

Helium users are at the mercy of suppliers

ALYSSA HONG

Researchers seek government help in addressing supply shortage as prices are expected to continue soaring.

“We’re in a crisis mode” when it comes to helium, says William Halperin, a physics professor at Northwestern University. A shortage of the inert gas and a rise in its price are plaguing experimental physicists and chemists whose research requires low temperatures. Although helium prices and availability are perennial gripes in the community (see *PHYSICS TODAY*, January 2017, page 26), in recent months the supply has become so restricted by growing industrial demand that users have been forced to de-commission superconducting magnets, a measure that could permanently render some useless.

In the last year, there have been three “shocks” to the helium supply, says Sophia Hayes, a Washington University in St. Louis (WUSTL) chemistry professor who studies such topics as spin orientation in semiconductors and new materials for capturing carbon dioxide for sequestration. The supply has become so scarce and prices so high that Hayes has shut down two of six NMR spectrometers in her laboratory. The instruments are a standard tool for university chemistry departments, and many institutions have half a dozen or more of them. At the core of each is a high-field superconducting magnet that must at all times be kept cooler than liquid helium’s boiling point of 4.2 K.

If helium levels get too low, magnets will warm to their resistive state. The conversion of stored current to heat could damage the coil irreparably or prevent magnets from reattaining their original field strength. It’s a slow and expensive process to return the magnets to their superconducting mode, and they can require 1000 liters of helium—costing up to \$25 000 at today’s prices, says Halperin.

Helium is a nonrenewable resource, and liquid helium has a limited shelf life. But distributors have recently been unwilling to supply it on the usual short notice, says Halperin. Unless, that is, customers are willing to pay an emergency fee of \$25–\$50 a liter.



“My situation is analogous to treading near the edge of a treacherous cliff,” says Joseph DiVerdi, a Colorado State University chemist. He maintains a 30-year-old 8.5 tesla NMR magnet that requires 60 liters of liquid helium every eight weeks. He’s dealt with “enormous” price increases and stretched-out lead times amid threats of rationing. “I harbor fears about timely availability,” he says. “The day my supplier fails to deliver on the schedule mandated by the magnet itself is the day that our impactful program goes down, permanently.”

Helium prices vary widely, depending on volume, region, the number of delivery points to be served at each institution, and the existence of long-term contracts. The University of California (UC) has one contract, with New Jersey-based Matheson Tri-Gas, that covers its entire sprawling system. Stuart Brown, a UCLA physicist, says he pays in the low teens per liter for the helium that cools the three superconducting magnets he uses to explore the properties of exotic quantum materials, superconductors, and frustrated magnets.

But Matheson began rationing helium last fall. Its primary source, Exxon-Mobil's processing facility in Shute Creek, Wyoming, will be partially shut down for maintenance for an extended period in the summer. Matheson may have to declare force majeure on UC's contract, and other suppliers are also rationing helium to their customers as growing demand for the gas outstrips production. The upshot: Users will have to scramble to find alternative sources, at a premium price. "The chemists are particularly panicked," says Brown. For them, shutting down instruments would hinder graduate student education and compromise researchers' competitiveness on grants.

A 2016 report from the American Physical Society (APS), the American Chemical Society (ACS), and the Materials Research Society estimated that 400 US research groups, mostly in the physical sciences, rely on liquid helium for experiments. In addition, research groups that use liquid-helium-enabled instrumentation, such as NMR spectrometers and superconducting quantum interference devices, number in the thousands.

The situation at WUSTL has reached the point where helium users have just instituted a triage system: Applications that must stay cold continuously, such as NMR spectrometers and particle accelerators, get first dibs. Urgent experiments go next, followed by those that could be put off for a few weeks or months if necessary.

Hayes has compiled anecdotal reports of the helium shortage from fellow researchers nationwide—all of them anonymized and with their suppliers' names removed. A user at a Maryland university reported having to decommission a magnet last July due to lack of helium. An NMR researcher in Colorado has a magnet that requires 250 liters every four weeks; a recent 50% price increase brings the annual cost for that magnet alone to \$56,000.

A researcher at a New York university said the cost of replenishing an NMR magnet with 45 liters of helium every 13 weeks had jumped 40% over two months, from \$850 to \$1200. An NMR user in Texas said they were looking into sharing 100-liter dewars—the smallest amount that the vendor will supply—with another nearby school that also needs just over half of a dewar to fill its machine. If forced to shut the magnet down, the researcher said, the region would lose its

only solid-state, publicly available spectrometer, and with it the ability to train undergraduates.

Crunch to continue

Research makes up a small fraction of total US helium consumption, just 8%, according to Intelligas Consulting, a market research firm. Larger uses include magnetic resonance imaging, weather-balloon and other lifting, electronics manufacturing, materials analysis, and instrument calibration. Phil Kornbluth, a helium market consultant, says total US demand is a little more than 56 million cubic meters (mcm) annually—about one-third of world consumption. With an annual output of about 96 mcm, the US is the world's largest producer.

Kornbluth estimates the current deficit of supply worldwide at around 10%. Some researchers report a level of rationing greater than that, he says, because the shortage has not affected all the major suppliers equally. Globally, supply has been nearly static. Consumption has grown in the aerospace sector and in the East Asian semiconductor industry, particularly in China, which is second only to the US in helium consumption.

Helium prices probably have yet to peak, says Kornbluth. The supply crunch should begin to ease next year when a new helium purification and liquefaction facility in Qatar is expected to come on line and add 11 mcm to the global supply. Russian energy giant Gazprom has a new source in eastern Siberia that is expected to begin operation in 2021 and eventually supply up to 55 mcm per year. A second, smaller new Russian source, also in eastern Siberia, will start production around the same time. A major helium prospect in Tanzania may be developed if helium prices remain high.

Another key cause of the shortfall is the continued decline in the ability of the US Bureau of Land Management (BLM), which manages the federal helium reserve in Amarillo, Texas, to deliver helium to private suppliers. For a decade or so beginning in 2004, the BLM was selling 59 mcm annually. But as the crude helium (50–70% pure) is withdrawn from the underground storage formation, the pressure drops, slowing extraction. According to the BLM, deliveries will be limited to around 20 mcm this year, a little more than half the 2016 amount.

After passage of 2013 legislation to

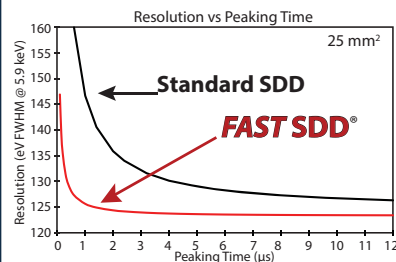
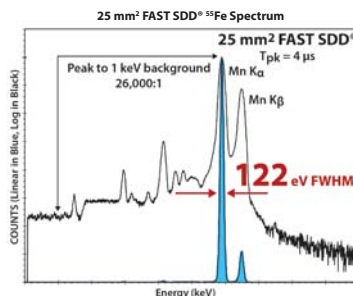
Ultra High Performance Silicon Drift Detectors

FAST SDD®

Count Rate = >1,000,000 CPS

The True State-of-the-Art

- In-house manufacturing
- Lower noise
- Lower leakage current
- Better charge collection



Options:

- 25 mm² collimated to 17 mm²
- 70 mm² collimated to 50 mm²
- Windows: Be (0.5 mil) 12.5 μm, or C Series
- TO-8 package fits all Amptek configurations



Please see our web site for complete specifications and vacuum applications



AMPTEK Inc.
sales@amptek.com
www.amptek.com

ISSUES & EVENTS

privatize the reserve, the BLM began holding annual auctions of helium, accompanied by sale of a smaller quantity at a fixed price. The final public auction and sale, totaling 8.5 mcm, was held last summer, and sales are now restricted to federal users. Universities that use at least 7500 liters of helium for federally sponsored research are eligible for reserve helium. But there are no restrictions on the price that distributors can charge for refining and liquefying the 99% pure helium product research users need.

As mandated by the legislation, the sale of all the government's reserve assets must occur no later than 30 September 2021. At that point, an estimated 68 mcm of helium will remain in storage, says Sam Burton, manager of the BLM's Amarillo Field Office. The terms under which that helium is to be sold have yet to be worked out.

Increasing leverage

The helium market is largely opaque, with most of the world supply controlled by a handful of vendors that include Air Products, Air Liquide, Matheson, Linde, and Praxair. Contracts typically prohibit customers from discussing the price they



THE CENTRAL HELIUM FACILITY at Northwestern University can liquefy up to 50 liters per day from instruments across the campus.

pay for their helium. Suppliers who were contacted for this story did not return requests for comment. Linde and Praxair just completed a merger, which resulted in the mandated divestiture of their helium assets. Germany's Messer Group has acquired a large portion of those as-

sets and will become a new US supplier.

Because of their large numbers and small individual requirements, researchers are largely at the mercy of their suppliers. To increase their leverage, APS and ACS in 2016 organized a one-year pilot purchasing arrangement for a small number

SINGLE PIVOT-POINT GALVANOMETER

An alternative to traditional two-mirror galvo scanners.

- Larger field-of-view than 2D scanners simplifies processing of large parts
- Minimal spot distortion over the entire field-of-view minimizes processing variation for highest quality laser-processed parts
- Air and water cooling options improve thermal stability and long-term accuracy
- Mirror surface treatments for a variety of laser wavelengths



Visit aerotech.com or Call 412-963-7470

AH1218B-LPM

of universities through the Defense Logistics Agency (DLA), which had long been purchasing helium for other federal purposes. The subsequent two-year supply contract negotiated by the DLA expired on 31 January.

No vendor would offer the DLA a new two-year pact, and only at the last minute did a supplier agree to a one-year contract extension—at nearly double the price of the expiring arrangement, says Mark Elsesser, manager of science policy at APS. Multiple sources say the offered price under the one-year DLA deal is \$21–\$23 per liter, compared with around \$12 previously. Nearly all the 20 universities who signed up with the DLA have agreed to the price, Elsesser says.

In December, APS and ACS arranged conference calls between helium users and staffers on the House of Representatives committees on Science, Space, and Technology and on Natural Resources. In February, researchers conferred with the White House Office of Science and Technology Policy (OSTP).

An OSTP spokesperson declined to comment on the talks but noted that helium was identified on a list of critical minerals published last May by the Interior Department in response to an executive order by President Trump. That directive calls for a report assessing progress with recycling and finding technological alternatives to the listed minerals, strategies for reducing their consumption, and other steps. The report, which was supposed to be completed last summer, has yet to be released.

Reducing demand

A partial solution to alleviate the shortage is to recapture and liquefy the helium that boils off. The cost of a small-scale liquefier, capable of producing 20 liters a day, is \$100 000 to \$150 000, says Halperin. Few principal investigators can afford such an up-front cost. NSF has a \$1 million dedicated program to pay for a half-dozen of its largest helium-consuming grantees each year to acquire liquefiers.

At WUSTL, the four NMRs that Hayes has kept cooled require a total of 2200 liters of helium annually. Even with a subsidy from the chemistry department, her lab's annual helium bill is nearly \$39 000. Hayes says she could cut that bill to \$7700 at current prices—excluding the initial investment and annual operating costs for the system—with a liquefaction system that recycles with 80% efficiency. WUSTL has

committed funding to liquefy enough helium for at least two machines.

Commercially available “dry” refrigerators require no helium, but the vibration they produce can make them unsuitable for the fine-resolution measurements made with NMR spectrometers, says Hayes. They also have large power requirements.

Halperin manages a central helium liquefying facility for Northwestern. It's one of just a few facilities in the country where helium is piped in from users across the campus. Even with that capa-

bility, Northwestern requires as much as 10 000 liters of additional liquid helium per year. Halperin's own lab recycles with 95% efficiency; 65% is recovered campus-wide because some researchers use helium inefficiently, he says. Such central systems, which can produce 40–50 liters per day, can cost several million dollars.

In the meantime, more efficient use of helium by researchers would help. In Europe, says Hayes, “they protect every puff of gas they can get out of a dewar. Why do we do it differently?”

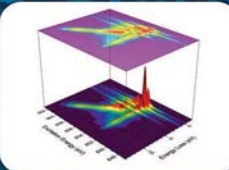
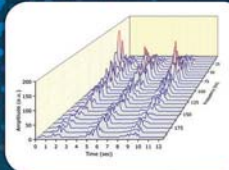
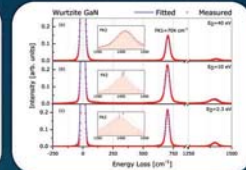
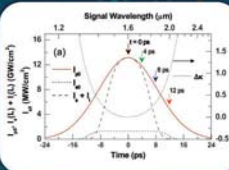
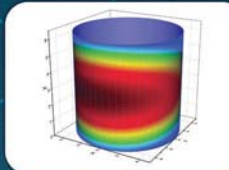
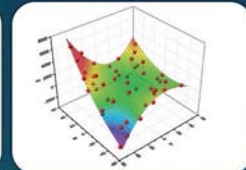
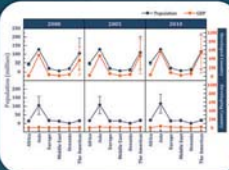
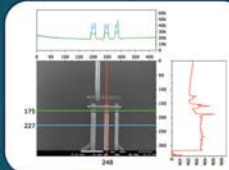
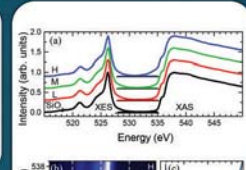
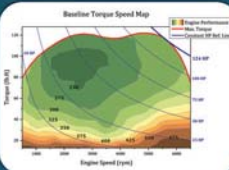
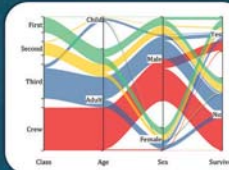
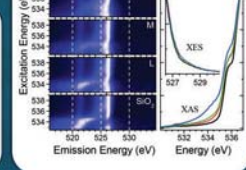
David Kramer **DT**

New Version!



ORIGIN® 2019

Graphing & Analysis

Over 75 New Features & Apps in Origin 2019!

Over 500,000 registered users worldwide in:

- 6,000+ Companies including 20+ Fortune Global 500
- 6,500+ Colleges & Universities
- 3,000+ Government Agencies & Research Labs

For a **FREE** 60-day evaluation, go to OriginLab.Com/demo and enter code: 2876



25+ years serving the scientific & engineering community