CAMRT ACTRM

Canadian Association of Radiologists
L'Association canadienne des radiologistes

POSITION STATEMENT

Establishing a Sustainable and Secure Canadian Helium Supply

MAY 2023

EXECUTIVE SUMMARY

- Ongoing liquid helium supply disruptions in Canada have a detrimental impact on Canadian healthcare, scientific research, and Canadian industry.
- We must establish a sustainable, stable, and secure helium (liquid and gas) supply in Canada to overcome these impacts.
- Short and medium-term investments in helium recovery systems would permit the re-use and conservation of helium at a local level.
- Long-term investment in large-scale Canadian helium purification and liquefaction facilities would support a "Made in Canada" solution for helium production, distribution, and self-sustainability.

THE ISSUE

In the past twenty years, there have been numerous disruptions to the global supply of helium.[1,2] Shortages have been brought about by unreliable production and further exacerbated by extended plant maintenance outages, while supply chains have been interrupted by geopolitical issues including COVID-19 and international conflict.[3] These issues have been a frequent threat to the medical, research, and industrial fields that depend on a consistent supply of liquid helium to function optimally. The diminished availability of helium presents unique challenges and risks, it also creates supply-and-demand issues that cause significant fluctuations in helium pricing. Persistent price increases and disruption in the supply of helium have negatively impacted Canadian helium users.[4] These disruptions provide an opportunity to develop a national helium supply chain, which will mitigate the risk of ongoing and future global supply chain challenges and price fluctuations for Canadian helium users, while simultaneously promoting the environmental sustainability of the system through funding support for helium recycling and recovery systems.

RECOMMENDATIONS

The Canadian Helium Users Group (CHUG) recommends:

1. That the federal government, working in collaboration with provincial governments and industry, expedite the development of a large-scale Canadian helium purification and liquefaction facility to complete a sustainable national helium supply chain.
2. That the federal government creates a funding mechanism so that laboratories and institutions can access funds to install helium recovery systems and to create and/or optimize existing local reliquefication systems to promote environmental sustainability.
3. That the federal government adds helium to the list of urgent mineral shortages to be addressed within the federal budget.

WHAT IS HELIUM AND WHY IS IT IMPORTANT?

Helium is a precious, non-renewable resource that is a side-product of natural gas production and is used in medical, industrial, and research applications. Its primary use in healthcare settings and research applications is to supercool the large superconducting magnets used in medical magnetic resonance imaging (MRI) scanners and in nuclear magnetic resonance (NMR) spectrometers. MRI and laboratory use of helium account for roughly 26% of total worldwide consumption (see Figure 1).[5] Helium is also used in industrial welding, semiconductor and fibre optic manufacturing, leak detection, military, and space applications, and in low-temperature research that must be carried out at just above absolute zero or minus 268.9 degrees Celsius. There is no replacement for liquid helium. It is such an important resource that the Canadian Government has listed helium as one of the 31 minerals deemed critical for the sustainable economic success of Canada.[6]

GLOBAL HELIUM SUPPLY CHAIN

The helium industry is very concentrated, with producers primarily located in the United States, Russia, Qatar, and Algeria. The United States Bureau of Land Management had previously supplied up to 40% of the world's helium via its Federal Helium Reserve, which historically set benchmark prices at public auctions. However, a 1996 Privatization Act and subsequent legislation[7] amended in 2013 resulted in the phased disposal of the reserve, caps on the percentage of helium that could be auctioned off each year, and led to significant increases in the price of helium.

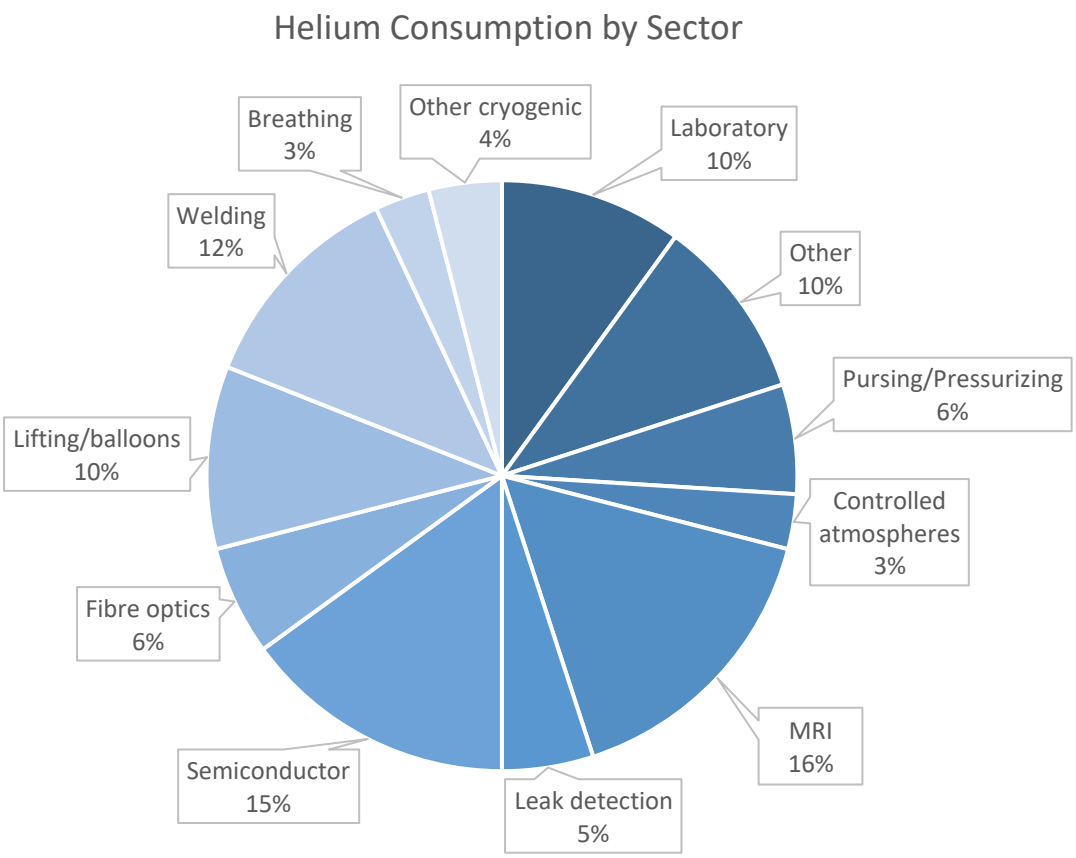

Figure 1: Helium consumption by sector (Kornbluth Helium Consulting, n.d., as cited in Saskatchewan Canada, 2015, page 3).

CURRENT CANADIAN PRODUCTION AND DISTRIBUTION CAPACITY

Helium production in Canada currently accounts for 1% of the global helium supply,[8] and the United States Geological Reserve estimates that Canada has the fifth-largest helium resource in the world.[9] Three major firms combined produce 60 million cubic feet of helium per year in Saskatchewan.

Recently in Saskatchewan, several new sites have been developed for helium capture,[10] and North American Helium has built a system to purify the gas, which is then shipped to the US for liquefication and distribution into the global market. However, Canada currently does not have an industrial-sized liquefication hub. This puts Canadian consumers in a difficult position as it has often been challenging to obtain liquefied helium from the United States due to the global demand and supply chain interruptions exacerbated by the pandemic. In some instances, pricing is elevated to cover cross-border transportation costs. Similarly, one also assumes that there is an increased carbon footprint associated with multi-site/multi-national chain-of-production practices. Currently, there are 4 major distributors of helium in Canada, who obtain their helium from the United States, Qatar, and Algeria (Linde/Praxair, Air Liquide, Messer, Air Products). As a result of the Russia/Ukraine war, many countries are unable to access helium from Russian suppliers who produce significant amounts of the global helium supply.

WHAT DO WE USE HELIUM FOR?

Medical Imaging

In Canada, medical imaging is a vital aspect of the patient care journey, and is at the heart of medical practice, facilitating the early detection of diseases and improving patient outcomes. Magnetic resonance imaging (MRI) is a non-invasive medical imaging test that uses powerful magnets and radio waves to produce detailed images of almost every internal structure in the body, including the organs, bones, muscles, and blood vessels. In 2019-2020, more than 2.3 million MRI examinations were conducted using the 378 MRI scanners distributed across Canada,[11] and the demand for medical imaging is expected to increase over time.[12,13]

Helium is essential to the operation of MRI scanners, as it permits the supercooling of the coils of wires that generate the magnetic field. Without helium, superconducting magnets cannot operate and would be unable to serve the needs of Canadian patients and healthcare providers.

Hospital Intensive Care Units (ICUs)

In patients, heliox (mix of helium and oxygen) breathing reduces the air-flow resistance within the bronchial tree and improves pulmonary gas exchange efficiency. Helium is used mixed with oxygen in Intensive Care Units (ICUs) for patients presenting obstructive airway diseases including respiratory distress syndrome, narrow endotracheal tubes, asthma, pneumonia, bronchiolitis, croup, pulmonary rehabilitation as well as acute vocal cord dysfunction, nebulized drug delivery, adjuvant for conscious sedation, awake intubation, and much more. Heliox is also used for patients presenting acute lung injury and acute exacerbation of chronic obstructive pulmonary disease.

NMR Research

Nuclear magnetic resonance (NMR) spectroscopy provides exquisitely sensitive chemical information of a sample with atomic scale resolution. NMR spectroscopy is critical in life science, chemistry, engineering, and physics research programs. NMR spectroscopy is vitally important for many diverse applications including: (1) drug discovery and design of new medicines; (2) metabolomics – complex mixtures of metabolism products are analyzed to determine the extent of diseases; (3) protein structure and dynamics – to learn about structure and function in healthy systems and in diseased patients; and (4) materials research such as batteries, polymers, clays, etc., to understand how to improve these technologies and to discover new ones. In addition to providing detailed structural information about a sample, NMR spectroscopy is responsive to real-time changes in a sample, making it a uniquely capable technique for studying kinetics and dynamical processes.

A recent survey conducted by the Canadian Helium Users Group (CHUG) distributed to 70 research facilities with more than 235 NMR magnets found that 72% of facilities had difficulty procuring liquid helium within the last nine months. In addition to being placed on “allocation,” meaning that they will

receive less helium than they require, many labs have been seeing unscheduled price increases from 25% to as much as 400%. In addition, two sites are considering decommissioning large magnets, and ten are considering decommissioning smaller magnets due to the current helium supply crisis.

Of the sites that reported, 5,195 highly qualified personnel (HQP), trainees including undergraduate students, graduate students, and post-doctoral fellows rely on NMR data to carry out their research. These researchers could not continue with their work if spectrometers in their institutions' NMR facilities were closed down due to difficulty obtaining liquid helium. The Canadian government supports NMR and MRI research in the sciences and social sciences via Tri-Council (CIHR[a], NSERC[b], SSHRC[c]) and other research grants totalling millions of dollars.

NO HELIUM, DEAD MAGNETS

Without an adequate supply of liquid helium, more than 610 MRI and NMR magnets located in Canadian healthcare institutions and universities are at risk of a "quench", which effectively shuts them down. An unplanned and uncontrolled quench due to helium loss can cause significant damage or even destroy the magnet. Unfortunately, it is not like unplugging an electrical device. This is a major concern, with the cost of a new unit ranging from $1.2 to 10 million.

Even if the unit can be saved, it would cost between $30,000 and $120,000 to restart with an additional loss of approximately 5 years' worth of normal helium operations. Additionally, the specialized equipment and trained service personnel required to re-energize these powerful magnets are in extremely limited supply. If multiple units are down simultaneously, the timeline to re-energize these magnets would increase exponentially. The impact of two to three months of magnet downtime would also have a significant impact on patient care and research projects. In a clinical environment, 240-350 examinations would be lost over the course of a two-week shutdown, causing additional stress to an already stretched medical service. Furthermore, emergent patients would not have access to MR imaging which would delay the early detection of disease.

MADE IN CANADA SOLUTIONS FOR ENVIRONMENTAL SUSTAINABILITY

Helium is a precious, non-renewable resource. Fortunately, many of the necessary steps and investments required to support the Canadian helium industry and to complete a national helium supply chain will also contribute to environmental sustainability.

Create a closed national supply chain

The Government of Saskatchewan's "Helium Action Plan: From Exploration to Exports" outlines their innovative plan to explore, produce, process and export helium.[5] The plan strives to have Saskatchewan

[a] Canadian Institutes of Health Research
[b] Natural Sciences and Engineering Research Council of Canada
[c] Social Sciences and Humanities Research Council

produce 10% of the world's helium by 2030. If these goals are achieved and liquefication available, this plan would support all Canadian helium needs and provide a significant surplus for export.

Grants to explore sites and produce helium are already bearing fruit with the North America Helium (NAH) plant in Battle Creek recently becoming operational, and, by the end of 2022, NAH had five sites online. An additional grant to develop an industrial scale liquefication hub would add the potential to optimize the helium supply in Canada.

Ultimately, having a national production facility to fill the gaps during times of crisis would mitigate the remaining risks associated with limited supply. This approach would be effective at a national level and would help to protect significant research investments that have already been made by Canadian and Provincial Governments.

Reduce greenhouse gas emissions at the source

One major advantage of Saskatchewan helium is that the reserves are not tied to natural gas wells, so drilling for helium does not produce methane, a known greenhouse gas. Recycling liquid helium can drastically reduce the amount of liquid helium used by magnets, from being lost to the atmosphere. As managers of these instruments, we are committed to preserving the environment.

Invest in recycling

Helium recycling can significantly reduce the consumption of this non-renewable resource, and programs are already in place at some of the larger Canadian research universities. Unfortunately, smaller institutions cannot afford the capital costs to purchase these recycling systems. Helium recovery systems can save as much as 5,000 litres of liquid helium per year for a large institution, and the systems pay for themselves within 2-3 years. In the US, the NIH[d] funded 26 helium recovery units (22 new, four upgrades) in 2019, and in 2020, a further 18 were funded, at a total investment of $8.6 million USD.

The return on investment (ROI) for installing recovery and liquefaction equipment is quite attractive at mid- and large-sized institutions. However, the up-front expense of installing the equipment is significant
and may be prohibitive. Federal subsidies to offset initial costs would allow institutions to pursue recovery equipment for the purposes of:

1. Conserving a non-renewable resource,
2. Reducing operational costs (i.e., by defraying ever-increasing helium prices),
3. Mitigating risks associated with lost instrumentation during times of crisis.

[d] National Institutes of Health

Savings associated with reduced helium costs and lost instrumentation could be distributed back to the universities and institutions involved, which would help to improve their financial stability, self-sufficiency, and ultimately reduce reliance on government funding in other areas.

ROIs can be further improved upon if smaller local institutions are incentivized to install gas collection and purification equipment locally for liquefication elsewhere. This 'hub-and-spoke' approach would further leverage government investment in liquefication equipment by allowing liquefaction hubs to re-sell liquid helium back to spoke facilities and attain financial sustainability at the operational level.

ABOUT US

The **Canadian Helium Users Group (CHUG)** includes individuals and associations concerned with the helium supply in Canada. We are the managers, technicians, and researchers who operate and maintain Nuclear Magnetic Resonance (NMR) spectrometers and Magnetic Resonance Imaging (MRI) instrumentation throughout Canada. https://cnsp-rcps.ca/technology-node/chug/

The **Canadian Association of Medical Radiation Technologists (CAMRT)** is the national professional association and certifying body for radiological, nuclear medicine and magnetic resonance imaging technologists and radiation therapists. Recognized at home and internationally as a leading advocate for the profession of medical radiation technology, the CAMRT is an authoritative voice on the critical issues that affect its members and their practice. Established in 1942, the CAMRT today represents over 11,000 members. www.camrt.ca

The **Canadian Association of Radiologists (CAR)** is the national specialty society for radiologists in Canada. We are committed to promoting the highest standards of patient care, lifelong learning, research, and helping radiologists contribute to the very best health care for patients. Our mission is to be the national voice for medical imaging excellence in patient care. www.car.ca

For more information, please contact:

- CHUG - chug@nmrx.ca
- CAMRT - professionalpractice@camrt.ca
- CAR - info@car.ca

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