

Making our world more productive



Liquefaction and refrigeration plants  
for research, science and industry

# Helium solutions





## Helium provides the ultimate cold

**In 1911, just three years after he succeeded in liquefying the noble gas helium at  $-269^{\circ}\text{C}$ , Kamerlingh Onnes observed that metals lose practically all electrical resistance below a certain temperature.**

**The phenomenon of superconductivity had been discovered.**

Today, research in high-energy and particle physics, fusion reactors, medical and material science as well as many other areas is inconceivable without the use of superconductors. The cold needed for the operation of superconducting magnets, whether in research or industrial applications, is supplied by liquid helium.

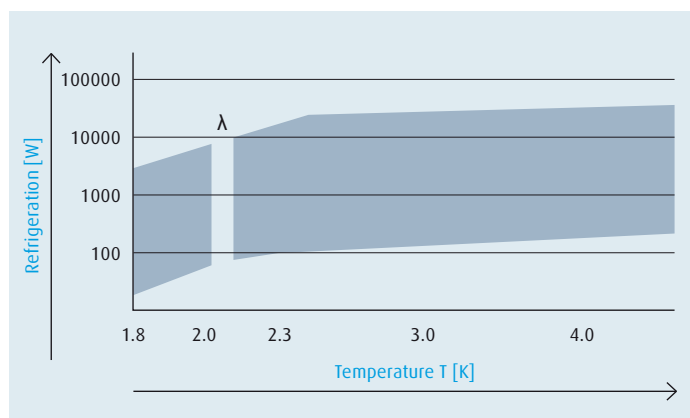
With more than 600 cryogenic installations around the world, Linde Kryotechnik is the design, construction and consulting specialist for helium refrigeration and helium liquefaction systems.



Drive cartridge with cold compressor rotor for 2K systems.



Standard L-Series helium liquefier with dryer and dewar.



Capacity range for customized helium refrigerators performing bath cooling.

## Helium liquefaction

Liquid helium is vital for experiments on superconductivity in many fields of research and technological innovation, and also for the functioning of superconducting components. What is more, when helium is shipped from around the world, economics dictates that it has to be in liquid form. It is these factors above all that create a demand for helium liquefaction systems.

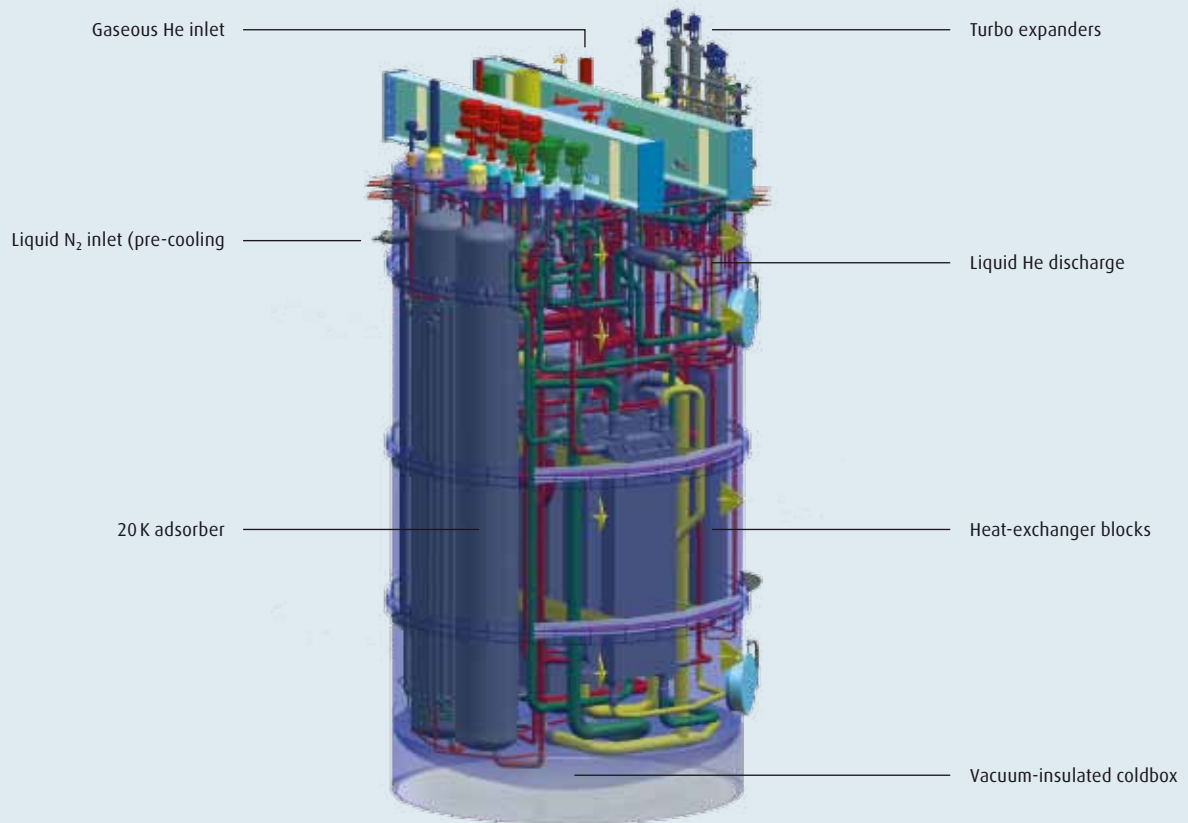
The process of liquefying helium involves compression followed by cooling in countercurrent heat exchangers. The extra cold needed to cool the helium is furnished by turbo expanders.

Linde Kryotechnik can cite projects spread all over the world to demonstrate its competence, from the standard L-Series helium liquefier to custom-designed research and industrial systems.

## Helium bath refrigeration

The most important application of helium bath refrigeration is to cool particle accelerator cavities, but superconducting magnets and many other experiments in scientific research laboratories around the world are also significant uses.

Linde Kryotechnik can claim more than four decades of experience in building specialty systems for helium bath refrigeration at 4.5K as well as at 2K, where the helium turns superfluid. These installations offer highest reliability, the industry's best energy efficiency, consistent refrigerating power, and helium bath pressure stability.



Liquefier (coldbox)

## Forced-flow helium refrigeration

Forced-flow refrigeration with gaseous or supercritical helium has become more popular. Applications include SC magnet generators, motors, space simulation chambers, hydrogen isotope separation, cold and spallation neutron sources.

From systems based on our standard L-Series (with refrigeration capacities of up to 900 W at 4.4 K) and highly specialized small plants (10–20 W at 1.8 K) all the way up to the very large CERN installations (over 18 kW at 4.5 K), Linde Kryotechnik offers solutions for research and industry that are not only designed to fit customers' requirements perfectly, but also offer unmatched reliability and durability.

## Storage and filling

Liquid helium is stored in special cryogenic tanks near atmospheric pressure at extremely low temperatures (4.5 K or  $-269^{\circ}\text{C}$ ).

For storage as well as for bulk shipment of the helium all over the world, double-walled, vacuum-insulated vessels and tanks – with very low heat in leak – are essential.

Linde offers technically advanced and economical solutions, drawing on its accumulated know-how in the design and construction of cryogenic storage tanks and liquid helium filling stations.

## L-Series: standard liquefier

Liquefaction capacities of up to 290 l/h (equivalent refrigeration capacities up to 900 W at 4.4 K) are covered by our standardized L-Series. The L-Series brochure provides more details.

# Performance that won't leave you cold

Linde Kryotechnik has supplied helium liquefaction and refrigeration systems for all major research institutes and industrial gas suppliers worldwide.

Helium	Applications	Range of performance
Liquefaction	<ul style="list-style-type: none"> <li>→ Bulk liquefaction for distribution (commodity)</li> <li>→ Interruptive operation of experiments</li> <li>→ Transfill stations</li> <li>→ Liquefaction centres</li> <li>→ MRI systems (magnetic resonance imaging)</li> <li>→ Cooling of power leads to superconducting magnets</li> </ul>	up to 5,000 l/h
Bath cooling @ 4.5 K and @ 2 K and 1.8 K	<ul style="list-style-type: none"> <li>→ Low-temperature superconductivity: magnets, cavities e.g. for accelerators</li> <li>→ Cooling of light sources</li> <li>→ Cryogenic storage rings</li> </ul>	up to 25,000 W @ 4.5 K up to 3,000 W @ 1.8 K
Forced-flow cooling @ 4 K–8 K	<ul style="list-style-type: none"> <li>→ Low-temperature superconductivity: magnets, particle accelerators, fusion test reactors, SMES systems</li> </ul>	customized
Refrigeration @ 15 K–25 K	<ul style="list-style-type: none"> <li>→ Re-condensation of hydrogen (cooling of cold neutron sources)</li> <li>→ Deuterium – hydrogen separation</li> <li>→ Cryogenic distillation (tritium removal, etc.)</li> <li>→ Cryo-pumping (space chambers, fusion reactors, condensation of air components, etc.)</li> <li>→ Refrigeration of superconducting power generators</li> </ul>	customized
Refrigeration @ 25 K–80 K	<ul style="list-style-type: none"> <li>→ High-temperature superconductivity</li> <li>→ Cooling of HTS cables, motors, transformers, etc.</li> </ul>	customized

# Engineering excellence – every step of the way

Linde Kryotechnik AG and Linde Cryogenics are the world's leading cryogenic technology and engineering companies, bundling low-temperature know-how and cutting-edge technologies with value-add services for scientific research and industrial organisations around the globe. Highly skilled Linde teams partner with customers to develop and deliver innovative cryogenic solutions for liquefaction and refrigeration systems at temperatures below 80 K (-193°C).

Linde Engineering is a leading player in the international plant engineering business, covering every step in the design, project management and construction of turnkey industrial plants. Drawing on its extensive, proven process know-how, this division sets the standards for innovation, flexibility and reliability with ground-breaking concepts and a dedication to engineering excellence.

## Core competencies of Linde Kryotechnik AG and Linde Cryogenics:

- Helium liquefiers
- Helium refrigerators
- Helium recovery systems
- Hydrogen liquefiers
- Storage and distribution systems
- After sales services
- Special cryogenic plant engineering services

## Get in touch – find the best solution.

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