Q&A

Hydrogen Gas Generation for GC Carrier Gas

Jack Mahan
Sales Manager, Analytical Gas Systems
Parker Hannifin

Helium's short supply and inflated cost have led laboratories to use hydrogen for gas chromatography analysis.

In gas chromatography (GC) analysis, use of proper high-purity gases is critical to the speed and accuracy of analysis. The recent global shortage in helium supply is resulting in significant gas cost increases and delivery rationing, making it more difficult for scientists to stay on schedule and under budget. The Van Deemter Curves, which measure relative carrier efficiencies of nitrogen, helium, and hydrogen, indicate that hydrogen and helium perform similarly at medium gas velocities, with hydrogen outperforming helium at higher velocities. Laboratories worldwide are turning to Hydrogen Gas Generation as a safe and economical way to stabilize gas costs while improving the speed of analysis. *LCGC* recently sat down with Jack Mahan, global sales and marketing manager of Parker Hannifin's Analytical Gas Business, to discuss the advantages of hydrogen generation for GC carrier gas.

LCGC: Can you briefly describe the helium shortage?

Mahan: Helium is a natural resource and it is very expensive to extract from underground deposits. Supplies are running low. The US is exiting the business and economic uncertainty in Qatar has affected the supply chain. In April 2019, the US government reported a 135% increase in the cost of helium from 2018 to 2019 (1). Initial news reports stated that helium shortages were affecting party supply centers that sold helium balloons—a more common consumer application for the gas. In May, a major US party supply company announced the closing of 45 of its stores due to the helium shortage. News reports are discussing helium's use in MRIs and are speculating about the impact to patients' schedules and availabilities. Surging costs decreased availability can also dramatically affect research and laboratory testing, which is our space in the chromatography world.

LCGC: Is hydrogen a real alternative for GC gas carrier applications?

Mahan: Hydrogen is an ideal replacement to helium as it is a faster gas and offers clear advantages in decreasing sample run times and improving overall production of the instrument. In addition, hydrogen frequently allows for lower oven temperatures for separations, which will increase column longevity. An interesting trend that we have been following is that hydrogen has long been the standard choice for many of our European chromatography customers, but, in North America, helium is the standard. We suspect that is largely due to its past availability and its lower price point.

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LCGC: What technology is used in a gas generator to produce carrier-grade hydrogen gas?

Mahan: It starts from a simple source of deionized water and a low current of electricity. We incorporate long-proven proton exchange membrane cell technology to separate hydrogen from water and then use a palladium purifier to polish the remaining gas and remove trace oxygen down to 0.01 ppm, which leaves the user with a 99.99999+% hydrogen, so it is very pure. State-of-the-art controlled software allows users to track flow rates, pressures, purity, and service needs, and also contains several internal safety controls. These systems can be monitored remotely and cascaded together to supply applications of high-volume demands.

LCGC: How safe is a hydrogen generator versus traditional bottle gas sources?

Mahan: Hydrogen generation offers significant safety improvements over traditional cylinder gases. With the traditional cylinder, you have more than 6,500 liters of stored gas, stored at up to 2,2200 psi. That requires additional costs for safety closets, security areas, long runs of expensive stainless-steel piping, and more to integrate. With an on-demand gas generator, you will never have more than 500 cubic centimeters of hydrogen stored in the system at no higher than 175 psi, and the systems can be placed right on the bench next to the GC system. In addition, the cylinders can weigh up to 130 pounds, and the changing and handling can create physical challenges for many users. You only need to periodically fill a generator with a couple liters of water.

LCGC: Can you elaborate on the internal controls on a hydrogen generator?

Mahan: Our hydrogen systems contain automatic shut-off controls when the system detects demands for overpressure or overflow because both could be symptoms of a leak in the downstream line. In addition, these systems offer both visual color changing and audible alarms when these controls engage or when the system needs water or routine maintenance. In short, it will let you know when it needs attention.

LCGC: If there was a leak in some downstream tubing, could that lead to a hazardous situation?

Mahan: If there were a leak in the downstream tubing, it can be easily detected and corrected. The leak will trigger the generator to shut down. Regarding safety, hydrogen has a lower explosion limit (LEL) of 4%. So, a leak or vented gas at such a low flow easily diffuses into the room safely. As a further illustration, a 6x4x3-foot completely sealed space, which is highly unlikely, would require 2,880 liters of hydrogen to reach that 4% LEL. So, a generator producing 500 cc/min would need to run for 96 hours uninterrupted to achieve that environment. A cylinder, however, could immediately create this event with a single leak.

LCGC: How expensive are hydrogen generators to maintain?

Mahan: Maintenance is both easy and cost effective. Simply fill the deionized water reservoir as needed, which is usually biweekly, or customers can opt for the automatic water fill feature to make it even easier. Depending on the model of the system, there are some low-cost consumables such as deionizer bags, desiccant cartridges, or environmental vents filters that require changing once or twice per year. As an option, Parker Hannifin offers a complete preventive services program whereby a factory-trained technician can conduct this maintenance or routine changes of consumable filtration onsite, if the customer prefers.

References

1. H. Tan, CNBC, https://www.cnbc.com/2019/04/12/helium-shortage-is-hitting-balloons-and-scientific-research.html, April 11, 2019.
2. K. Gibson. CBSNews, https://www.cbsnews.com/news/party-city-helium-to-close-45-stores, May 10, 2019.

Parker Hannifin manufactures a range of laboratory gas generators to support analytical equipment and instruments.

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