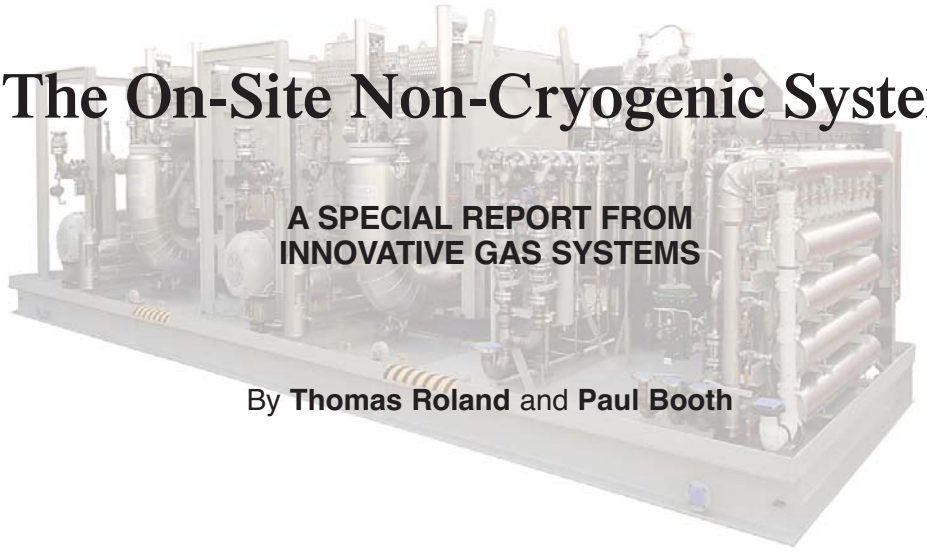
The On-Site Non-Cryogenic System



A SPECIAL REPORT FROM INNOVATIVE GAS SYSTEMS

By **Thomas Roland** and **Paul Booth**

On-site non-cryogenic gas separation systems have come a long way since their introduction in the early 1970s. Today, Innovative Gas Systems' (IGS) non-cryogenic technologies, with their improved production capabilities, are in high demand. The company has an extensive backlog of work with Chevron, Exxon Mobil, Halliburton, Weatherford and BJ Services, as well as a host of other large industrial customers and has expanded its facilities around the world to meet the challenges of the industry's call for higher capacities and more innovative technologies. IGS now manufactures both membrane and PSA systems at three global sites. Our US facility in Houston, TX, sits on 23 acres and consists of Research and Development, testing, warehousing, and manufacturing facilities. Current IGS projects involve compression systems, instrument air packages, and core on-site gas technology in the form of nitrogen and oxygen generation systems. IGS's membrane modules are manufactured in Pittsburg, CA, on the company's 15-acre campus that contains all the manufacturing tools necessary to spin the fiber and bundle the modules, which are the core of the IGS membrane system.

IGS also has two facilities overseas. In Grosseto, Italy, the company has a three acre site with R&D, manufacturing and warehousing facilities. Some remarkable advances in IGS PSA technologies have been made at this facility, including achieving the European equivalent to FDA approval for its oxygen Pressure Swing Adsorption (PSA) design. IGS also has R&D, manufacturing and warehousing facilities on four acres in Chengdu, China. This facility has seen exponential growth due to the expansion of the Asian industrial market. IGS just delivered one of the largest PSAs in the company's history.

Monthly Cost of NonCryo Membrane N_2 vs Purchased LIN

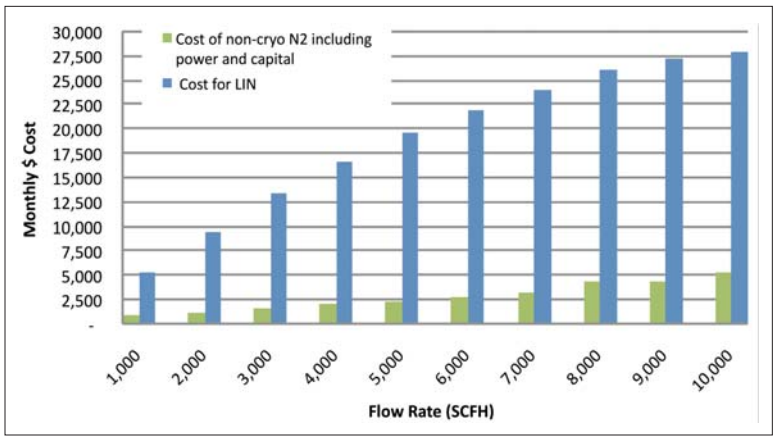


Figure 1 Source: IGS

THE ON-SITE ADVANTAGE

The traditional method of air separation is, for the most part, by cryogenic distillation processes. Using that technology, the main components of the cost/price of liquid nitrogen (LIN) are plant capital, electric power, diesel fuel, and distribution equipment costs. All of these input costs are tied to rising energy and other costs, and are summarily passed on to the end-users of N_2. As liquid demand has risen, capital investment in new liquid capacity has not kept pace, resulting in the market price for LIN increasing significantly. These factors have given end-users, as well as distributors, less confidence in bulk liquid suppliers' ability to deliver nitrogen consistently at a fair price using cryogenic technologies.

On-site non-cryogenic air separation can be more cost-effective than cryogenic separation technology for a variety of reasons. For example, on-site systems eliminate the need to transport the product, thus avoiding the increased costs associated with diesel fuel and the increased cost of capital related to distribution equipment. A liquid nitrogen system also has more up-front capital cost associated with its installation than an on-site system due to the weight of the product and the hazards associated with cryogenic fluids. With liquid supply, customers that use gas are being charged for liquefaction that is unnecessary to them and only benefits the industrial gas companies in ease of transportation. And importantly, on-site supply is a gas-to-gas process; it eliminates the losses inherent in cryogenic processes. With cryogenic storage tanks (which degrade over time) losses can range from 0.1 percent to 3 percent per volume of the tank per day, depending on the quality of the vacuum. If a customer is down for extended periods, the losses can be a real problem.

The typical non-cryo on-site system can produce N_2 gas at a cost of $0.14/ cscf with all cost factors accounted for. This can provide the N_2 end-user with a substantial savings over the costs of traditional LIN supply, where LIN can cost from $.50 to $1.00/hcf, depending on supply conditions and volume.

Figure 1 shows the projected monthly savings based upon a power cost of $0.08/kwh, and when hourly delivery flow rates are from 1,000 to 10,000 scfh. Estimated surcharges and tank rental are included in the total cost of LIN. The savings could be higher or lower depending on the landed cost of LIN and supply contract terms.

Liquid systems have traditionally been able to supply higher purity product over on-site technology. The advancement of non-cryo on-site separation technologies, however, allows higher purities to be achieved using on-site systems, increasing their cost effectiveness in applications that traditionally could only be supported by LIN. PSA technology can provide a product purity of up to 99.999 percent nitrogen, which is comparable to liquid product. Targeting the exact purity needed for an application is critical in deciding on the configuration and cost of on-site supply. True cost savings occur when you use the lowest purity nitrogen acceptable for the application. The cost of energy to produce the lower purity nitrogen can be dramatically less when compared to that of the traditional liquid model. On-site nitrogen generation also has the flexibility to meet the end user's needs in terms of flow. Small membrane cabinet systems or low-flow PSA systems can meet the smallest of flow needs and still deliver a product in the purity range of 95 to 99.999 percent.

IGS's new innovative expandable PSA technology comes in a modular design that allows a user to expand the system.

MEMBRANE NITROGEN

The membrane separation of gases is simple in concept. At the heart of this technology are polymeric materials that allow for the rapid passage of one gas while minimizing the passage of another, when applying a pressure gradient across the membrane. Generon IGS's polymer has very efficient selectivity that allows the fast gases to permeate the membrane at a higher rate relative to the slow gases. This results in the most efficient membrane performance and lowest unit power consumption.

Precipitated polymer is formed into hollow fibers to provide high surface area for high volumetric gas processing rates. Generon IGS holds many patents on the packaging of these hollow fibers into highly efficient modules. The combination of the highest performing polymer and the best fiber bundling techniques, means that Generon IGS has the most efficient modules in the industry. Compressed air is fed into the membrane modules forcing air to penetrate the hollow fibers. Due to the selectivity of the polymer, the oxygen permeates through the wall of the fibers at a different rate than the nitrogen, thus causing separation of the two molecules. The enriched nitrogen exiting the product side of the membrane is consumed at a specific purity ensuring the lowest cost of supply.

IGS's PSA technology has a patented flat flow design that allows users to add banks to the unit to expand production.

PRESSURE SWING ADSORPTION

The second method of non-cryo on-site supply employs PSA technology that extracts the nitrogen in ambient air from the other gases. During the PSA process, treated compressed air is fed into a vessel that is filled with carbon molecular sieve (CMS). The CMS has an affinity for oxygen molecules, which causes the separation of air allowing specified purities of nitrogen to pass through as a product gas. The other gases that are absorbed from the air stream remain attached to the CMS. The sieve releases the adsorbed gases to the atmosphere. The vessel returns to ambient pressure and is back purged with pure nitrogen gas from a storage tank that is utilized in the PSA process to prepare the vessel for the next cycle. The cycle repeats itself every 60 to 90 seconds depending on the purity level that is desired. In order to guarantee a constant product flow, The IGS NitroSwing® generator uses two vessels of CMS, which alternatively switch between the adsorption and the regeneration phases.

IGS has done extensive research on developing new sieves to ensure that our units use less power per cubic foot than our competitors. IGS also supplies smaller volume PSAs for the production of up to 95 percent oxygen. Zeolite is the sieve that is used in the production of oxygen via the PSA process. The same basic principle, using recycled sieve containing vessels, is used in the nitrogen PSA process. Under normal operating conditions and with correct maintenance, the CMS and Zeolite will have an indefinite lifetime.

Two different methods are employed in Generon IGS's design of PSA. The standard that the industry uses for PSA design is a twin tower, two vessel arrangement. IGS has the ability to supply tonnage volume plants as well as lower flow systems at 99.999 percent nitrogen purity utilizing the twin tower design. Oxygen is also produced using the twin tower design substituting Zeolite for CMS.

IGS's new innovative expandable PSA technology comes in a modular design that allows users to expand the system to keep up with their growing demand for product. The patented flat flow design allows users to add banks to the unit to expand production. To further increase the production, the innovative design allows the master unit with the controls to operate a second set of towers. Innovative Gas Systems is the only company in the industry to offer this feature.

Non-cryo on-site production of oxygen via PSA technology has the same benefits as nitrogen PSA, with the only difference being the sieve material. The IGS oxygen PSA can produce from 10 schf to 500 tons per day at purities that range from 90 to 95 percent. The most common use for oxygen delivered via on-site is for enhancing combustion processes that are currently using air burners, so for most oxygen applications this purity level is adequate.

IGS systems built to specification for companies serving oil and gas operations can be mounted on a trailer in order to facilitate transporting them to wells.

OIL & GAS INDUSTRY

IGS business in the oil patch has sky-rocketed along with the rising price of crude. IGS has relationships with all of the major oil and gas companies, as well as the related service industries that support them, and has positioned itself to meet their needs with a range of systems and technologies — from offshore platform applications to pipeline and drilling support systems. Offshore platform systems can include instrument air, primary compression, booster compression and the nitrogen package itself.

The industries that service these offshore platforms require IGS systems and technologies as well, particularly for the production of nitrogen. These systems are built to specification and can be containerized or mounted on a trailer in order to facilitate transporting to the site of the oil or gas well.

INTO THE FUTURE WITH NON-CRYO

Non-cryo on-site technologies have come a long way with regards to improved purity, greater flexibility, and general reliability. Gases are liquefied to make transport more efficient and are produced at the highest purity possible, then downgraded for the application. There is no appreciable cost/price reduction to the low-purity user who now can produce these gases on-site. In addition, as energy costs remain high for both production and transportation of cryogenic liquids, interest in non-cryogenic technologies just gets stronger. Membranes and PSAs provide end-users with an efficient and less costly supply mode in many of today's markets. Given these factors, IGS sees continued strong demand for its non-cryogenic systems and technologies going forward.

For more information on IGS, visit our website at www.IGS-Global.com.

Thomas Roland is Sales Manager for Generon — IGS. He can be reached at troland@Generon.com. Paul Booth is Vice President of Business Development for IGS. He can be reached at PBooth@Generon.com ❑