

An introduction to...

ASU's

Air separation units (ASU's) are integral to the production of all industrial gases such as argon, oxygen and nitrogen by separating air into their constituent components.

ASU's also play a vital role in the production of specialty gases and rare gases – and, interestingly, are also highly reliant on these types of gases for their efficient, consistent and safe operation.

In this highly effective closed loop model, the ASU is the primary unit for the production of the main constituents of air and rare gases. Without ASU's in modern industry, it would not be possible to produce these molecules in the quantities required today and in such a cost-effective manner. Although other technologies exist to produce these molecules, the processes they harness are far more costly.

ASU plants separate atmospheric air into its primary components, typically nitrogen and oxygen, and sometimes argon and the so-called rare gases. The separation process utilises various technologies, the most common of which is cryogenic distillation. 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.

Nitrogen and argon extracted from the air separation process are normally produced directly from modern ASU's at a purity suitable for most industrial and specialty gases applications. When extracted from an ASU, oxygen can generally be used without further purification for many medical and industrial applications, but specially designed ASU's are required to produce the high purity oxygen needed for specialty gases applications.

The rare (or noble) gases neon, krypton and xenon are only present in the air in trace amounts of parts per million. Therefore in order to extract them in viable amounts from the air separation process, large scale units with huge air intakes, of the order of at least 1,000 tonnes per day (tpd) oxygen capacity, are needed.

Krypton and xenon are usually extracted with oxygen, but require several additional steps to be separated and purified. To yield these rare gases, the ASU must be equipped with a second column in which liquid oxygen is produced containing approximately 0.3% of these two rare gases. This 'crude raw material' is shipped



to an enrichment plant to remove oxygen. In a subsequent purification and distillation step, the rare gases are then separated and purified to about 99.999% purity where they are then suitable for the majority of market applications.

Neon has significantly different physical properties compared with krypton and xenon is normally extracted from the lower pressure column of an ASU, along with nitrogen. The subsequent enrichment and purification process is simpler than for krypton and xenon because typically, the crude product already contains about 50% neon. This is transported to a separate plant to be purified using cryogenic separation technologies.

Process control & safety applications

In the closed loop process in which these essential gases are produced, the same high purity specialty gases, rare gases and accurate mixtures of these gases are required daily for process control and safety functions on and around the ASU.

Highly precise specialty gases mixtures are required for the proper function of the analytical instrumentation controlling the ASU process. These instruments require calibration and periodic testing with accurate gas mixtures to ensure they are functioning correctly and therefore that the ASU functions optimally.

Specialty gases mixtures are also used to ensure people and plant safety. At ASU facilities where more than 1,000 tpd of pure oxygen and nitrogen are often being

produced, the consequences of a leak could be potentially very severe. Although these gases are not toxic, if leaked out in sufficient quantities, enriched oxygen poses a fire hazard and nitrogen or argon create the risk of asphyxiation via oxygen deficiency. It is therefore critical to test for gas leaks around an ASU continuously, using either fixed or mobile detectors, worn by plant personnel as part of their personal protective equipment. These gas detectors also require specialty gas mixtures in convenient portable cylinder packages for daily testing and calibration.

Hydrocarbon, carbon dioxide and nitrous oxide analysis are required during the extraction of krypton and xenon to ensure the ASU is operating within safe parameters and avoid the accumulation of these flammable components or deposition of solid carbon dioxide and nitrous oxide in the liquid oxygen. This process safety instrumentation must be calibrated and tested regularly using specialty gases mixtures and will require high purity specialty gases for daily operation.

Welding gas mixtures and technical grades of pure gases such as argon or oxygen are also essential for construction of the ASU in the first instance, and equally to conduct maintenance or retrofit projects on the ASU during its life cycle of operation.

So, like the story of the chicken and the egg, the gases that are produced on the ASU are ultimately responsible for its safe and sustained operation in a finely balanced closed loop system. □