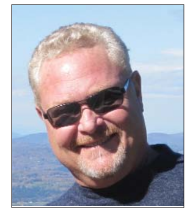
Still Bullish on Rare Gases

A CryoGas International Market Report
by Richard Betzendahl



Rare gases, which include krypton (Ke), xenon (Xe), and neon (Ne), are byproducts of air separation units (ASUs) that produce large quantities of oxygen and nitrogen. Historically, to be economically feasible, the rule of thumb was that an ASU must produce at least 1,000 tons per day (tpd) of oxygen to be considered for crude rare gas production. With today's lower rare gas prices, a plant must produce about 2,000 tpd of oxygen or more to produce enough crude rare gas byproduct to obtain a reasonable return on investment. Only large steel mills and some large petrochemical projects, such as coal and pet-coke gasification projects, require this size of oxygen plant. The time frame to design and build a large ASU that adds new capacity of rare gas crude to the global market is almost three years. This makes trying to balance the supply and demand of rare gases very difficult and results in volatility in pricing and supply. In this report, we examine the worldwide market and outlook for rare gases, with a focus on production, which will be the rare gas product price driver in the short term.

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Production

In my last report (*"Rare Gases Market Recovers with Global Economics," CryoGas, March 2011, p. 40*), I reported the world production of Kr was about 100 million liters and production of Xe was about 11 million liters. Today I believe actual production is a little less than that with Kr at around 97 million liters, Xe at 10.5 million liters, and Ne at 625 million liters. Coming up with an accurate analysis of rare gas production is difficult, as many plants do not run at a consistent production volume and others never produce the volumes they were expected to. I take these variations into account with my estimates. Errors in estimates tend to overstate production rather than underestimate.

Krypton and xenon are produced together as a byproduct from an ASU. (*For a complete discussion of ASUs see "Cryogenic Air Separation," by Goutam Shahini, Cryogas, December 2011, p. 30.*) They are taken out at the bottom of the low pressure column above the reboiler, or from the hydrocarbon vent. The latter source is significantly less efficient in maximizing total rare gases availability and favors xenon recovery. Both of these methods require an on-site second cryogenic purification column to concentrate the Kr/Xe mixture. This mixture is then taken to an off-site third cryogenic purification column where the final purification and container filling takes place. There are 17 final purification locations around the world. Due to the fact that the total global final purification capacity is 2–3 times the actual amount of crude available, a few of these purification plants are not currently in operation.

Neon (Ne) is taken from the top of the low pressure column of an ASU and comes out as a neon/helium/nitrogen mixture. As shown in Figure 1, there is much more neon available in the air than Kr or Xe. Therefore, the cost associated with purification per liter of Ne is less than that of other gases. As stated earlier, global neon production is 625 million liters. Combined, production of krypton and xenon is only 107.5 million liters. As a result the market price for neon is less than that of the other rare gases.

As with the Kr/Xe mixture, neon production requires an on-site second cryogenic purification column to concentrate the Ne/He mixture and strip out most of the nitrogen. This mixture is then taken off-site to a third neon cryogenic purification column where the final purification and filling takes place. The neon final purification is completed at one of about eight purification centers in the world. Some of these centers are not currently operating, as the world capacity for final purification of neon is a number of times greater than the actual global production of this gas.

Gases as a Percent of Air

GAS	% BY VOLUME
Nitrogen	78.08
Oxygen	20.95
Argon	0.93
Carbon dioxide	0.033
Neon	0.0018
Helium	0.00052
Methane	0.0002
Krypton	0.00011
Nitrogen oxide	0.00005
Hydrogen	0.00005
Xenon	0.0000087
Ozone	0.000001

Figure 1 Source: Betzendahl Gas Consultants, LLC

The Players

Included in my analysis are three charts that show the relative shares by player of rare gas production. While I have purposely left out the actual numbers, the reader can get an idea of production by player.

Looking at the production graphs on page 29 you see the four big players are Air Liquide, Linde, Praxair, and Iceblick, a company located in Odessa, Ukraine with plants in Odessa and in Moscow. These four companies control about 75 percent of all rare gas sales globally. The Other group is made up of a number of steel mills in Russia and China as well as the industrial gas companies Air Products, Messer, Taiyo Nippon Sanso, and a half a dozen or so small purifiers in Eastern Europe.

The regional supply trend I reported on last year continues; North American production is still flat to declining; Western Europe is basically flat; Eastern Europe is in decline; and China is adding capacity. The net effect is that global supply is flat. The only player who is adding any significant production is Linde, and the Linde plants were approved and planned when pricing was much higher relative to today's prices. Significant increases in production are mostly in China, as that is where most new large projects that require 2,000-plus tpd plants are being built. In Eastern Europe we see some older existing rare gas-equipped ASUs being replaced with new plants, some of which are not equipped with rare gas extraction capabilities. In the western world we do not see many new large projects with rare gas crude production potential. Many of the West's existing rare gas extraction plants are small and inefficient, and I expect some may shut down in the near future. On the whole, I do not expect to see much total additional capacity added in the next few years. However, with a flat supply and slight demand growth over time I expect prices to rise. Rising prices will begin to make new investment more profitable.

Demand

Last year I reported that supply and demand was beginning to balance, and in 2011 all rare gas pricing either stabilized or increased slightly. This trend seems to be continuing. I predicted price increases in Kr and Xe would occur this year, which they did, but not at the levels I anticipated in last year's article. This was caused by two factors: expected growth rates in the global economy did not materialize due to the US and Western European debt crises, and inventories of rare gases, particularly Xe, were not totally consumed.

Key applications for krypton include lighting, window insulation, and laser markets. Xenon is also used in lighting and laser markets and for satellite ion engines, flat panel displays (mostly plasma), and electronic applications. Neon is most familiar to us as a lighting application but is also used in manufacturing flat panel displays and in laser markets.

These applications exhibit various degrees of growth or decline. The lighting industry is seeing changes with the government-enforced elimination of incandescent light bulbs in major Western countries. The incandescent bulb is being replaced by the more efficient compact fluorescent and halogen bulbs. This change favors increases in Xe demand while keeping Kr and Ne flat.

Laser applications continue to grow with much of the new demand in medical markets, which are strong growth markets globally. This growth favors all rare gases, but in particular neon as it is frequently the balance gas in a laser mix.

The major application for krypton is window insulation. This market has recovered fairly well in Europe since the recession and is developing in the US and other countries. Market demand for insulated windows is largely driven by government mandates for more energy efficient building design and by rising energy prices. However, new glass coating technologies that make windows more energy efficient compete with gas-insulated windows. These coating technologies, which do not use rare gases, will likely replace some of the standard energy efficient Kr-filled windows. Given this trend, I expect Kr use for window insulation to continue to increase, but not as quickly as originally anticipated.

The satellite xenon ion engine application

Player Share of Krypton Production

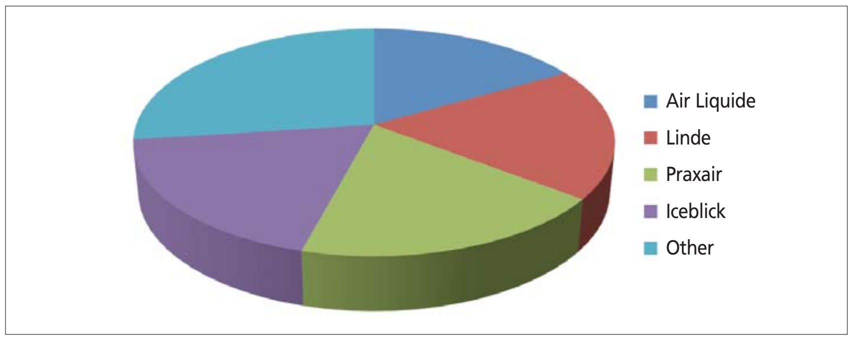

Figure 2 Source: Betzendahl Gas Consultants, LLC

Player Share of Neon Production

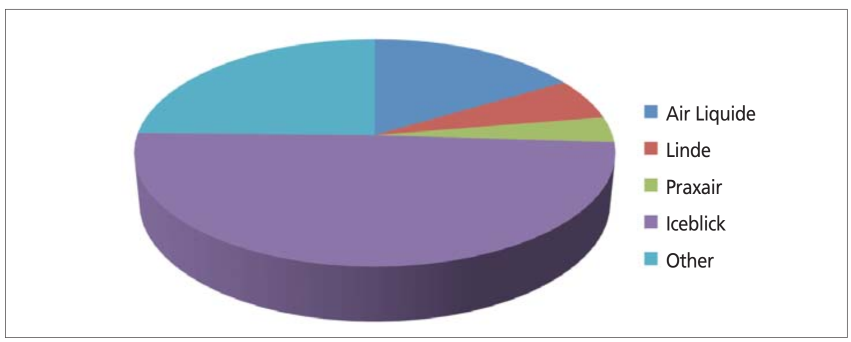

Figure 3 Source: Betzendahl Gas Consultants, LLC

Player Share of Xenon Production

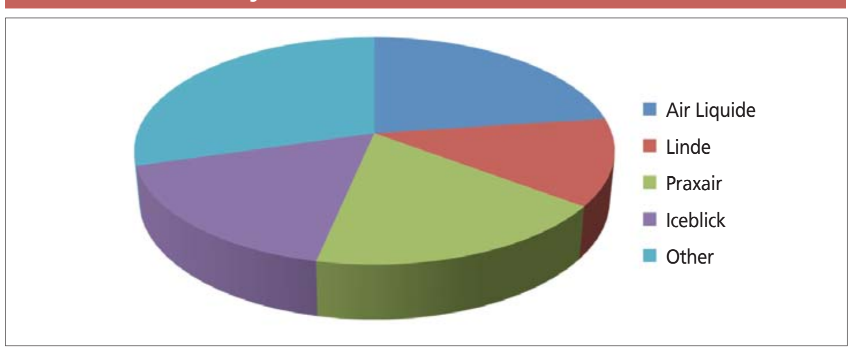

Figure 4 Source: Betzendahl Gas Consultants, LLC

is still moving forward, driven by the US, Russia, and China, which send the most satellites into the earth's orbit. I am not aware of any large satellite projects on the horizon, so I expect this use will remain stable. China is the satellite wild card, however. If the Chinese continue to build military strength, they may add new spy, communication, and GPS satellites, which could add significantly to xenon demand.

Demand for flat panel plasma displays, which use Xe and Ne, has rebounded, but they are still being overshadowed by LCD and LED panels in terms of market demand. Also, the new plasma panels use a lot less rare gas than their predecessors. In the electronics segment, AMOLED (active-matrix organic light-emitting diode), a display technology for use in mobile devices and televisions, is the big growth market. AMOLED displays provide higher refresh rates than their passive-matrix OLED counterparts, can improve response time to under a millisecond, and consume significantly less power. This advantage makes active-matrix OLEDs well suited for portable electronics, where power consumption is critical to battery life. This technology uses small amounts of xenon. How much it will consume in the next few years is still unknown, but it could be significant. It is an application to watch.

What's Ahead

As we begin 2012, barring any significant world recession, the $250 million global rare gas market will continue to grow. The lack of significant new production and the decline of older plants, together with some increase in application demand, may result in a tightening of supply. This tightening will cause prices to increase. To justify investment in new Kr and Xe production except in very large projects, it is necessary for the prices of Kr and Xe to increase by about 25–50 percent from current levels.

Krypton demand is beginning to meet supply, and we are seeing pricing begin to rise in the wholesale market. This will soon hit the retail market, and I predict the price of krypton will rise about 10 percent or more by year end. Xenon and neon on the other hand, will be stable as demand has not increased significantly. Prices for these products are expected to remain stable and not increase significantly until next year. The new demand opportunities for xenon and neon could lead to significant increases in prices of these gases in 2013 or beyond. All in all, the future for krypton, xenon, and neon is bright, and again I am bullish on rare gases. ■

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