

# Helium Recovery and Recycling Makes Good Business Sense

Donald J. Bove, Air Products & Chemicals Inc., Allentown, Pa.

**Because helium resources are limited, the economics of installing a helium recycle system becomes increasingly attractive.**

**H**elium has unique properties that make it valuable for use in a wide range of applications. For example, its properties make possible faster cooling rates, which has led to adoption of helium in vacuum quenching technology, enabling many heat treaters to remain competitive and grow their business.

However, helium is a finite resource. Because of a delicate balance between helium availability and increasing demand, it is imperative that the helium-producing industry work with helium

end users to conserve, recover and recycle this resource. Technology for recovering and recycling helium developed by Air Products offers heat treaters an opportunity to significantly reduce costs.

## Helium gas quench benefits

Vacuum furnace gas quenching using helium can result in higher production rates, improved metallurgical properties, and can reduce overall process costs. Lower heat-transfer properties of argon and nitrogen can require expensive furnace modifications, higher quench pressure and increased blower speeds to achieve the same cooling rates achieved using helium.

Helium's heat transfer coefficient is 60% greater than that of nitrogen at the same pressure. Also, helium is less dense than nitrogen or argon, which makes it easier to move in the furnace. Furnace fans need less power to circulate helium, therefore, increasing fan speed or pressure becomes a cost-effective practice in accelerating cooling. Additional benefits of helium gas quenching include:

- Like argon, helium is inert and will not react with components being treated. Nitrogen is considered inert in most cases, but can form nitrides in certain materials.
- Parts clean up is minimal compared with oil quenching.
- Helium quenching can open new markets for heat-treating processes that may be limited by conventional gas quenching. For example, heavier loads or parts with thicker cross sections can be quenched at a faster rate.

## Why recover and recycle helium?

Helium is a finite, nonrenewable resource that can be extracted from only a few natural gas fields around the globe (Fig. 1). The U.S. alone consumes more than half of the world's supply (Fig. 2). U.S. helium consumption, estimated to be 2.9 billion ft<sup>3</sup>, is used in various applications in addition to heat treating applications, including cryogenic applications, pressurizing and purging, welding, leak detection, breathing mixtures and other applications (Fig. 3 and Table 1).

According to the U.S. Bureau of Land Management (BLM), helium used in the U.S. in large-volume applications is seldom recycled, and helium demand will continue growing at a rate of about 5% in 2004 and into 2005. As the world's leading producer and supplier

Air Products' helium manufacturing plant in Liberal, Kans.



of helium, Air Products aims to help heat treaters lower their operating costs while protecting and conserving this valuable resource through the use of recycle and recovery technologies.

Because process requirements differ, many factors need to be taken into account when deciding on the most cost-effective helium recycle system. These include overall consumption, process helium-purity requirements, helium pressure and flow rate, number of furnaces, backfill pressure, off gas, impurity levels and types of impurities. Companies specializing in helium supply systems should assist in the evaluation of possible solutions. Air Products' experience shows that heat treaters can reduce their helium costs by about one-third by means of recovery and/or recycling.

There are other advantages as well:

- Recovery and recycle systems are easily installed and integrated into the manufacturing process

- Total supply reliability is maintained because bulk helium still is available as a backup when maintenance is performed on the recycle system
- Recovery reduces vulnerability to shortages and possible supply disruptions
- Conserving natural resources makes good business sense

### Recycle-system design

Three main functions in a helium recovery system are gas capture from the waste helium stream, purification and returning recovered gas back into the process. Capturing the waste helium stream in closed systems like vacuum furnaces lends itself to efficient recovery; the gas is directed into the recycle system instead of venting it to the atmosphere.

The second step is purification. Most applications have stringent purity specifications and require that the recovered helium meet original product purity specifications. The choice of which purification

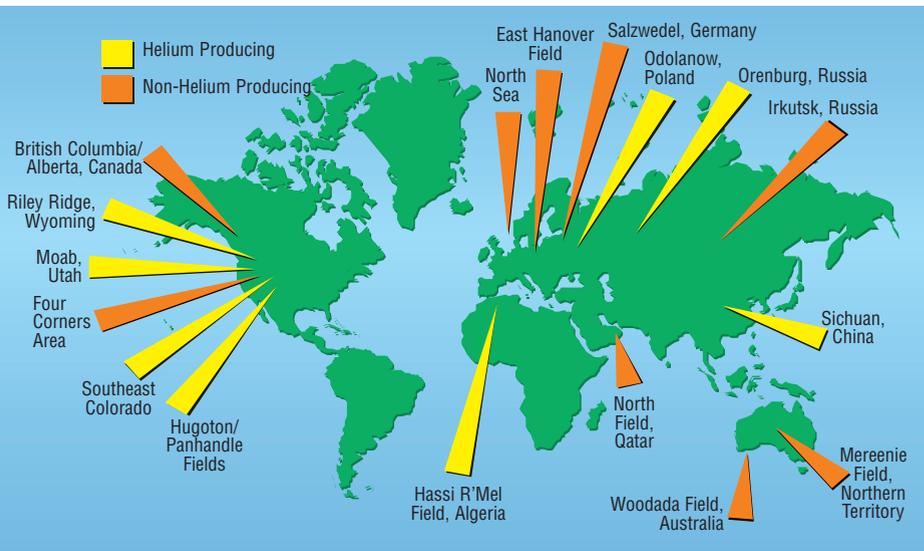
technology to use depends on the purity requirements of the particular process and the type of contamination in the waste stream. Typical purification techniques include pressure swing adsorption, membrane, and cryogenic technologies.

The third step involves compressing and returning the recovered and purified helium back into the process. This presents the greatest economic challenge due to the high cost of gas compression.

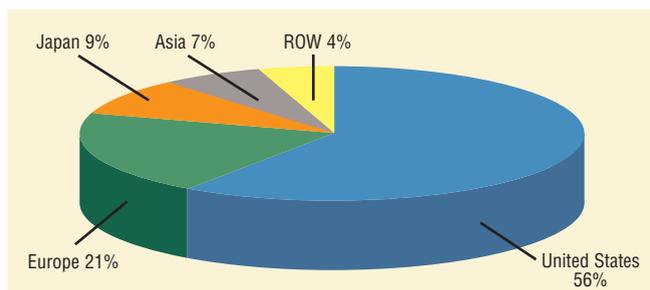
Air Products has addressed these challenges and developed recycle systems for use in vacuum furnaces as well as other applications, such as fiber optics, plasma furnaces and air ships. Typical systems can save about a third on the cost of virgin helium. The payback for implementing such a system can be about six months, depending on individual process variables.

Figure 4 shows the component details of a typical system. A low-pressure blower quickly removes the backfill gas from the furnace and delivers it into the low-pressure storage vessel. This is a critical component because the helium must be removed as quickly as possible so furnace time is not wasted. A compressor transfers recovered helium to the purification unit, and recovered helium is analyzed for impurities. At the very least, the gas must be analyzed for trace oxygen and dew point. After the helium purity is verified, the gas is transferred to a high-pressure storage vessel and is ready for reuse. Virgin helium and recycled helium are typically stored independently. There always is a virgin helium supply for backup.

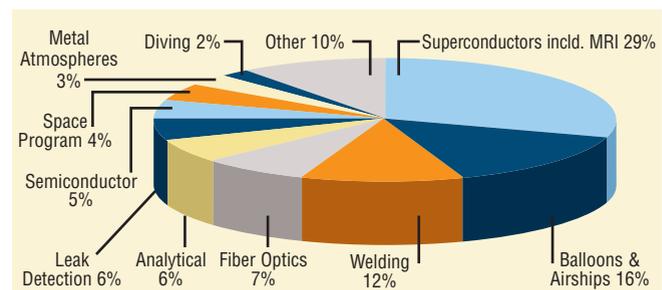
Because every heat treaters' requirements for helium recovery and recycling are different, Air Products can customize the most effective system taking into consideration purity requirements of the spe-



**Fig 1 Helium can be extracted from only a few natural gas fields around the world. The richest field is in the state of Utah in the U.S.**



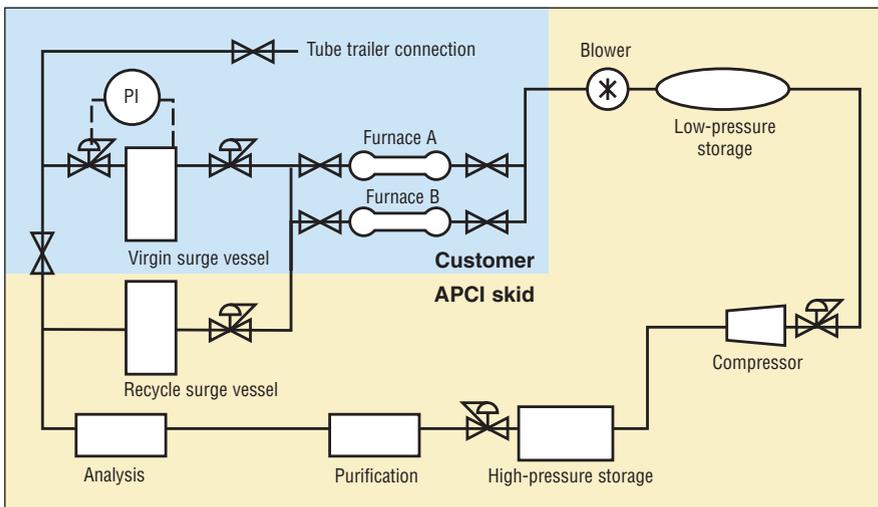
**Fig 2 The U.S. alone consumes more than half of the world's supply of helium (2002)**



**Fig 3 Helium use in various applications**

**Table 1 Properties and applications of helium**

Property	Application
Lowest boiling point; does not solidify at atmospheric pressure and 0°K	Liquid cooling of LT superconductors Purging liquid hydrogen systems
Second lightest element (after hydrogen)	Lifting medium for balloons, airships
Smallest molecular size	Leak detection
Chemically inert	Carrier gas; analytical, semiconductor
Very high specific heat and thermal conductivity	Faster cooling in vacuum furnaces Gaseous cooling: fiber optics
Radiologically inert (no radioactive isotopes)	Heat transfer medium in fusion reactors
Highest ionization potential	Metal-arc and plasma-arc welding
Extremely low solubility in water	Deep sea-diving gases
Very high sonic velocity	Metal coating

**Fig 4 Schematic of typical helium recovery and recycling system**

cific process, operating pressures, flow rates and overall use. Every system is designed to take up a minimal amount of floor space, and can be easily retrofitted to existing furnaces or expanded to accommodate additional furnaces.

Recovery and recycle systems are easily integrated into an existing operation seamlessly with little impact on the operation and can increase supply reliability.

### Conclusion

Helium recovery and recycling make sense for heat treaters. Because helium supplies remain fixed, the economics of installing recycle systems become increasingly attractive. Many factors need to be taken into account in deciding the most effective helium recycle solution for a given situation. The economics of recycling improve with increased volume use. Heat treaters need to be aware that using a helium recy-

cle unit can not only lower costs and protect an important resource, but can also open the door to other applications and opportunities. **IH**

**For more information:** Don Bowe is a Senior Principal Development Engineer in Commercial Technology Atmospheres, Air Products and Chemicals Inc., 7201 Hamilton Blvd., Allentown, PA 18195-1501; tel: 800-654-4567 (code 189); fax: 800-272-4449; e-mail: [gigmrktg@airproducts.com](mailto:gigmrktg@airproducts.com); Web: [www.airproducts.com/metals](http://www.airproducts.com/metals).

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