Lake Shore CRYOTRONICS

environment by JANIS

How to deal with the high cost of helium

The high cost of helium is a big issue most researchers face. There are a number of reasons why helium is so costly and there are a few different ways to deal with the high cost. We will outline them here so you can make the best choice when deciding how to outfit your cryogenic laboratory.

Why is helium so costly?

Helium is a non-renewable resource. It is generated deep within the Earth over geological timescales through the radioactive decay of heavy elements. Once released into the atmosphere, helium is nearly impossible to recapture, as it eventually escapes into space. Not to mention that extracting helium is a complex and expensive process. It is usually found in small quantities mixed with natural gas, and separating helium requires sophisticated equipment and processes. The cost of extraction adds to the overall price of helium.

The demand for helium has also been rising in various industries. It is indispensable in medical imaging (MRI machines), scientific research, electronics manufacturing, space exploration, and other applications. This growing demand puts pressure on the limited supply.

Helium distribution and storage is also a factor. Helium must be stored and transported in specialized cryogenic tanks to keep it in a liquid state. This requires significant energy and specialized equipment.

The majority of the world's helium supply comes from a small number of sources. Political or economic issues in these regions can affect the global supply and prices. In the past, the U.S. government had a significant stockpile of helium and sold it at low prices. However, in recent years, the U.S. government has been gradually selling off this stockpile, resulting in reduced market intervention and higher prices.

As with many commodities, the price of helium can be influenced by market speculation. If suppliers, traders, or industries anticipate a shortage or increased demand, they may hold onto supplies or bid up prices.

Given the critical role of helium in various industries and its finite nature, efforts will continue to be made to develop more efficient methods for helium extraction and recycling. However, for the foreseeable future, the cost of helium is likely to remain relatively high.

Steps to take to mitigate the high cost of helium

Conduct a consumption audit

A helium consumption audit can help you monitor and manage your consumption patterns, costs, and possible wastage. Here are the steps to perform a helium consumption audit:

Understand helium usage: Identify all the areas where helium is used within your organization. Understanding where and how helium is used is crucial.

Collect data: Gather data on helium consumption over a period of time. This can include the amount of helium used, the frequency, costs, and any patterns in consumption. Check delivery receipts, invoices, and logs of helium containers. Also, record the specifications of the equipment that uses helium.

Measure and monitor equipment: Install meters or monitoring devices to measure the actual consumption of helium. This helps in getting more accurate data on the flow rates and total volume consumed.

Analyze consumption patterns: Once you have collected enough data, analyze it to understand the consumption patterns. Look for any irregularities or spikes in usage that may indicate leakage or inefficient use.

Detect any leaks: It's common for helium to be wasted through leaks in storage tanks or distribution systems. Employ leak detection methods, such as ultrasonic detectors, pressure decay tests, or sniff tests, to find and fix any leaks.

Evaluate equipment efficiency: Check the efficiency of the equipment using helium. Some equipment might be outdated or not working efficiently, causing higher helium consumption. It's worth considering replacing or upgrading equipment to more efficient models.

Assess operational practices: Evaluate the practices and procedures of employees who handle helium. There could be operational inefficiencies contributing to the excessive consumption of helium. Training and best practices could mitigate this. We do have a forum post on how to reduce cryogen consumption in probe stations.

Analyze costs: Calculate the costs associated with helium consumption. Consider the direct costs of helium as well as indirect costs such as lost productivity due to equipment downtime or maintenance issues.

Implement conservation measures: Based on the findings of the audit, implement measures to reduce helium consumption. This could include fixing leaks, improving equipment efficiency, changing operational practices, or exploring helium recycling options.

Document and report: Detail all the findings and analysis. Create a comprehensive report with current helium consumption patterns and recommend actions for improvement.

Keep in mind that a helium consumption audit should be thorough and take into account all aspects of helium usage within an organization. It's often helpful to involve experts or consultants who specialize in gas management and auditing to ensure a comprehensive and effective audit.

Install a helium reclamation system

A helium reclamation system is designed to capture, purify, and recycle helium gas that would otherwise be lost to the atmosphere during various processes. Helium is a finite resource, and it's often expensive, so reclamation systems are used to reduce costs and conserve the gas. These systems are commonly used in industries where large quantities of helium are used, such as MRI manufacturing, cryogenics, welding, and research laboratories.

A reclamation system typically consists of several components:

Capture: This involves collecting the helium that would normally be vented into the atmosphere. This can be achieved through specialized hoods, containment systems, or direct connections to the equipment that uses helium.

Compression: Once captured, the helium is compressed to a higher pressure. This is often necessary to store the gas efficiently and to prepare it for purification.

Purification: As helium is reclaimed, it may be contaminated with impurities such as moisture, oxygen, or other gases. The purification stage involves filtering and processing the helium to remove these impurities.

Storage: After purification, the helium is stored in pressurized containers, ready to be reused.

Liquification: Helium gas can be liquified for use in cryogenic applications.

Distribution: The stored helium can then be distributed back to the equipment or processes that require it.

To determine if you are a good candidate for a helium reclamation system, consider the following factors:

Volume of helium usage: If your facility uses a significant volume of helium regularly, it might be economically viable to invest in a helium reclamation system.

Cost of helium: The cost of purchasing new helium is high, and is expected to increase, so a reclamation system can be a wise investment to hedge against future price hikes.

Environmental concerns: If your organization is committed to sustainability, a helium reclamation system can help reduce the environmental impact by conserving a non-renewable resource.

Supply reliability: If you are in a region where helium supply is inconsistent or unreliable, having a reclamation system can provide a more stable source of helium.

Regulatory requirements: Some jurisdictions may have regulations or incentives in place to encourage the conservation of helium. A reclamation system might be a requirement or beneficial for compliance with these regulations.

Technical feasibility: Assess if your current infrastructure and processes can be adapted to incorporate a helium reclamation system. You need to have enough space and the right kind of equipment to integrate such a system.

Economic analysis: Perform a cost-benefit analysis, taking into account the upfront investment, operational costs, and the savings from reusing helium over time.

If you find that the factors listed above align favorably with your situation, it is likely that you are a good candidate for a helium reclamation system. In such cases, consulting with experts or companies specialized in gas reclamation can provide further insights and options tailored to your specific needs.

Use a recirculating gas cooler

Using a recirculating gas cooler (or RGC) with a cryostat provides several advantages in terms of efficiency, performance, and maintenance. The combination can be especially beneficial in applications that demand precise temperature control and stability. Here are the advantages of using a recirculating gas cooler with a cryostat:

No new helium consumption: With a wet cryostat, the liquid helium evaporates and needs to be replenished. By using an RGC, the helium is continuously cooled and recirculated, eliminating helium consumption.

Lower costs: As there no new helium consumption, the operating costs associated with purchasing and handling cryogens are eliminated. Also, an RGC can be a less expensive option as compared to a helium recovery system.

Extended operating time: With an RGC, the cryostat can operate for extended periods. This is especially useful for applications that require long, uninterrupted run times.

Convert an existing cryostat setup: An RGC can be added to an existing continuous flow cryostat setup to make it essentially cryogen-free. The RGC can also be used with more than one cryostat in your laboratory, eliminating extra helium use for whichever cryostat is paired with the RGC at the moment.

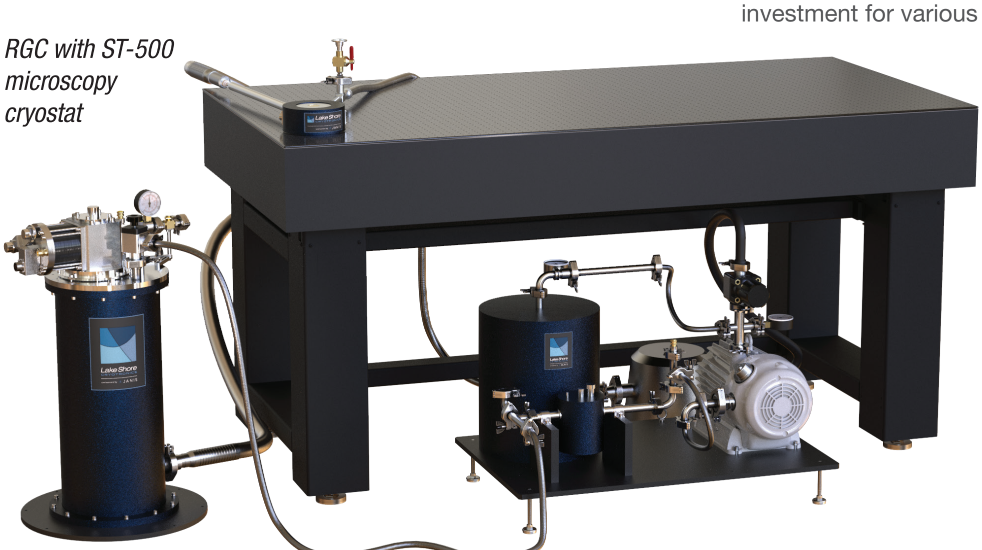
Enhanced safety: Handling liquid cryogens involves risks, especially for the unexperienced. Using a recirculating gas cooler reduces the frequency of handling cryogens, enhancing safety.

Independence from cryogen supply: For facilities in areas where cryogen supply is unreliable or costly, a recirculating gas cooler can provide a level of independence by extending the time between necessary cryogen refills.

Flexibility and adaptability: Recirculating gas coolers can be adapted to work with various types of cryostats and can be optimized for different temperature ranges and cooling capacities. This makes them versatile and suitable for a wide range of applications.

While recirculating gas coolers offer many advantages, it's also important to consider the initial investment cost, which can be higher than traditional cryostat setups. However, in many cases, the long-term benefits in terms of reduced operating costs, enhanced performance, and safety make it a worthwhile investment for various applications.

RGC with ST-500 microscopy cryostat



Invest in cryogen-free equipment

Refrigerator closed-cycle cryostats don't require the regular use of cryogenic liquids. And though refrigerator closed-cycle cryostats can have higher initial costs, eliminating the need to regularly purchase and handle cryogenic liquids can result in lower long-term operating costs.

Cryogen-free cryostats also often require less space than liquid cryogen cryostats, with no need for cryogen storage tanks.

However, it is also essential to note that refrigerator cryostats might not be suitable for all applications. In some cases, liquid helium cryostats might still be necessary because mechanical refrigerators may not be able to achieve low enough temperatures, or they may not fulfill some other application requirement, such as low vibration. The choice between refrigerator cryostats and liquid cryogen cryostats should be based on the specific requirements of the application, as well as considerations of cost, safety, and convenience.

Our engineers can help you decide which cryostat setup is right for you. You can also use the cryostat decision trees (on the following two pages) to help narrow down what type of cryostat you need.

CCS-100 cryogen-free cryostat

Choose the right cryostat for you

Use these cryogen-free and LHe and LN_2 decision trees to help you choose the cryostat system that fits your specific application and experimental needs.

Cryogen-free systems

Need <4 K?
- Yes → **1.5 K closed-cycle cryostat**
  - SHI-950-LT 1.5 K to 800 K Low-temperature
  - SHI-950T-LT 1.5 K to 800 K Low-temperature non-optical
- No ↓

Specific application?
- Mössbauer → CCS-800 <4.5 K to 300 K
- UHV → CCS-XG-UHV <4 K to 325 K 40 nm vibration
- Noble gas trapping → CCS-TRAP <8 K to 450 K
- No ↓

Need low vibration?
- Yes → CCS-XG <4 K to 325 K 40 nm vibration
- No ↓

Is sample thermally non-conductive?
- Yes, sample is non-conductive or unsure → CCS-900 <2 K to 800 K General-purpose; CCS-900T <2 K to 800 K General non-optical
- No ↓

Require sample rotation?
- Yes → CCS-900 <2 K to 800 K General-purpose; CCS-900T <2 K to 800 K General non-optical
- No ↓

Max temp >325 K?
- Yes → CCS-400 <4 K to 500 K High temp; CCS-400H <5 K to 800 K Ultra-high temp
- No ↓

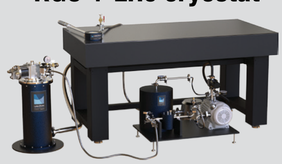
Need to fit in electromagnet or very small space?
- Yes → CCS-300S <4 K to 325 K Compact; CCS-300ST <4 K to 325 K Compact non-optical
- No ↓

CCS-100 <4 K to 325 K General-purpose

Blue = Sample-in-vacuum

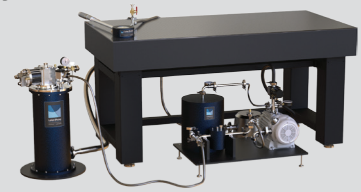
Orange = Sample-in-exchange-gas

Also available for cryogen-free operation: RGC + LHe cryostat



LHe and LN_2 systems

Make any ST or STVP cryostat cryogen-free with the addition of an RGC



Application-specific?
- Yes →

NMR

STVP-NMR Non-optical	<2 K to 325 K

or

UHV

ST-400 High-temp	2 K to 500 K
ST-400-H Ultra-high temp	2 K to 800 K

or

Microscopy/low-vibration

ST-500 <15 nm vibration	3.5 K to 475 K
ST-500-C <15 nm vibration, compact	6 K to 475 K

or

FTIR

VPF-FTIR	77 K to 500 K
ST-FTIR	2.5 K to 500 K
STVP-FTIR	<2 K to 325 K

- No ↓

Is sample thermally non-conductive?
- Yes, sample is non-conductive or unsure → For optical applications / For high-temp (non-optical) applications
- No, sample is conductive ↓

Is sample throughput critical?
- Yes, <10 min sample change → For optical applications / For high-temp (non-optical) applications
- No ↓

Require sample rotation?
- Yes → For optical applications / For high-temp (non-optical) applications
- No ↓

Need to fit in electromagnet or very small space?
- Yes ↓

ST-300 2 K to 500 K Magnetotransport	
ST-300-C 2 K to 500 K Magnetotransport Compact	

- No ↓

CryoComplete™ with VPF-100	
VPF-100	77 K to 325 K
VPF-100-H	77 K to 800 K
ST-100	2 K to 500 K
ST-100-H	2 K to 800 K

For optical applications

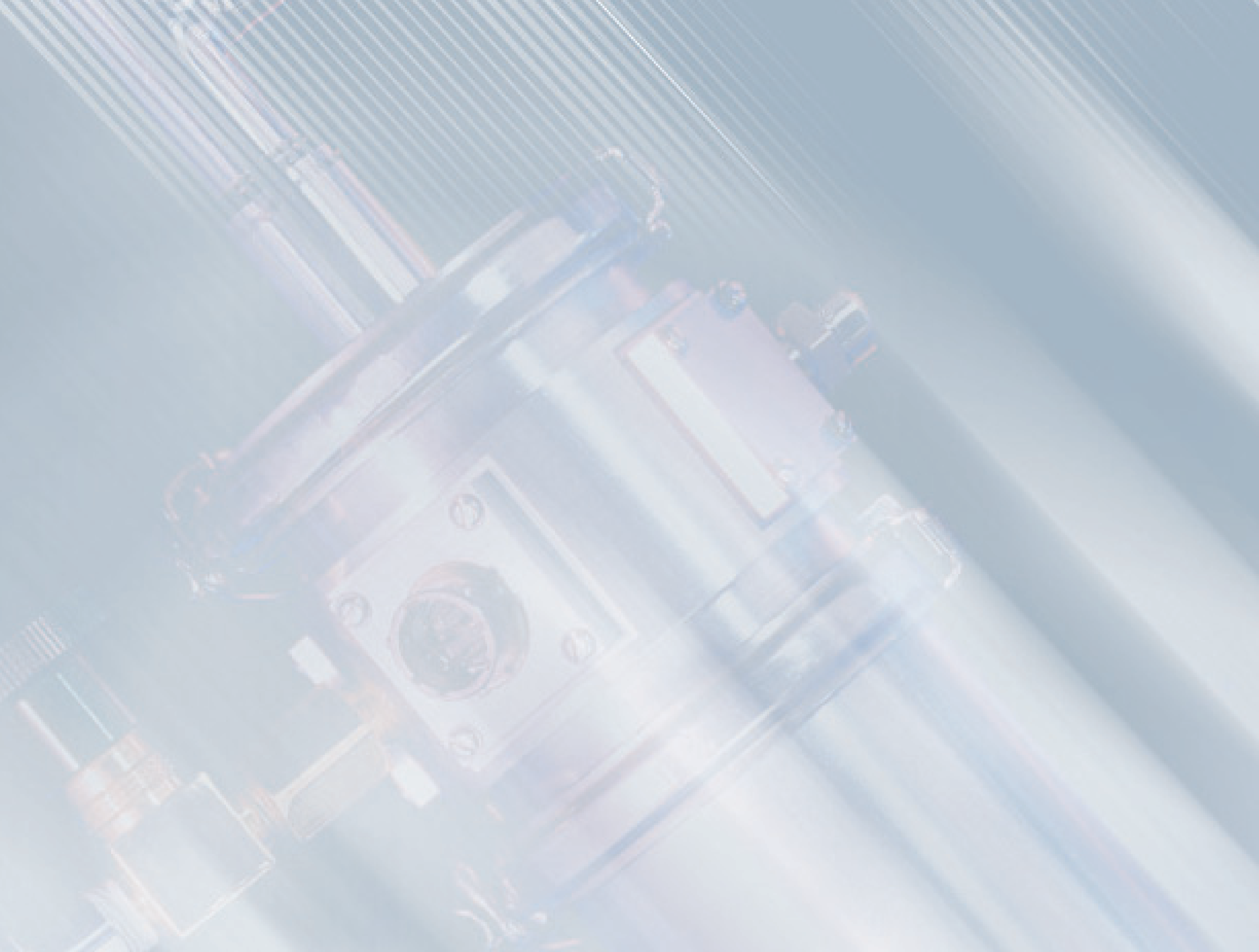
VNF-100	77 K to 325 K
STVP-100	<2 K to 325 K

For high-temp (non-optical) applications

VNF-100-TH	77 K to 500 K
STVP-100-TH	<2 K to 420 K

Best for non-conductive samples (works equally well with conductive samples). Best for temperature uniformity.

- (dark blue) = LHe sample-in-vacuum
- (light blue) = LN_2 sample-in-vacuum
- (dark orange) = LHe sample-in-flowing-vapor
- (light orange) = LN_2 sample-in-flowing-vapor



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