

Exploring Fullcryo's Helium Refrigeration and Liquefaction Platform

High-performance helium refrigerators and liquefiers have become indispensable core cryogenic infrastructure for delivering ultralow-temperature operating conditions worldwide. This is amid a tightening global helium supply and the rapid expansion of frontier low-carbon industries including fusion energy, quantum computing, and commercial helium recycling. Built on decades of advanced proprietary cryogenic technologies, Fullcryo USA provides standardized and customized helium refrigeration and liquefaction turnkey solutions for global resource recycling and cutting-edge scientific and industrial applications.

Fullcryo's core helium cryogenic product lineup covers two mainstream ultralow-temperature grades: 20 K and 4.5 K. Both systems adopt fully modular, skid-mounted configurations to enable flexible on-site integration, rapid commissioning, and minimal site adaptation for global projects.

20 K Helium Refrigeration Series

Based on the mature reverse-Brayton cryocycle, Fullcryo's 20 K refrigeration portfolio includes both standard and custom-engineered units. Standard cooling capacity ranges from 500 W to 3,000 W @ 20 K, while custom high-capacity models exceed 3,000 W @ 20 K. Field-proven benchmark units cover 10 kW @ 20 K large-scale systems and 200 W @ 20 K compact units for laboratory scenarios.

The complete system consists of an oil removal unit, vacuum-insulated cold box, PLC intelligent control cabinet, and helium buffer tank. Inside the cold box, multi-stage heat exchangers, radial inflow turbo expanders, and room-temperature adsorption modules enable efficient closed-loop helium circulation. Cold helium absorbs process load heat and returns to the cold box for cyclic reuse; ensuring high efficiency and stable long-term operation. Typical applications



A helium liquefaction system. Credit: Fullcryo USA

include aerospace environmental simulation, large-scale aerospace testing, and spallation neutron source facilities.

4.5 K Helium Refrigeration and Liquefaction Series

Fullcryo's 4.5 K helium refrigeration and liquefaction systems feature a full-spectrum product matrix with standardized and customizable cooling capacities. The product range covers standard refrigeration power of 160 W to 1,400 W @ 4.5 K and custom high-power units exceeding 1,500 W @ 4.5 K, alongside standard liquid helium liquefaction capacity of 40–400 L/h and tailor-made high-capacity systems above 400 L/h. Built with skid-mounted modular architecture, closed-loop ultrastable cryogenic operation and industry-leading near-zero helium loss performance, this 4.5 K series delivers turnkey, low-maintenance cryogenic solutions for global advanced scientific research, fusion energy, quantum technology, and commercial helium resource utilization, serving research institutions and industrial clients worldwide.

Global Large-Scale Scientific Research Infrastructure

What do worldwide high-energy particle accelerators, synchrotron radiation facilities, spallation neutron sources, and steady-state high-magnetic-field laboratories have in common? They all require continuous and precise 4.2 K ultralow-temperature conditions to sustain the stable operation of superconducting magnets, radio-frequency cavities, and high-sensitivity cryogenic detection systems. Fullcryo's 4.5 K closed-cycle refrigeration systems provide long-term, high-precision cooling for large-scale magnet assemblies; while matching liquefaction units automatically supplement helium boiloff to guarantee non-stop operation of flagship scientific facilities. The compact, modular design enables flexible integration for both newly constructed and upgraded cryogenic stations, fully complying with the rigorous low-temperature stability and low-loss operational standards of international big-science projects.

Fusion Energy Research and Commercial Fusion Projects

Tokamak fusion devices and next-generation commercial fusion reactors depend on 4.2 K liquid helium to maintain the superconducting state of core components, including toroidal field coils, poloidal field coils, and superconducting feed systems. Fullcryo delivers graded professional cooling solutions for diverse fusion research scenarios. Standard 160–1,400 W refrigeration units are ideal for medium and small-scale fusion experimental platforms, while customized high-cooling-capacity systems over 1,500 W cater to large-scale national and international fusion test facilities. Integrated with advanced on-site helium re-liquefaction technology, the systems effectively reduce helium consumption and operational costs, supporting long-duration, stable operation for global fusion energy R&D, and industrialization projects.

Quantum Technology and Ultrasensitive Precision Detection

Superconducting quantum chips, superconducting quantum interference devices (SQUIDs), ultraweak magnetic monitoring systems, and deep-space astronomical infrared detectors all rely on stable 4.2 K cryogenic environments to suppress thermal noise and maximize detection and computing accuracy. Fullcryo's compact skid-mounted 4.5 K refrigeration systems are widely applicable to university quantum laboratories, commercial quantum computing R&D centers, and global astronomical observatories. The independent on-site liquefaction capability enables self-sufficient liquid helium supply for research facilities; significantly improving experimental continuity and mitigating operational risks and costs associated with global helium supply chain fluctuations.

Commercial Helium Extraction and Global Helium Resource Utilization

Natural gas helium extraction is a core, stable source of commercial helium resources across the globe. Fullcryo's high-efficiency 4.5 K helium liquefaction systems



A 4,000 W x 4.5 K Helium Refrigeration unit. Credit: Fullcryo USA



A 350 L/h helium liquefaction system. Credit: Fullcryo USA

are specially optimized for crude helium purification and liquefaction in natural gas processing facilities. Through standardized deoxidation, low-temperature adsorption, and precision impurity removal processes, raw crude helium is deeply liquefied into high-purity commercial liquid helium that conforms to universal international industry standards. Standard 40–400 L/h liquefaction units adapt to medium and small-scale helium recovery projects, while customized ultrahigh-capacity systems above 400 L/h serve large-scale global helium industrial bases, providing reliable, cost-effective on-site liquid helium production solutions for

international energy and helium resource developers.

All Fullcryo cryogenic systems feature distinct technical advantages including fast startup and shutdown response and emergency operation that requires no liquid nitrogen pre-cooling. Beyond standalone equipment supply, Fullcryo USA offers full-lifecycle global services covering cryogenic system layout design, precision piping fabrication, automatic control system integration, on-site commissioning, and long-term operational maintenance for international clients. www.fullcryousa.com