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Type them into questions box!

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This ACS Webinar will begin shortly...

Helium: An Irreplaceable Resource and Why We Must Conserve It

William Halperin
Orrington Lunt Professor of Physics, Northwestern University

Sophia Hayes
Professor, Department of Chemistry, Washington University

Will Hartwig
Science Policy Fellow, American Chemical Society

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He*lium

An Irreplaceable Resource and Why We Must Conserve It

Why are we here today?

- **Supply**  Now and in the future

- **Price**  Now and in future

- **What can we do?**
Early warnings of a helium shortage to the public...

Global Helium Shortage

Helium supply has always been a little up in the air (pun intended). With only three sources producing 75% of the world’s helium, any disruption causes a significant impact. Currently, helium supply is very low while demand is growing.

Wait, where does helium come from?
You might think we capture helium from the air, but it’s actually extracted from the ground. It’s typically found in small pools mixed with natural gas, then separated.

Who else uses helium?
Helium is very versatile. Besides making your voice sound like a chipmunk and lifting up party balloons, helium is used in creating many electronics, medical devices, and even rockets.

Can I still use balloons at my party?
Of course! If helium is not available, we have other options. You can create a balloon arch or balloon wall with latex and foil balloons as seen below — no need for helium; just some tape and creativity.

Because of this global helium shortage, fulfillment of balloon orders may be affected at your store. We’re working to replenish the helium at the affected stores as more supply becomes available. Despite this helium hiccup, Party City is committed to helping you throw an unforgettable party.

Check out some unique balloon ideas that don’t need helium.

Early warnings of a shortage amongst scientists...

“Hey, are you guys getting helium? Our vendor just delayed all shipments.”

-- AMMRL listserv (Association of Managers of Magnetic Resonance Labs)
End-uses for Helium worldwide (2015)

Data provided by Intelligas Consulting in https://www.aps.org/policy/reports/popa-reports/helium-crisis.cfm

Helium Touches Many Industries – and Lives

GASEOUS
- Weather Balloons
- Blimps
- Optical Fibers
- Lasers
- Dilution Fridges

- Party Balloons
- Semiconductors
- Plasma
- Hadron Collider
- NMR

LIQUID
- Leak Testing
- Welding
- Rocket Engines
- Fusion
- MRI Imaging

End-uses for Helium worldwide (2015)

- MRI 20%
- Analysis & spectrometry 15%
- Lifting 14%
- Other a 15%
- Science & engineering 6%
- Electronics & semiconductors 11%
- Welding 5%
- Fiber optics 6%
- Diving 6%
- Controlled atmosphere 2%
- Other 15%
- Includes leak detection, pressurization, purging and other uses.
From where do vendors get their helium:
(choose all that apply)

• capture it from our atmosphere
• extract it from seawater
• collect it from nuclear reactors
• extract it from natural gas mining
• extract from the National Helium Reserve

* If your answer differs greatly from the choices above tell us in the chat!

Answer Question 1:

The answers are:

• extract it from natural gas mining
• extract from the National Helium Reserve

Helium is refined from natural gases (methane, CO₂ etc.) at a concentration typically 1 to 3%. Helium is also extracted from the National Helium Reserve, slated for closure in 2021.
A little background on Helium

How is Helium formed?

- **Helium** is a byproduct of radioactive decay of *uranium* and *thorium* emitting an alpha-particle; half-life of \(~10^8\) years.

- The alpha-particle – which is charged – obtains electrons from its environment to become \(^4\text{He}\).

- What about \(^3\text{He}\)?

Where do we find Helium?

- Helium is a byproduct of natural gas extraction
- Helium must be present at sufficiently high concentrations to make it “worthwhile” to separate it from natural gas
  - Usually around 2%
- Natural abundance in the atmosphere ~ 5 ppm

From where do we get Helium? (worldwide)

Top 3 Suppliers:
- U.S.A.
- Qatar
- Algeria

https://geology.com/articles/helium/
From where do we get Helium? (U.S.A.)

- Private plants & pipelines
- Bureau of Land Management (BLM) facilities

What causes supply shocks and price changes?

- Increasing demand for helium worldwide
- Political instability
- U.S.A. pipeline maintenance
- Market fluctuations of natural gases can influence helium
- Natural gas well depletion and discovery of new wells
- Shutdown of the Helium Reserve in 2021 that has provided 30% of world supply for many years
Who is affected most by supply and price “shocks”?

**End-users with fixed budgets:**
(Researchers on federal grants.)

1) Low-temperature research in physics, chemistry, engineering
2) Astrophysics, accelerators, cryogenic detectors
3) Materials science and quantum information
4) Cryogenic instrumentation

**End-users with critical cryogenic applications:**

1) Superconducting magnets
2) NMR – nearly all ACS-accredited chemistry departments
3) NMR researchers in chemistry, physics, engineering
4) Mass-spectrometry

Stories from the “front lines” of researchers
Magnet “rescue” in Puerto Rico (after Hurricane Maria)

https://cen.acs.org/education/Puerto-Ricos-universities-road-recovery/96/i37
Is there a Helium supply problem?

Anecdotes from around the country – in people’s own words…

“…we were scheduled to move our NMR system into our new building. We were told by the vendor we needed 400 L of LHE on hand …but [our vendor] could not provide that much He. Our stockroom director did a lot of hunting around, but there was not a single He supplier in the country that could provide that much He. The delay caused us to lose our window …we lost the use of the instrument at a time when we needed it for teaching and research. Lack of He was the only reason we could not move the instrument on schedule.”

“In October we were told that we had reached our allocation and no Helium would be available for at least 6-8 weeks. We have a 900 MHz that needs 250 liters every 4 weeks. We went 10 weeks without helium and have never quite got back to a complete fill. More importantly our Helium cost went up ~47% at that time. Our cost for the 900 alone are now $56K/ year and that cost has to be passed on to our users.”

Helium price over time

Crude Helium:
70% helium + 30% natural gas

Conversion:
37.6 liquid He liters = 1 Mcf

https://www.aps.org/policy/reports/popa-reports/helium-crisis.cfm
Regional prices (2015)

Have you experienced shipment delay?

- Never had a delay
- One or more delays up to 2 weeks
- Longer delays
- Not applicable – I don’t order / use helium

* If your answer differs greatly from the choices above tell us in the chat!
What can we do?

Helium conservation and recycling

**Liquefaction**
- Large-scale > 50,000 L/yr. National Laboratories
- Mid-scale 30,000 to 50,000 L/yr. Universities
- Small-scale 5,000 to 30,000 L/yr. A few laboratories
- Very small-scale < 5,000 L/yr. One magnet/instrument

**Conservation**
- Improved efficiency will reduce cost

**Storage:**
- Only available in gas form; like National Helium Reserve
  - 1000 L liquid = 26,600 cubic feet gas (room temperature)
  - The Reserve will have 3 billion cubic feet in 2021

**New directions** (helium-free systems)
Helium liquefaction

Mid-scale

**pluses**
- On-site inventory: 4,000 to 6,000 L equiv.
- Technician support
- Immediate availability of liquid helium, 40-50 L/hr
- Pricing advantage for make-up helium (delivery in large dewars, 250 L)
- Pricing advantage for single site delivery
- Pricing advantage for “In-kind” helium

**minuses**
- Expensive capitalization: 2 to 3 M$
- Cost of full time technician
- Institutional space
- Efficient helium transfers; efficient recovery from boil-off
- 7,500 L/year threshold for purchase from federal grants to qualify for “In-kind” helium

Helium liquefaction

**Mid-scale**  Northwestern Univ.
Helium liquefaction

Small-scale

**pluses**
- Cheap capitalization: 150 to 250 k$
- No technician required
- Some lab space is required, ~ 300 to 500 ft\(^2\)
- Immediate availability of liquid helium: 20 to 40 L/day
- Very efficient, low cost

**minuses**
- No inventory, only ~ 150 to 250 L equiv.
- Lab staff do the work (soft money: students, postdocs, . . . )
- Uncertain availability and cost for make-up helium ~ 300L/year
- Considerable energy consumption (~5kW - 7kW)
- Requires efficient helium handling
Helium conservation: efficiency and recycle

- Helium recovery and liquefaction
- Efficient helium transfers
  "Don’t waste a drop" or even a “puff” of helium
- Dewars hooked up to recovery

**Audience Survey Question**

**ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT**

Which of these is of the HIGHEST priority?

- Refrain from buying helium balloons
- Improve transfer efficiency
- Call your congress members and request a hearing on helium
- All of the above

*If your answer differs greatly from the choices above tell us in the chat!*
Answer to Question 3

The highest priority is: Call your congress people

Helium for balloons is too small to be a concern.
While it is always wise to improve efficiency, a higher priority is to press Congress to take action, beginning with holding a hearing on ensuring helium supplies for research.
This requires congressional action.

In preparation ... for the next supply shock

• Recognize there are different “types” of users – ones with a fixed periodic critical need

• Triage helium orders

• Early-warning system for researchers (i.e., AMMRL or other professional society)

• Keep officials informed (to build awareness)

• Call your Members of Congress
Want more info?

- American Chemical Society
  [https://www.acs.org/content/acs/en/policy.html](https://www.acs.org/content/acs/en/policy.html)

- American Physical Society

- Materials Research Society
  [https://www.mrs.org/advocacy-issues](https://www.mrs.org/advocacy-issues)


Want more info?

- Bureau of Land Management:
Want more info?

National Academies

• **2010**: (report)
  https://www.nap.edu/catalog/12844/selling-the-nations-helium-reserve

• **2013**: (testimony)
  “Up in the Air: The BLM’s Disappearing Helium Program”
  http://www.nationalacademies.org/OCGA/113Session1/testimonies/OCGA_145533

• **2000**: (report)

ACS / APS / MRS action

Our professional societies are considering some of the following in their interactions with Members of Congress. Potential points to raise with MOC’s:

1. The Administration listed helium in its critical minerals list last year, but has yet to take action.

2. Short-term: researchers that are in dire situations need some assistance.

3. Privatization (sale) of the Helium Reserve should be contingent upon a continuation of the in-kind program—providing access to helium for federal users.

4. Long-term: Congress needs to assist federally-funded research with helium recycling and development of helium-free technologies. Congress could use monies from helium royalty contracts for this purpose.
Helium: An Irreplaceable Resource and Why We Must Conserve It

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