Lake Tangayika and Tanzania's lake Rukwa

Decoupling helium sourcing from natural gas processing

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Co-recovery of helium from natural gas streams has been the helium sourcing paradigm since the 1970s. The countries with the largest helium reserves are Qatar, US, Algeria, Russia and Australia. Armed conflict, international tensions, depleting reserves and planned or unplanned outages in these key locations have influenced the global helium supply and demand balance dramatically.

The concentration of helium in natural gas streams, where its recovery is commercially viable, is typically between 0.2-2%. This makes helium production costly and complex which is sometimes an unwelcome distraction from the core activity of natural gas processing. This means that planned maintenance shutdowns are timed around the needs of the gas processing machinery and gas market prices. These cycles do not necessarily reflect the need to balance the global helium supply and demand.

Over the past three decades, the US has been both the largest producer and consumer of helium. However, US reserves are dwindling, production is falling and imports are growing. The international dynamics of helium sourcing are at a pivotal point. Excessive tension in the supply chain is frequent and four major global shortages have disrupted the industry since 2005.

A phoenix will rise from the ashes

There is increasing pressure to reduce fossil fuel usage and mitigate greenhouse gas emissions. Natural gas production may peak around 2050 and then decline. But helium applications will continue to be critical for humanity long after that, and turning off the tap will not be a solution for patients in hospitals which run MRI scanners for medical diagnostic purposes.

A new paradigm for the 2030s must emerge. Helium sourcing will progressively be de-coupled from natural gas production. The answers will include co-extraction of helium with natural hydrogen and on-purpose helium exploration and exploitation. Increased circularity of helium usage through recovery and loss avoidance will also be ongoing imperatives.

Armed conflict and geopolitical tensions

In June 2017, Saudi Arabia placed a blockade on shipping leaving Qatar. This cut off the world's second largest helium producing nation and led to a 15% global helium supply deficit. At a similar time, planned maintenance at ExxonMobil's facility in Wyoming and Sonatrach's Skikda plant in Algeria exacerbated the helium shortage and led to a 40% deficit in global supply. These events triggered what is referred to as the 'Helium Shortage 3'.

The first half of 2024 was expected to welcome end of the next crisis, known as 'Helium Shortage 4.0'. However supply chain disruptions rumbled on through the year and delayed the recovery. In March 2024, tensions in the Middle East put the supply of helium from Qatar under pressure as many shipping firms re-routed their vessels to avoid the Strait of Hormuz for security reasons. This resulted in a capacity bottleneck through the busy Suez canal.

The war in Ukraine has also impacted the international helium supply chain. When the conflict broke out in Feb 2022, supply of Russian pipeline gas to Europe was reduced. A surge in natural gas prices immediately followed. The consequence was that Algeria's Arzew LNG plant reduced its liquefaction output. Instead, the available natural gas was compressed and piped through the MEDGAZ pipeline under the Mediterranean Sea to southern Spain to boost gas input to the European pipeline network.

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bloc has been banned. In practice, helium exports from Russia to the EU had been curtailed by earlier sanctions packages which limited access to Russian ports, where cryogenic ISO tanks containing liquid helium has previously been loaded onto container ships destined for European ports.

Fires and unplanned outages

Natural gas processing comes with the inherent risk of handling massive quantities of high-pressure, flammable methane. The risk of fires and explosions cascades to the co-production of helium.

On 19th January 2004, an explosion and fire at Sonatrach's Skikda LNG facility in Algeria destroyed three out of the plant's six natural gas liquefaction trains. Restart of the three surviving LNG trains took until September of that year to complete. Helium production at Skikda commenced about one year later, but with a 40% reduction versus the planned capacity, due to the reduced volume of natural gas being processed at the site.

2019 saw another setback for Algeria's gas processing industry. On 1st July, a gas pipeline at the GL1Z plant at the Arzew LNG complex exploded, resulting in a major fire. Despite the severity of the incident, Sonatrach declared that it did not impact LNG production capacity.

Great hopes were pinned on Russia's Amur gas processing plant and its potential to complement the fragile global helium sourcing situation. However, in October of 2021 a fire disabled the #2 gas processing train during commissioning and startup. Soon after, in January 2022, a similar fire on the #1 train also put that out of action. Combining these issues with export restrictions means that very little helium from Amur will reach international markets in the near future.

Depleting natural gas reserves

Natural gas production in North America ramped up significantly from 1950-1970, then plateaued until shale gas exploitation took off in the early part of the 21st century. During the 1960s a helium pipeline and storage network was established. The 400-mile route extended from Bushton (Kansas) to the south, where crude helium was stored in the depleted Cliffside gas field close to Amarillo in Texas. This became the cornerstone of the US National Helium Reserve.

Many of the most productive helium wells in the US are now largely depleted, and the inventory of the National Helium Reserve is also declining. On the other hand, consumption of helium for medical, aerospace, manufacturing, lifting, and scientific applications is growing. As a consequence, the US is now a net importer of helium.

The rise in US imports increases demand for helium from overseas sources such as Qatar. In turn, as these sources deliver more to the US market, there is a domino effect on other markets. Competing regional markets in Europe and Asia have been under pressure to find local sources to balance the global picture to avoid shortages and surges in helium pricing.

The helium source at Odolanów in Poland has often played a balancing role in the European market. In the southern hemisphere, the first commercial production of helium was at Darwin in Australia's Northern Territory. This source served both the Australia and Asian, relieving pressure on the lengthy supply chain to these markets from the Middle East via the Indian Ocean or from the USA across the Pacific.

As with sources in the US, Russia and Algeria, natural gas exploration led the way in Poland and Austria. The Darwin source was operational from March 2010 to December 2023. It shut down when the gas pressure in the Bayu-Undan gas field, operated by Santos fell to uneconomically low levels.

Hope from natural hydrogen

In addition to abundant natural gas reserves, Australia is emerging as a natural hydrogen power-house. This gas, like helium and methane, is present in the earth's crust where it has been formed over millions of years and has accumulated in sub-surface geological formations.

The historical synergy between natural gas exploration and helium production is now being repeated in the search for natural hydrogen. Drilling by the Australian company Gold Hydrogen has confirmed that natural hydrogen in South Australia's Yorke peninsula contains more than 15% helium. This far exceeds the concentration of helium that is found in most natural gas sources. The richer helium concentration enables cost effective purification and synergistic recovery of helium can materially enhance the business case for natural hydrogen exploration.

A focused search for helium

On-purpose helium exploration is also on the rise. Traditionally, fossil fuel extraction has led the way and natural gas sources have been evaluated for their dual potential as a helium source. Given the issues of producing helium as a minor co-product of natural gas processing, the tables are now turning.

Helium is slowly formed underground through natural radioactive decay of uranium and thorium. An ideal helium source is likely to be siliciclastic sediments enriched in heavy minerals. Due to the long half-lives of uranium and thorium, it takes thousands of years to accumulate significant quantities of helium in the source minerals.

A high underground temperature is required to purge helium from its source mineral. Helium is then released from the pore spaces and transported upwards through the subsurface by natural underground fluids. Helium gas reserves are found in locations where the helium-enriched fluid becomes trapped in a non-porous, domed rock formation with good reservoir properties.

Southwest Tanzania is an on-purpose helium exploration hot-spot. Awareness of its potential was aroused when gas analysis confirmed that helium was degassing from hot springs along the East African rift.

The companies Helium One, headquartered in the UK and Noble Helium, based in Australia, have both drilled exploratory wells in the Rukwa basin. Helium is contained in multiple reservoirs as shallow as 85m, as well as in the granitic basement at about 1,000m depth. This region is believed to have the potential to have the third largest helium reserves, after Qatar and the US.

When commercialisation begins, purification of helium from the Rukwa basin in Tanzania will present a different technical challenge to the separation of helium from natural gas because nitrogen is the carrier gas. However, the prize of decoupling helium supply from natural gas processing will surely justify the price of innovation. gw

Sonatrach Skikda LNG plant, Algeria

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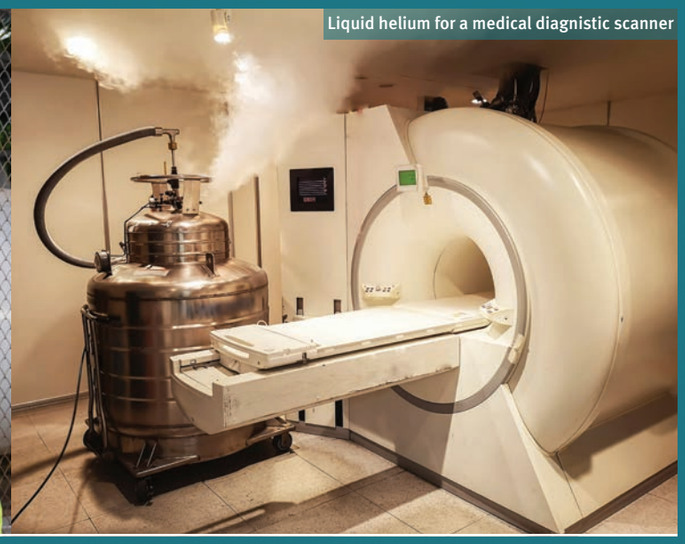
> "Given the issues of producing helium as a minor co-product of natural gas processing, the tables are now turning"

Helium liquefier, Thailand



Liquid helium for a medical diagnistic scanner