Environment

Helium-3 Shortage

A vanishing stock of the isotope used by research and industry catches most users by surprise

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May 10, 2010 • 9 min read
A version of this story appeared in **Volume 88, Issue 19**

SAVE

BORDER PATROL

Large radiation portal systems with 3He detectors (tall yellow panels) are used to check for smuggled nuclear material. | Credit: SAIC

A serious supply shortage of the isotope helium-3 is creating havoc among low-temperature physics researchers, medical imaging scientists, oil and gas drilling companies, and national security chiefs. The problem is that the only supplier is the federal government, and it is almost out of the isotope.

Until just about a year ago, the supply of ^{3}He appeared to be fine. Scientists were getting all they needed, and makers of neutron detection devices, which require the largest amounts of ^{3}He for operation, were ramping up because of ballooning demands from the Department of Homeland Security (DHS). Then the isotope's supply just disappeared.

The story behind this sudden turn of events was the topic of an April 22 hearing convened by the House Science & Technology Committee's Subcommittee on Investigations & Oversight. Pulling all the stakeholders together, subcommittee Chairman Brad Miller (D-N.C.) tried to find out just what had happened. "Looking back, it is clear that the shortage was inevitable," Miller said at the hearing. "It is astonishing that the Department of Energy did not see this coming."

Miller called out DOE because it handles the nation's ^{3}He supply—including production and sales—through its Isotope Development & Production for Research & Applications Program. The nonradioactive, nonhazardous isotope is a by-product of the radioactive decay of tritium and is collected in the U.S. from the refurbishment and dismantling of the nation's tritium-containing nuclear stockpile. The U.S. stopped making tritium for nuclear weapons in 1988, so the stockpile is of limited size. Helium-3 is separated from tritium stocks at the Savannah River Site, in South Carolina, and then made available to companies, resellers, and researchers through annual auctions.

According to DOE, since 2003, it has sold more than 200,000 L of ^{3}He. On the basis of such sales, the agency predicts that demand will be more than 70,000 L per year through 2013. The total available supply of ^{3}He, however, was down to 47,600 L in 2009, and the projected annual production is only 8,000 L.

The isotope is in sudden demand by DHS because the gas is the most sensitive material used for detecting neutrons, which are given off by nuclear material. A typical neutron detector consists of a metal tube filled with ^{3}He to which a voltage is applied. When a neutron strikes a ^{3}He atom, sufficient energy is released so that a measurable voltage change occurs. Because of national security concerns since Sept. 11, 2001, over illegal nuclear material being smuggled into the U.S., DHS has installed hundreds of radiation portal monitors around the nation that use ^{3}He.

At the House hearing, witnesses from both DOE and DHS took little responsibility for the isotope shortfall and focused instead on their response once the problem was recognized sometime in 2008. William F. Brinkman, director of DOE's Office of Science, told the subcommittee that his office and the National Nuclear Security Administration began explaining shortages to ^{3}He users in July 2009 and that DOE had formed an Interagency Policy Committee to investigate ways to decrease ^{3}He demand. As a result, Brinkman said, ^{3}He demand for fiscal 2010 dropped from a projected 76,300 L to just 14,557 L. The reduction resulted from an agreement between DOE and DHS that no new ^{3}He would be used for radiation portal monitors, the largest sink for the isotope.

DHS claims it only realized there was a ^{3}He supply problem when it heard about delays from a supplier of neutron detection tubes in 2008. DHS formed its own Interagency Integrated Product Team, which included DOE as well as the Department of Defense, to assess the impact of the shortage and to make sure available supplies are properly distributed, according to William K. Hagan, acting director of the DHS Domestic Nuclear Detection Office. "The team explored opportunities to manage the existing ^{3}He stockpile, investigate alternative technologies to replace ^{3}He for neutron detection, and examine policy issues that impact use, distribution, and production," Hagan said.

However, none of this activity has been of much comfort to those outside the government using ^{3}He who repeatedly told the subcommittee that their situation was critical. William P. Halperin, a physics professor at Northwestern University doing low-temperature research, said, "Shortages of ^{3}He, driven by increased homeland security demands and decreased production capability, are already creating major difficulties in areas of research.” Halperin bluntly noted that much of the research in areas such as advanced materials, superconductivity, and magnetism will cease entirely without supplies of ^3He. He also said that he has not been able to get even 20 L of ^3He for his research this year and that DOE has not responded to his requests for information. The situation is hindering his research and putting his National Science Foundation support in jeopardy, he added.

Medical research using ^3He is also facing problems. According to Jason C. Woods, an assistant professor of radiology, physics, and molecular biophysics at Washington University in St. Louis, the lack of ^3He is stifling developments in the study of pulmonary disease. By using ^3He magnetic resonance imaging, he said, “we are at the cusp of leading pulmonary medicine to a renaissance of new drug development and image-guidance surgical interventions for various lung diseases.” But by March of last year, Woods was told by his supplier, Spectra Gases, that there was no more ^3He available for medical applications.

Another area negatively impacted by the shortage of ^3He is the oil and gas drilling industry, according to Richard L. Arsenault, corporate radiation safety officer for ThruBit, which makes devices that help evaluate reservoirs during drilling. Using ^3He detectors, the devices measure and record porosity—called logging—which indicates whether a reservoir has oil, gas, or water. The entire drilling industry relies on ^3He neutron detectors, Arsenault said at the hearing. The lack of ^3He is already causing a business slowdown, and no alternative technologies are available.

It was generally recognized at the subcommittee hearing that the demand by DHS for hundreds of large radioactivity portal monitors installed internationally and at U.S. ports and border crossings has depleted the DOE’s ^3He stockpile. Although no specific amount of the isotope used for these portals was given, DOE’s Brinkman noted that the portal systems will account for up to 80% of future ^3He demand. These portals, which can be 18 feet high or more, use various amounts of ^3He; the largest ones are estimated to hold up to 100 L of the gaseous isotope each.

Thomas R. Anderson, product-line leader for GE Energy, which makes the neutron detectors for these portal monitors and for the oil and gas logging industry, told the subcommittee that the sudden drop in ^3He availability has led GE to speed efforts to find alternative neutron detection methods. The firm is also searching for ways to conserve the existing stocks of ^3He. One product under development is a detector that uses a tube coated with boron-10 and filled with an inert carrier gas to replace ^3He.

Anderson, along with the other ^3He users at the hearing, told the subcommittee that they had no idea of the extent of the supply problem until last year. One factor they cited for their lack of knowledge is that DOE apparently did not want the amount of ^3He stockpiled to be publicly known because of its relationship with the nuclear weapons stockpile. By keeping the amount secret, DOE led companies to believe that enough ^{3}He would be available when it was needed.

Another supply factor was a drop in ^{3}He marketed by Russia. Until last year, Russia was supplying the U.S. with about 25,000 L of ^{3}He annually, an amount also extracted from its nuclear weapons tritium supply. Russia stopped selling ^{3}He on the world market last year, it said, because it was saving the isotope for its own use.

It was apparent at the hearing, too, that the various stakeholders still need to improve their communication. A major issue for industry and researchers is the cost of ^{3}He. DOE's Brinkman indicated that ^{3}He has been selling for $350 to $400 per L. But the scientists who were in attendance said they were being quoted much higher prices.

Washington University's Woods said that he was quoted a price of $600 per L last year, a 500% increase over previous years. And Northwestern's Halperin said that he had seen prices from $800 to $2,000 per L, a 10-fold jump from earlier purchase prices and well outside his research budget. No reason for these price disparities was given, but the fact that the government thinks that ^{3}He is three to five times cheaper than it actually is indicates a disconnect between DOE and its customers.

No long-term solutions to this isotope shortage were presented at the subcommittee hearing, although DOE and DHS have cut demand for the next couple of years. But that does not help scientists like Halperin or small companies like ThruBit that cannot get the ^{3}He they need now.

At the hearing, the government did not seem open to making tritium again just for the production of ^{3}He, a process that would take several years to ramp up in any case. And although scrounging for ^{3}He to recycle from old equipment is already happening in the oil and gas industry, that process is not likely to yield enough material to sustain all companies.

Technological alternatives, such as GE's boron-10 portals, will help, but only for replacement of the larger neutron detectors. Another alternative discussed at the hearing involved using boron trifluoride as the gas for detecting neutrons. But BF_3 detectors seem impractical because the gas is less sensitive to neutrons than ^{3}He; it would take more detectors to achieve the sensitivity that current detectors already have. BF_3 is also toxic.

For most users, however, it appears as though there will be enough ^{3}He to get through the next couple of years—if government use estimates are correct and reductions are successful—but the outlook after that is up in the air.

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Chemical & Engineering News
ISSN 0009-2347