

The Rare Gases Market Recovers with Global Economies

By Richard Betzendahl

The rare gases krypton (Kr) and xenon (Xe) are both volatile global products. This volatility stems from their end use applications in fluctuating markets like construction, lighting, and electronics, and from the global control of sources of their production. Furthermore, the supply of krypton and xenon, which are by-products of large scale oxygen production via air separation units (ASUs), is driven by the demand in the oxygen markets, not rare gas markets.

Given the high degree of market volatility for krypton and xenon, and some degree of concern for safety due to the concentration of hydrocarbons in the oxygen stream that contains the crude Kr/Xe, producers have been reluctant to make the necessary investment to add crude Kr/Xe capacity. There is a three-year lead time required to design and build a large ASU with crude Kr/Xe capacity, and this process is very capital intensive. Today's economic conditions make it difficult to find and sign long-term large-scale oxygen contracts, so going forward, I expect added or lost rare gases capacity to come in lumps relative to current global capacity for crude Kr/Xe. This will have an impact on the global supply/demand balances of these gases, which in turn is likely to impact global pricing.

Current Production

The current world production of crude gas mixture (approximately 90 percent Kr, eight percent Xe, and two percent impurities) is around 111,000,000 liters. Of this, krypton is approximately 100,000,000 liters and xenon is about 11,000,000 liters. Note that xenon is about 10 percent of the total, not the eight percent you would expect given the ratio of xenon in the crude mixture. This is because a Kr/Xe crude production column is retrofitted to the hydrocarbon waste streams of some oxygen plants, instead of having these oxygen plants initially equipped with internal trays. Also, some newer plants are built and run to minimize power costs, which changes the economic benefit of Kr and Xe recovery. In both cases some of the krypton is not retained but most of the xenon is, causing a higher percentage of xenon to be produced than you would expect.

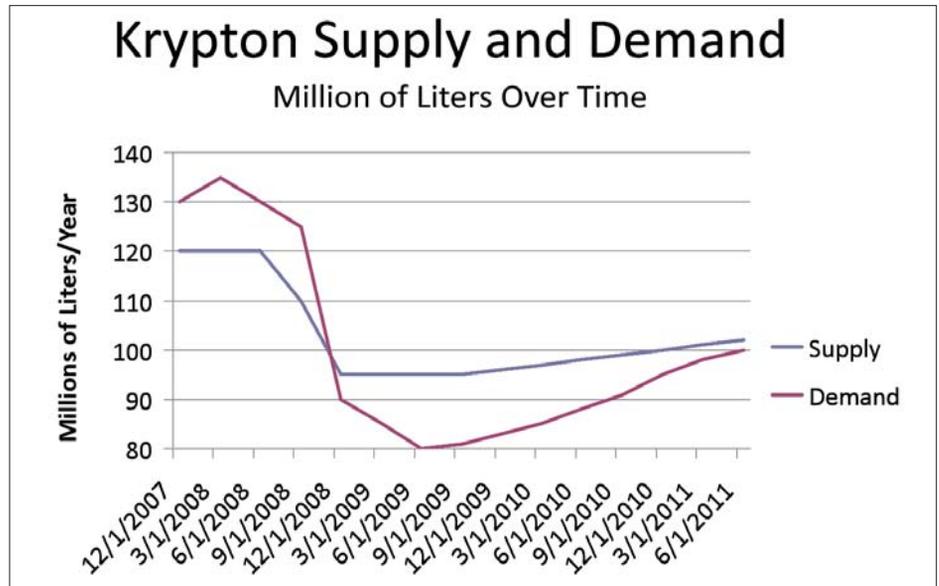


Figure 1

Source: Betzendahl Gas Consultants LLC

The world production of crude Kr/Xe is controlled by the three largest industrial gas companies—Air Liquide, Praxair, and Linde—plus Iceblick, an Eastern European-based company and the second largest global supplier of purified Kr/Xe. Together, these four companies control more than 80 percent of all krypton and xenon produced.

Unlike other industrial gases, rare gas supplies are not based on local production. Rare gases are, in fact, global commodities where the balance of global demand, supply, and speculation determines price. This makes tracking these markets very challenging. The location of crude Kr/Xe production is changing, moving from East to West. Over the next few years, an increasing portion of the new rare gases production will be attached to the large ASUs being built in China, where steel, chemical industries, and coal gasification are driving demand for oxygen.

Production by Region

The United States currently produces 12 to 14 million liters of crude Kr/Xe per year, with Praxair controlling 85 percent of total production. I do not see any large projects in the funnel right now that would increase this production number. In fact, I expect US Kr/Xe crude production will continue its slow decline as most US plants now producing crude are associated with aging ASUs at

steel mills. However, gasification with its associated large scale oxygen requirements, is the rare gases wild card. There were several gasification projects planned prior to the recent recession. Should these move forward, there is the potential in the US for increased Kr/Xe capacity at ASUs built to support gasification projects.

Eastern Europe is the leader in crude Kr/Xe production, supplying 32 to 34 million liters per year. Iceblick, the second largest producer of high purity krypton and xenon in the world, controls almost 70 percent of this production. Production is in slow decline. It is estimated that peak production five years ago of krypton and xenon crude was almost 40 million liters per year in this region.

As in the US, rare gas production in this geography is associated with aging ASUs at older steel mills. As steel mills begin to upgrade to new, larger, more efficient plants, some have opted for no Kr/Xe crude production. Again this is due to the safety issue and/or energy costs. For example, a large steel mill in Russia closed some older ASUs and replaced them with a 3,000 ton per day (tpd) oxygen plant that does not have crude Kr/Xe production. This is a trend I expect will continue.

Western Europe now produces 18 to 20 million liters of crude Kr/Xe and production in this geography is stable, with some capacity added and some lost recently. Almost 100

percent of this production is controlled by Air Liquide and Linde. In Western Europe Xe/Kr is sourced mostly from steel and chemical plants that have large ASUs. In this region, I believe the current volume of crude Xe/Kr production will continue to hold at around 20 million liters over the next few years.

About 14 to 16 million liters of crude Kr/Xe is produced in the Middle East and Africa. This area has been fairly stable, with few production losses or additions. Sasol's coal gasification plant in South Africa, a Sasol/Air Liquide joint venture, is by far the largest producer of crude Kr/Xe in the region. It produces nearly 10 million liters of crude, with a ratio of about 30 percent xenon and 70 percent krypton.

A fire, a few years ago, in the crude column at a petro plant in Saudi Arabia took out some capacity in this region. The plant had been producing between 3–4 million liters of crude Kr/Xe. Today it produces none and this experience has others in the region wary of building large projects with crude Kr/Xe columns.

China and the PacRim produce the second largest amount of crude Kr/Xe globally, estimated today at 22 to 26 million liters and growing. Approximately 15 to 20 million

liters of this total are produced in China. Production in this geography has grown over the last few years. As readers of *CryoGas International* know, a number of very large oxygen projects are now in the works in this region and I expect to see continued growth, especially in China.

Currently there are almost 10 million liters of new Kr/Xe crude production capacity due to start up in the next three years in China. This is driven by the growth in steel mills, chemical complexes, and coal gasification projects. Producers, both current and future, include Linde, Air Liquide, Messer, Praxair, and four Chinese steel mills. There are now four final purification plants in China to support this growth.

In summary, I see a decline in the crude Kr/Xe production in the US and Eastern Europe, stability in Western Europe and the Middle East/Africa, and significant growth in the China/PacRim region. Overall global growth in supply is not expected to be significant in the short term.

More specifically, I see declines of about 10 percent in crude Kr/Xe production in the US and Eastern Europe over the next three years, with those regions combined losing about five million liters of crude production.

On the other hand, I see China adding about 10+ million liters over the same time period, which will represent growth in that region of about 75 percent. Globally, the net increase in crude Kr/Xe production will be only about 5–7 million liters, or two percent per year. This is not enough to fulfill growth in Kr/Xe demand, which I anticipate will be greater than five percent per year driven primarily by demand in window insulation, lighting, and satellite markets.

Krypton

The world krypton market declined almost 30 percent in 2009, hitting the bottom in 2Q of 2009 (see Figure 1). As pricing lags demand in this market, prices did not stabilize until 1Q of 2010.

Krypton demand seems to be currently in balance with supply. Pricing for krypton dropped just over 50 percent from its peak in 2008, moving from \$1.60–\$2.25 per liter in 2008 to \$0.75–\$1.10 per liter in 2010, for large users. We now see some price pressure as demand begins to meet supply. The decline in price between 2008 and 2009 was directly related to the world economic recession, and specifically to the collapse of the

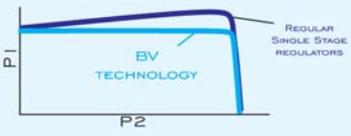
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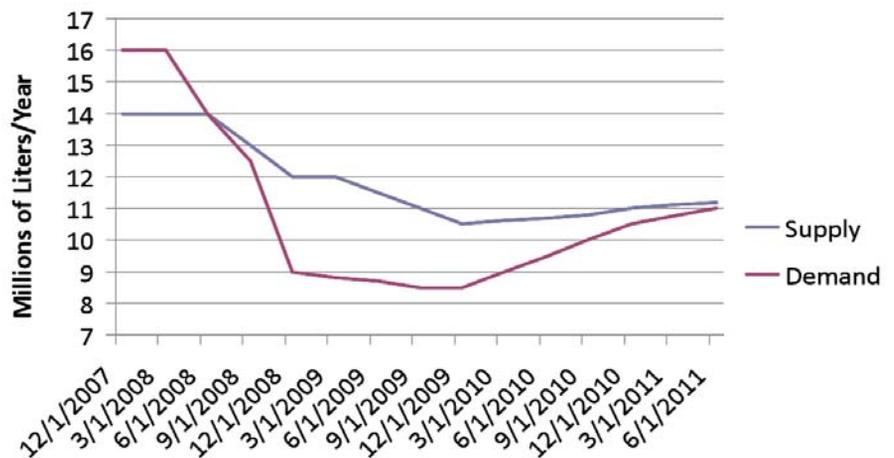


Figure 2

Source: Betzendahl Gas Consultants LLC

construction industry. The environmental regulations in Europe require energy efficient windows, and krypton is widely used in the manufacture of insulated windows. With construction being one of the industries hardest hit by the recession, rapidly decreasing demand for windows drove down demand for krypton. This drop in demand was felt to a lesser extent in the US where the market for insulated windows is smaller.

In the last quarter of 2009 demand for krypton began to pick up as European window manufacturers ran out of krypton inventory and orders for window products resumed. This demand growth continued throughout 2010. In the US, the strengthening green movement, the US Department of Energy's replacement window program (*see www1.eere.energy.gov/buildings/windows/volumepurchase/*), and new government tax credits for energy efficient replacement windows have boosted demand for krypton. With this continued growth in demand we expect pricing in 2011 to increase between 10 and 20 percent by year end.

Xenon

World demand for xenon fell by about 40 percent in 2009 and, like krypton, xenon demand bottomed out in 2Q'09 (*see Figure 2*). Pricing for xenon dropped nearly 75 percent from its peak of \$20.00–\$30.00 per liter in 2008 to \$6.00–\$8.00 per liter in 2010, for large users. As in the krypton market, this decline was driven by the global recession, most significantly by losses in demand in electronics, satellite, and plasma display

panel (PDP) markets.

Xenon is also used in the lighting industry, another sector that was hit hard by the recession. The faltering US auto industry, where xenon is used in headlights, caused the largest drop in demand.

Xenon pricing stabilized during 2Q'10 and demand picked up slightly. As I reported last August (*see "Restraint in Supply Makes for a Better Managed Business," CGI, August/September 2010, p. 46*), this growth accelerated in the second half of 2010 and continued into 2011 as lighting and satellite markets improved. Going forward, xenon demand in the lighting market will be driven by European Union (EU) and US regulations, which are phasing out incandescent light bulbs. Replacements for incandescent bulbs include compact florescent light (CFL), Light Emitting Diodes (LED), and halogen incandescent. Halogen incandescent lights require xenon, making the future demand picture for xenon encouraging as the world moves toward more energy efficient forms of lighting. (*See "Glad Tidings: The Good News in Gas Markets," CGI January 2010, p. 33, for more on gases used in lighting.*)

Satellites are another xenon-intensive application. Over the last four months, Russia has purchased more than one quarter of a million liters of xenon for its satellite program. Satellites could add more than one million liters of additional demand for xenon over the next 12 months as China, the EU, Russia, and the US restart their satellite programs and begin to require more xenon for these projects.

The Look Ahead

As the world economy continues to trend upward, the demand for rare gases is picking up steam. Supply, however, remains fairly flat. As discussed, prices for both krypton and xenon stabilized in 2010, and in early 2011 we saw the first indications of prices on the rise.

If world economies continue to regain strength, I expect the demand for both krypton and xenon will continue to increase, supply to tighten, and prices to increase in the range of 10–20 percent over the next 12 months. This growth will push new supply schemes, making some start-ups probable over the course of the upcoming year, most likely in China.

Xenon demand has already increased dramatically in the first two months of 2011, driven by new PDP production in China, satellite programs, and lighting. For xenon, price increases of the 10–20 percent could be here the end of 1Q'11 or early 2Q'11. However, before prices increase, any existing inventories of xenon must be consumed. Excess inventory could cause a lag in pricing, followed by a surge in pricing when the inventory is consumed, creating a dramatic swing in the cost of xenon.

As always, the next 12 months are difficult to predict. While the economic outlook for 2011 is generally good, worldwide unrest like that in the Middle East as we go to press, could stall the worldwide recovery. A “double dip recession” would also throw the rare gases market off course by slowing demand and dampening prices.

I remain bullish on krypton and xenon in the coming year. World economies are improving and many applications for these gases are showing great growth. Add to this limited net additional production, and you have a good climate for moderate price increases. Now, let there be peace.

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