# Evolution of the Global Helium Business

## 1990 — 2015

By Phil Kornbluth

Congratulations to *CryoGas International* on reaching the 25th anniversary of publishing its first issue! Throughout its history, *CryoGas International* has always shown a keen understanding of developments in the Helium Business and has done an excellent job of keeping its readers informed on helium-related topics affecting their businesses.

Of course, the only constant in the Global Helium Business has been change, and the 25 year period coinciding with the life of *CryoGas International* has seen a great deal of it. Let's start at the beginning. What was the Helium Business like circa 1990?

The Helium Business was very US-centric in 1990. Approximately 80 percent of the world's helium production came from a half dozen helium refining facilities that were tied-in to the US Bureau of Mines' (BOM) Crude Helium Pipeline and Storage System that stretches 425 miles from the Cliffside Field near Amarillo, Texas, through the Texas and Oklahoma panhandles, and then northeast from southwestern Kansas to its terminus in Bushton, Kansas. The US midcontinent area and the Hugoton Field, which provided the helium bearing gas from which this helium was produced, were truly the center of the helium universe. The only significant helium production not linked to the BOM Pipeline came from Exxon's massive natural gas processing facility located in LaBarge, Wyoming, which initially produced approximately 800 million standard cubic feet (MMscf) per year of liquid helium, or more than 15 percent of then-current world production, beginning in 1986. The only significant commercial helium production from a source outside of the United States came from a plant in Odolanow, Poland that produced less than 100 million scf per year, or 2–3 percent of world production.

The business in 1990 was dominated by the three companies who owned the refining capacity that was tied to the BOM Pipeline — the Linde Division of Union Carbide (now Praxair), Air Products and Chemicals, and the British company, The BOC Group (now Linde AG). The only other companies that were basic in the Helium Business (i.e. controlled supply at the source) were Air Liquide and Messer Griesheim, who became basic as a result of a contract they signed to purchase helium from Exxon.

On the demand side, 1990 was a very exciting time for the Helium Business. Magnetic Resonance Imaging (MRI) was in the early stages of a period of rapid growth that would eventually make it the single largest application for helium and, by far, the largest application for liquid helium. MRI systems utilize liquid helium as the refrigerant that cools the superconducting magnets at their core to temperatures where they lose their resistance to electricity. The early MRI systems were sometimes referred to as "CryoHogs" because they required as many as three separate magnet cool-downs and had much higher boil-off rates than we see today. MRI also made very important customers out of the companies that manufactured MRI systems including General Electric, Siemens, Phillips, Picker, Technicare, Diasonics, Toshiba and others. There was quite a feeding frenzy among the major industrial gas companies to secure their business, with Air Products and BOC emerging as the early winners. MRI drove double-digit demand growth for helium throughout the 1990s and, as MRI systems were installed throughout the world, it was the primary catalyst for the build-out of the gas companies' liquid distribution networks into new markets where liquid helium was previously unavailable.

Besides MRI, helium demand associated with the manufacture of optical fiber also drove growth during the 1990s, especially in the second half of the decade. Companies such as Corning, AT&T, and others, became major helium customers. Toward the latter half of the 1990s, when both MRI and optical fiber were both driving helium demand, growth rates were in the mid-high teens per year.

Besides the high rate of growth, the 1990s also saw several important developments on the supply side. In May 1993, BOC and Air Products signed agreements to begin purchasing liquid helium from Russia for export to Western Europe. While production from Orenburggazprom's plant located in Orenburg was relatively modest, Orenburg became the second non-US source and Gazprom/Russia, with huge reserves of helium bearing gas in Siberia, became a participant in the Global Helium Business for the first time. Messer Griesheim also secured a portion of the Russian source.

In 1995, the first large scale production from a source outside of the US began at Arzew, Algeria. At Arzew, a joint venture between Sonatrach and a separate joint venture between Air Products and Air Liquide produces liquid helium from the adjacent LNG (liquefied natural gas) plant's vent gas. This plant, which has nameplate capacity of roughly 600 MMscf per year, was significant in that it was the first time that helium was produced from LNG waste gas and it expanded helium recovery potential to natural gas with much lower helium concentrations than were previously viewed as economically viable.

With two additional non-US sources by the end of the 1990s, the Helium Business was beginning to become slightly less US-centric.

Politics also impacted the Helium Business during the 1990s, with the major event being the passage of the Helium Privatization Act of 1996. This legislation mandated the sale of crude helium from the US Federal Helium Stockpile (sales of crude helium commenced in 2003, delaying helium shortages until 2006) and forced the shutdown of the Bureau of Land Management's (BLM) Exell, Texas, helium refining facility, which ended the BLM's sale of both gaseous and liquid helium in competition with the private sector. The availability of gaseous helium from the BLM at a "posted price" that was not reflective of market conditions

had distorted US pricing for gaseous helium and depressed profitability in that segment to some degree. The BLM continued as the operator of the BLM Crude Helium Pipeline & Storage System and continued to sell crude helium (instead of pure) for sale to government users.

Since 2000, most of the bigger stories related to the Helium Business have been about supply. There have been two periods of fairly severe shortages driven by delays in new supply or outages of existing supply as well as a period of surplus capacity that the industry is currently experiencing. But let's start with a look at demand.

In the early 2000s, the demand party caused by MRI and optical fiber manufacturing began to ease. MRI magnet and system manufacturers became much more efficient in their use of helium, as they mastered the art of cooling down magnets (only) a single time and shipping them cold, while also learning how to minimize helium boil-off. While the number of installed MRI systems continued to grow, the retirement of old CryHog machines combined with more efficient helium use greatly reduced the helium demand growth associated with MRI. Also, in the early 2000s, demand for optical fiber dropped off, as the telecom companies had installed more optical fiber capacity than the world required. People began to talk about "dark fiber," which was essentially fiber optic cable that was installed, but unutilized due to a lack of demand for the additional bandwidth.

While global growth rates for helium demand slipped into single digits for much of the post-2000 period, the big story on the demand side was the geographic shift in demand from North America, Europe and Japan to the emerging Asian economies. While the developed economies experienced unexciting single digit growth or less, demand for helium in China, Korea and Taiwan grew at double digit rates as electronics manufacturing shifted into these lower cost markets. By the time the helium shortage of 2011–2014 reduced helium shipments worldwide, China, Korea and Taiwan were all among the world's largest helium markets.

On the supply side, the BLM began to sell crude helium from the Federal Helium Stockpile in 2003, helping to keep the helium refining capacity that was linked to the BLM running at capacity and delaying helium shortages until later in the decade. The trend toward non-US production continued, as the Qatar 1 plant, with capacity in excess of 600 MMscf per year, commenced production in October 2005. This source, which was shared 50:50 between BOC and Air Liquide, was the second largest non-US source and the second plant whose feedstock was the waste gas from LNG production. Like the Algerian source, the Qatar 1 source came with difficult logistics and relatively long supply lines to major helium markets. With access to supply from ExxonMobil, Arzew, Algeria and Qatar 1, Air Liquide was beginning to close the gap with Air Products, BOC and Praxair.

In April 2007, production began from a second Algerian plant located in Skikda. Linde secured this source and became the industry's fifth (if my arithmetic is correct, by this time, Air Liquide had gobbled up Messer) prime supplier of helium. The Skikda plant was also producing helium from the waste gas of an LNG plant. Due to a major explosion that destroyed three trains of the LNG plant, the Skikda Plant was limited to less than 50 percent of nameplate capacity until late 2013.

Linde's acquisition of BOC in September 2006 also had a significant impact on the Global Helium Business. Linde replaced BOC as a global major in the Helium Business, but a new fifth prime competitor was created when the anti-competition authorities in both the US and Europe forced Linde to divest a significant chunk of the helium assets acquired from BOC. Taiyo Nippon Sanso Corporation acquired most of the divested assets and became the first Japanese gas company with a basic position in the Helium Business.

The years 2006 and 2007 were a period of tight supply and supply allocation as the BLM Pipeline System began to lose capacity due to depletion of the Federal Reserve. At this time, the Skikda and Qatar 1 plants also produced below expectations, and industry supply was periodically reduced by maintenance shutdowns at ExxonMobil's Wyoming plant and at other sources. Due to overall tight supply and crude helium delivery allocations, the BLM Pipeline was no longer able to provide the swing capacity on which the industry had traditionally relied to balance supply and demand. Helium markets returned to a comfortable balance during 2008–2010 when worldwide economic activity experienced a severe recession and demand for helium fell.

The 2010s started out on a positive note with ample supply and the start of production from Linde's Darwin, Australia plant. Darwin was the fourth plant processing waste gas from an LNG plant and the sixth non-US source. As it turns out, this was the calm before the storm. Beginning around March of 2011, the industry experienced a severe shortage of helium that and lasted for roughly three years (Helium Shortage 2.0). This shortage, unprecedented in both its depth and duration, was almost entirely driven by production shortfalls. There were a number of significant supply constraints and outages that suppliers had to deal with during this period, including: outages of the BLM's Crude Helium Enrichment Unit that greatly reduced the effective capacity of helium refining facilities tied to the BLM; sustained allocation of crude helium deliveries to the helium refiners; prolonged

An aerial view of Linde's Otis, Kansas Helium Plant. Photo courtesy of Linde.

| 1990 – 2015 Summary | | |
|---|---|---|
| 1990 | | 2015 |
| 8 | Liquid He Plants* | 16 |
| 1 | Non-U.S. Plants | 7 |
| 97% | U.S. Share Of Capacity | ~55% |
| >30 BCF | BLM CHe Stockpile | 6.7 BCF (12/31/14) |
| 5 | Prime Suppliers | 6 |
| 0 | LNG-based Sources | 5 |
| 5% | MRI Sahre Of Market | ~20% |
| 1X | Container Fleet | 4X |
| 1X | Transfills | 5X |

*Expected to be in operation during 2015

**Figure 1** **Source:** Kornbluth Helium Consulting

maintenance outages at ExxonMobil's Wyoming plant in both 2011 and 2012; and production outages/shortfalls at the plants in Arzew, Algeria, and Orenburg, Russia. This "Perfect Storm" of circumstances resulted in a worldwide supply shortfall of roughly 20 percent (and far worse at times) throughout much of the period, with all of the major helium suppliers forced to allocate supply to their customers.

Besides the tremendous inconvenience of not being able to acquire the helium required for their businesses, helium customers were faced with prices that doubled as a result of the shortage. In some instances, where access to helium was critical to production of optical fiber or semiconductors, spot prices reached astronomical levels. Applications that were considered non-critical, most notably party balloons, had their helium supply cut off completely.

While Helium Shortage 2.0 persisted, there was increasing concern that the BLM would lose funding for operation of its pipeline at the end of its fiscal year 2013, potentially removing three billion scf of capacity from world markets. In fact, new legislation was required to prevent the Helium Business from going over what was commonly referred to at the time as the "Helium Cliff." With the Helium Business continuing to struggle with the helium shortage, this would have been a disaster, which would have demonstrated to the world just how vital helium is to many critical industries. While passage of new helium legislation was viewed as a "no brainer," Washington gridlock and several areas of disagreement between helium refiners and non-refiners delayed the new legislation. Fortunately, common sense prevailed and the Helium Stewardship Act of 2013 (HSA) was signed by President Obama during the first week of October 2013, just before the deadline.

With passage of the HSA, the Helium Cliff was avoided and the BLM Pipeline System remained in operation, with funding for maintenance and required investments in additional compression. The volume of crude helium offered for sale by the BLM will decline each year, due to the depletion of the Federal Helium Stockpile, reducing the capacity of the helium refining facilities linked to the BLM Pipeline. The BLM will sell an increasing quantity of crude helium each year via auction and these auctions will open to a larger group of potential buyers, with the intent of providing non-refiners increased access to the Federal Helium Reserve. Once the Federal Helium Stockpile has been reduced to three billion scf, the BLM will end commercial sales of crude helium and the BLM's crude helium stockpile will only be available to government users. The three billion scf threshold may be reached after 2021.

With passage of the Helium Stewardship Act, and the prospect of new supply from the massive Qatar 2 project, as well increased production from Linde's Skikda, Algeria source, there was finally anticipation of the end of supply shortages. The Qatar 2 Plant, which is shared between Air Liquide, Linde, and Iwatani (now the sixth prime supplier of helium), ramped up quickly after a Fall 2013 start-up to reach full capacity of 1.3–1.4 billion scf per year by early 2014. Around the same time, the installation of an LNG mega-train at Skikda finally provided the feedgas required to increase Linde's Skikda production from around 250 MMscf per year toward its 600 MMscf potential. With all of this new supply entering the market at roughly the same time, world helium markets quickly shifted from shortage to oversupply. Exacerbating the oversupply was the fact that some helium demand was lost during the extended shortage due to a combination of replacement of helium in non-essential applications and more efficient use of helium, including increased recycling.

While helium markets are now flush with supply, demand for helium emerging from the years of shortage can best be described as sluggish, and is most likely less than it was pre-Helium Shortage 2.0, due to demand destruction during the shortage. After three years of struggling with shortages and supply allocations, industry participants are now struggling with the challenges associated with too much supply. These challenges include difficulty meeting Take or Pay commitments, excessive inventory and an insufficient number of helium containers to hold the growing inventories. It is difficult to estimate exactly when helium markets may rebalance, but most industry participants estimate that the oversupply could persist for another year or more.

So there you have it — 25 years of *CryoGas International* and 25 years of change in the Global Helium Business, which has grown larger, more internationally diverse, more competitive and more volatile due to the decline of the BLM Pipeline and an increasingly complex supply chain. ■

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