In focus...

Air separation technologies

By Joanna Sampson

Air separation units (ASUs) are at the heart of the industrial gases business. Towering structures with clean lines and vast lengths of piping, these mega facilities are also synonymous with the image of the industry, just like the cryogenic tankers that ship the gases produced.

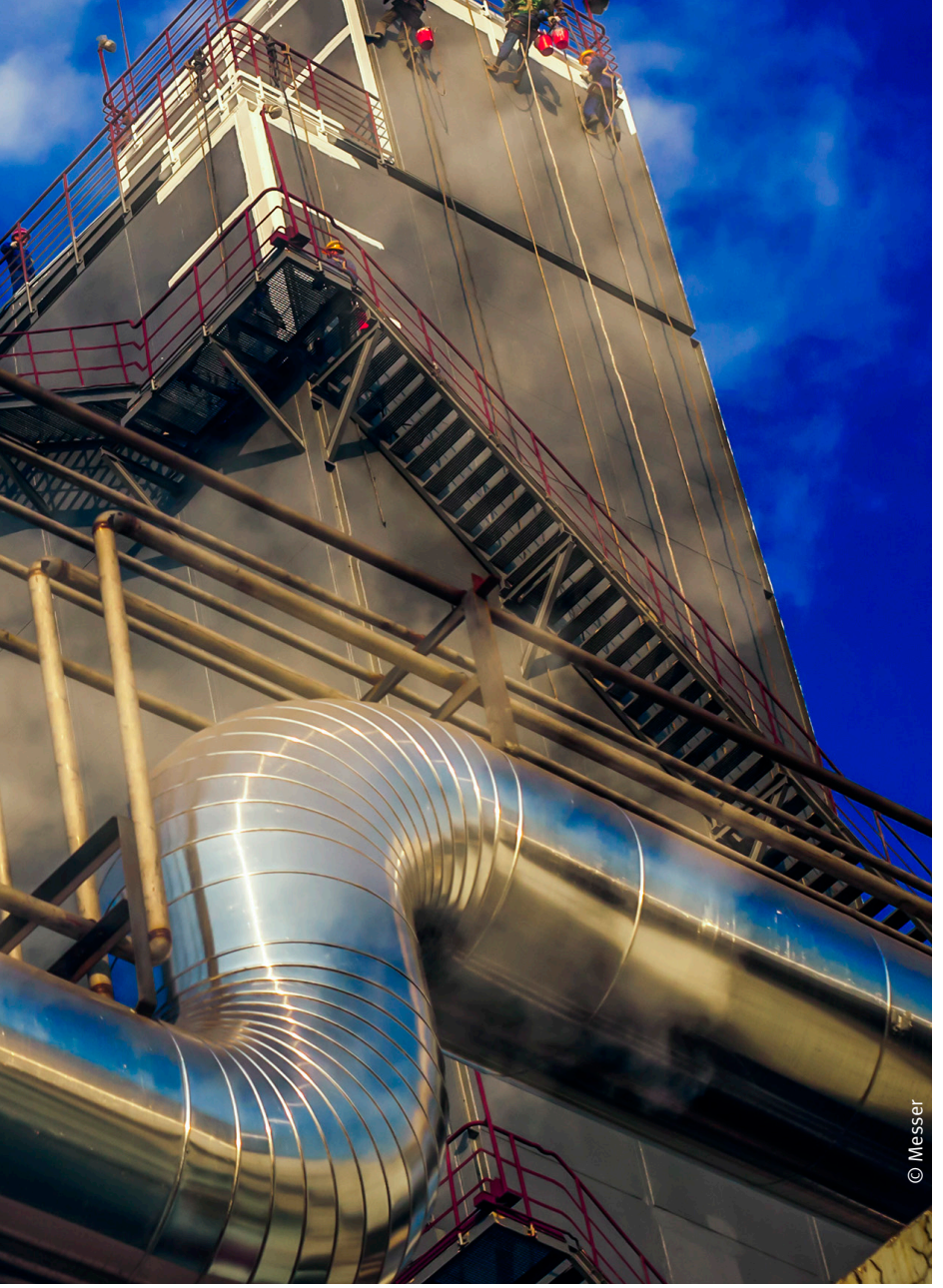
Oxygen, nitrogen and argon are the primary products of an ASU, but these facilities are integral to the production of all industrial gases. A cryogenic ASU exploits the fact that air can be cooled sufficiently for it to become a mixture of liquids and the difference in their boiling temperatures allows the component gases to be separated by distillation – ultimately producing an array of industrial and specialty gas products.

This groundbreaking process was invented by refrigeration pioneer, Carl von Linde, when, in 1895, he liquefied air, swiftly following this achievement in 1902 by separating it into its constituent gases - and laying the foundation for the modern industrial gases industry. During this same period, French engineer George Claude successfully developed a new air liquefaction process and along with his business partner, Paul Delorme, launched the public company Air Liquide in 1902 to research Claude's processes.

The air separation unit has come a long way since it was first pioneered over a century ago. These huge feats of engineering are emerging around the world all of the time, in various configurations and ever-increasing capacities. This year alone has seen numerous significant ASU projects either completed or announced in a number of regional markets.

In the US, Linde North America achieved a significant construction milestone in its progress to build its newest ASU in Adel, Georgia in June, which is expected to begin operating in Q1 2019. In December, Airgas revealed plans to build two new ASUs in Minnesota and Pennsylvania to increase bulk gas production in the Midwest and Northeast. In the same month, Air Products said it planned to build, own and operate a new large-scale ASU in the Twin Cities area of Minnesota, which would come onstream in early-to-mid 2020.

In Europe, Linde signed a long-term industrial gases supply agreement with



NLMK Group in November and invested around €100m into a new state-of-the-art ASU which the Tier One company will build, own and operate at NLMK's site in Russia. Air Liquide signed a long-term contract for the supply of oxygen, nitrogen and argon with steel producer Evraz in May. The French corporation will invest around €130m for the construction of two ASUs, which will improve energy efficiency and the overall environmental footprint of the production process. In September, Ghani Gases commenced operations at its third state-of-the-art ASU plant in Pakistan.

In Vietnam, Messer built three new state of the art ASUs with a total capacity of 5,800 metric tonnes per day. These plants, which come on stream in the second quarter of 2019, will cover the new demand of a local steel producer and provide bulk products for the local market. The Vietnamese subsidiary of Taiyo Nippon Sanso Corporation (TNSC), Vietnam Japan Gas Joint Stock Company (VJG), constructed a new ASU in May in southern Vietnam to respond to increased demand.

In China, Kaifeng Air Separation Group (KFAS), signed a contract for two sets of 60,000 Nm^3/h ASUs – a big order for the start of 2018.

In South Africa, Air Liquide started the world's largest oxygen production unit for integrated energy and chemical company Sasol in March. The company invested around €200m for the construction of an ASU in Secunda, with a total production capacity of 5,000 tonnes of oxygen per day.

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Transition to cleaner energy

Air Liquide has developed a range of industry-leading solutions, state-of-the-art ASUs and cryogenics technologies designed to optimise capital and operational expenditure for plants ranging from 30 metric tonnes per day (mtpd) to 30,000 mtpd. This includes the use of vacuum swing adsorption for smaller sized plants and the use of cryogenics for medium and large sized plants.

The French company's expertise in this field is drawn from more than 117 years of experience and know-how, with high standards of safety, reliability and efficiency. Air Liquide is applying its expertise to tackle some of the broadest and most challenging issues facing its customers today: by providing cleaner technologies and energy efficient tools and processes that help them address the need for cleaner solutions.

"Underpinning much of the current market activity is the need to produce cleaner energy," David Maloney, Group Vice-President of Engineering & Construction and Capital Implementation, and Engineering & Construction Chairman and CEO, tells gasworld. "This trend, which forms part of the wider energy transition, has many dimensions, such as the capture and use of CO_2, the recovery of other valuable gases, such as hydrogen, which not only improves process efficiency (and hence minimises emissions), but have commercial value in their own right."

"The drive across a wide range of sectors to make the transition to cleaner energy production and use has significant long-term impact and is the most far-reaching trend we are seeing."

"Air separation contributes towards better energy efficiency (kWh/Nm^3) and in the drive towards greater use of

renewables, within the limit of their capacity given their intermittency."

This is echoed by Johann Ringhofer, Executive Vice-President of Engineering and Production at Messer Group, who says Messer is also seeing the trend to even larger plants with the focus on energy efficiency and a lower CO_2 footprint.

"In this context, the argon yield is also quite important. Another promising tendency are lower oxygen purity environmental driven projects, for example oxyfuel combustion."

The family-run business builds all types of ASUs including cryogenic plants and air separation plants at ambient temperatures. Messer's capacity range comprises cryogenic air separation plants for tonnage products from 100 tonnes per day up to 3,000 tonnes per day with an argon production and for plants in the upper range with krypton or xenon recovery.

The German company also builds cryogenic ASUs for bulk products. The total liquid oxygen and liquid nitrogen capacity including cryogenic argon purification varies from 250 up to 600 tonnes per day. The capacity range of non-cryogenic separation plants spans from a few hundred Nm^3 per hour up to 300 tonnes nitrogen and oxygen per day.

Other trends

Linde's ASUs serve all industries from steel works to electronic fabs and copper smelters to coal gasification plants. It offers standardised cryogenic ASUs for oxygen production from 70 mtpd to customised ASUs of 5,500 mtpd size. Linde also offers nitrogen generation plants from standardised units of 15 to customised ASUs of 10,000 mtpd. Low purity applications are served by vacuum pressure swing adsorption systems (VPSA) ad high purity and high capacity applications by cryogenic air separation. Linde's VPSA systems deliver up to 10,000 Nm^3/h of oxygen.

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Key trends Linde is seeing are:

- Digitisation and technological advancements in the electronics industry requiring bigger amounts of nitrogen and other gases.
- Flexibility requirements making use of fluctuating costs of power.
- Customers focusing more and more on best total cost of ownership rather than price alone. Power efficiency and costs of operation and maintenance playing an increasingly important role.
- Over-the-fence contracts to see a continuous growth.

Growth drivers

The areas with high opportunities for industrial gases are the electronic industry, medical applications in medical care as well as in home care, the food industry and gases applications in environmental improving technologies, notes Ringhofer.

"From a geographical perspective, there are many growth potentials in the developing countries, as they will catch up with the living standard in our hemisphere," he adds.

For Air Liquide, Maloney says gas monetisation remains a promising market application with large to very large ASUs, integrated to the main processes. "Growth may come as well from hydrogen for zero-carbon energy generation."

Linde sees China remain as the biggest market for air separation with new gasification projects visible on the horizon. The company says electronics is still a significant growth sector due to fab extensions of the majors.

Future

While the underlying principle of cryogenic air separation is still the same, the size of a modern ASU has multiplied by around 80,000 in capacity and energy efficiency has vastly improved.

So, what does the future hold for this industry?

"The future is very positive, principally because of the tremendous diversity of uses of separated industrial gases across a wide range of sectors and the contribution of industrial gases to better industrial process efficiency and lower emissions," highlights Maloney. "For many industries, having the right volumes and quality of gases such as oxygen and nitrogen are essential to successful operations."

"For oxygen, there are a vast number of industrial uses: in heavy manufacturing, chemicals production, pulp and paper, fermentation, biotechnology and pharmaceuticals, waste treatment and food processing."

"Nitrogen is widely used to eliminate the risk of fire and explosion, in numerous industrial inerting systems, in a number of food industry applications including packaging, freezing and processing and is being increasingly used to improve oil and gas recovery."

"The ability to separate gases cost effectively, to create valuable feedstocks and products, is already a strong market. But it is one with the potential for significant global growth; overall there will be significant value in the ability to maximise the value of all resources."

He adds, "The industry will also evolve with the digitisation of plant operations. Today Air Liquide is already servicing 140 sites across the globe through centralised coordination of plant operations via remote control centres and we see this trend will grow to improve efficiency and reliability of plants."

"The gases industry will improve its performance by more efficiently operated plants, optimised supply chains enabled by digitalisation, Internet of Things and big data processing in a highly competitive market," Ringhofer concludes.