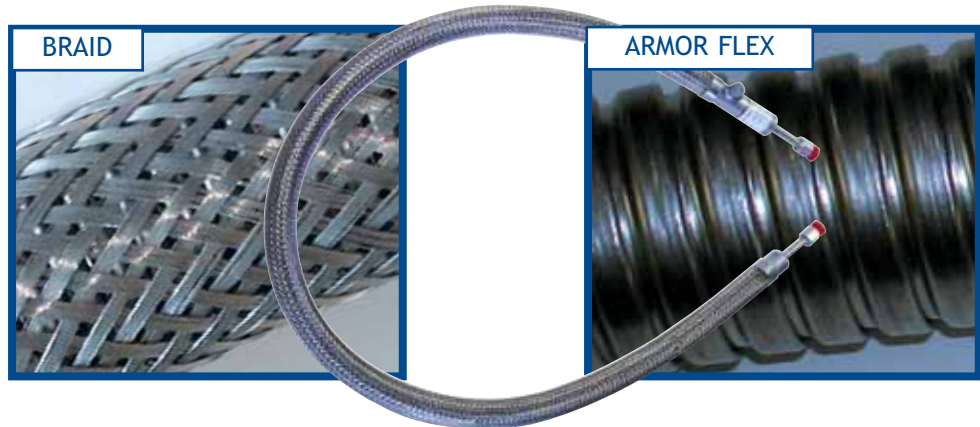
Vacuum Insulated Pipe



Flexible Vacuum Insulated Pipe

Many vacuum insulated pipe systems require vacuum insulated flexible lines. These applications include connection points to the bulk tank or the application equipment such as food freezers, test chambers, cryo-biological freezers or nitrogen injectors. Flexible sections may also be used to make installations in tight, confined spaces easier.

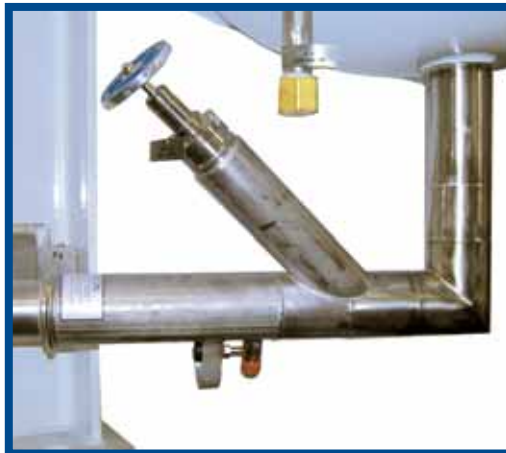
- ### Product Advantages
- Simplifies the installation and absorbs small vibrations and thermal movements in the system over time
 - Available in any length and diameter to fit any installation
 - Optional end connections from standard CGA flare fittings to small bayonets
 - Custom outer jacket available in braid or armor flex for better durability
 - Manufactured with a permanent static vacuum for life-long, trouble-free service
 - Maximum Allowable Working Pressure (MAWP): 125 psig



Vacuum Insulated Withdrawal

One of the most important options for any vacuum insulated pipe system is the vacuum insulated withdrawal on the liquid storage vessel. Because this option is part of the vessel vacuum system, it must be specified with the tank order. Chart's engineers can help make sure the tank and pipe connections are correct for proper integration in the field.

- ### Product Advantages
- Eliminates ice build-up and dripping water at tank connection
 - Reduces liquid consumption from boil-off
 - Available on bulk tanks and Perma-Cyl® units
 - Specify end connection and isolation valve style with tank order



Bulk tank with vacuum insulated liquid withdrawal



Perma-Cyl tank with vacuum insulated liquid withdrawal

VIP Accessories



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Liquid Flow Meter

For applications that require accurate cryogenic metering, the liquid flow meter is the solution. Based on the field-tested Orca flow meter, this meter system is a proven product without any moving parts to service. It accurately measures the pressure drop through a fixed orifice and reads the actual temperature of the liquid to calculate the liquid flow.

Product Advantages

- Accuracy capability: +/- 1.5%
- Approvals: National Institute of Standards and Testing (NIST) and California Weights and Measures
- Computer interface: RS-232
- Electronic display module to view current flow rate as well as totalized flow
- Readouts: pounds, kilograms, imperial gallons, US gallons and liters of liquid; cubic feet and cubic meters of gas
- Meter section is permanently encased in a vacuum insulated pipe section for thermal efficiency and meter accuracy



Liquid Flow Meter

Adjustable Pressure Phase Separator (APPS)

The APPS-160 provides a convenient method of providing low-pressure liquid to an installation that is supplied from a bulk tank at higher pressure. The APPS provides a lower cost solution to supplying liquid at different pressures than installing two bulk tanks.

Product Advantages

- Provides tighter pressure control for the lower pressure liquid application
- Adjustable outlet pressure ranges of either 10-50 psig or 40-85 psig
- Working capacity: 160 liters
- Bayonet outlet connection is standard. Consult factory for custom designs.



APPS-160

Vacuum Insulated Pipe

End-Use Equipment and Operating Cost Comparison



www.chartinjectors.com

Liquid Nitrogen Injector

Extend food shelf life and improve package integrity with our liquid nitrogen injector. Designed for easy interchangeability to various packaging lines, our injector provides continuous operation at fill speeds up to 2400 units per minute. Engineered options are available to meet your packaging specifications.



www.chartchambers.com

Environmental Test Chamber

Using the extreme cooling capabilities of liquid nitrogen, our REAL series HALT/HASS reliability test chambers can reach the lowest temperatures at the fastest rates possible for maximum thermal stress testing and screening of your components. The REAL series product line offers a wide range of features, from vibration tables to user-friendly touch screen controls.



www.chartbiomed.com

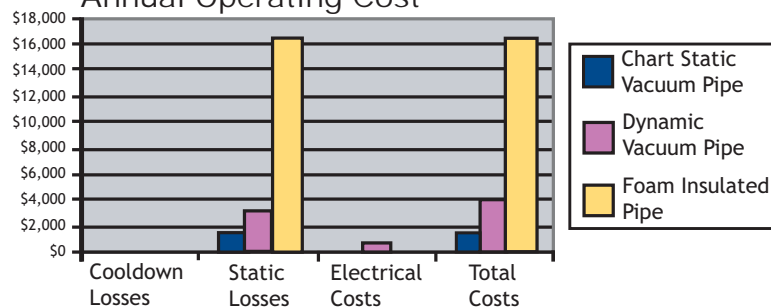
Biological Freezers

Chart/MVE Biological Systems is the leading supplier of products for freezing, long-term storage and distribution of biological materials with liquid nitrogen. Our XLC series offers a wide range of models with electronic controls to match your application and storage process.

Typical Operating Cost Comparison

	Chart Static Vacuum Pipe	Dynamic Vacuum Pipe	Foam Insulated Pipe
Cooldown Losses	\$2	\$2	\$2
Static Losses	\$1,631	\$3,210	\$16,405
Electrical Costs	\$0	\$675	\$0
Total Costs	\$1,633	\$3,887	\$16,407

Annual Operating Cost



Based on vendor published studies with LN₂. Cooldown is from room temperature and static losses are based on 24/7 operation. Dynamic vacuum system costs include pump electricity but not pump maintenance.



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