THE END FOR HIGH-PRESSURE GAS CYLINDERS?

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INTRODUCTION

Does the development of analytical gas generators mean the end is near for high pressure gas cylinders?

High-pressure gas cylinders are a common sight in many laboratories. They have become a default solution for supplying the required gas to analytical instruments. Even though high-pressure gas cylinders have some drawbacks, they are familiar to many users and meet the essential gas supply need. Some might say that 'if it ain't broke, don't fix it.

Nevertheless, increasing numbers of analytical instrument users are choosing to supply their GC-FID, LC/MS and other types of instruments with gas via an analytical gas generator. If you are considering a conversion from gas cylinders to gas generators it is important to evaluate a variety of factors. Key considerations fall into four areas: safety, cost, convenience, and purity.

SAFETY CONCERNS WITH HIGH-PRESSURE GAS CYLINDERS

High-pressure gas cylinders can provoke safety concerns for multiple reasons and in multiple different scenarios—some with potentially fatal consequences. The presence of high-pressure gas cylinders in a facility has been likened to sharing the laboratory with a potential missile. This comparison stems from the behavior of a cylinder that suddenly de-pressurizes. For example, when a European L size cylinder depressurizes, the blast of escaping gas releases enough force to accelerate the cylinder to roughly 66 mph (108 kmh) in about 10 seconds. Cylinders this size can weigh 200 lb (98 kg) once empty, generating enough momentum to cause some severe damage to expensive lab fixtures and/or people.

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To avoid this "missile" scenario, cylinders are usually strapped down to something fixed. Even when they're restrained, however, if a large cylinder suddenly vents its contents into the laboratory, potentially fatal consequences can result (unless it's an air cylinder). For example, if a high-pressure cylinder of nitrogen suddenly vented into the atmosphere of a laboratory, more than 9,000 liters of unbreathable gas would be released. This rapid influx would dramatically reduce the oxygen content of the air—threatening occupants with the real possibility of asphyxiation.

Liquiefied gases also pose a risk of oxygen displacement from the atmosphere because their volume will increase as much as 1,000-fold when in the gas phase. This means liquid nitrogen dewars can also be hazardous. If the gas suddenly venting was potentially explosive (e.g., hydrogen), the result could be much more dramatic. Hydrogen forms a potentially explosive mixture at just 4% volume in air.

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Alongside the possibility of these life-threatening safety concerns associated with high-pressure gas cylinders, there is also potential for non-fatal injuries. For example, it is common practice to move large cylinders by rolling them on their bottom edge, risking crushed or trapped toes or feet. Even smaller cylinders present the potential for back or other injuries due to heavy lifting required to place them on a bench top.

COST, CONVENIENCE, AND PURITY CONSIDERATIONS

High-pressure cylinders are subject to stringent storage requirements to ensure safety (as mandated by OSHA, NFPA, and other regulatory bodies in different countries). For example, hydrogen cylinders and cylinders of oxidizing gases must be stored separately. This often means cylinders are located some distance from where the gases are used, resulting in long gas lines. While the longer gas lines help address cylinders safety concerns, they can negatively impact the cost, convenience, and purity of gases.

Any gas line has the potential to leak—the longer the line the greater the potential. Hence facilities are required to leak-check the gas supply line regularly, adding labor time, which increases costs and decreases convenience. Additionally, leaks do more than allow gas to escape, they also allow impurities to enter the gas supply, which can reduce the accuracy of any analysis.

ANALYTICAL GAS GENERATORS PROVIDE GREATER PURITY

Gas generators can effectively replace high-pressure cylinder gases for many analytical instrument users. Analytical gas generators pose a much lower safety risk and are typically placed next to the instrument they're servicing. This removes any need for extended gas lines, thus eliminating the associated problems with purity, cost, and convenience.

Gas cylinders can have variations in purity from cylinder to cylinder, but generators provide a constant source of gas with consistent purity, helping to improve sensitive analyses. Additionally, switching cylinders and changing over regulators can allow impurities to enter the gas pipes, affecting analysis results.

By contrast, gas generators are designed to run continuously with minimal annual maintenance and therefore minimal disruption to the gas supply. They all but eliminate the introduction of impurities; installing in-line purifiers can further reduce the chance of impurities.

Inherent design features of gas generators and how they operate mean they offer clear and compelling reasons to switch from high-pressure gas cylinders. For example, the latest gas generators use new technologies including membranes, adsorbents, and catalysts to produce ultra-high-purity gases. Because the generators are designed for the point of use, they simplify and minimize the amount of pipe work needed. This proximity guarantees that ultra-high-purity gases reach the instrument.

GAS GENERATORS REDUCE SAFETY RISKS

High-pressure gas cylinders typically contain gas at a pressure of around 200 to 300 times atmospheric pressure. If this gas was released to atmospheric pressure it would have a volume of approximately 9,000 litres.

By contrast, analytical gas generators operate at a fraction of this pressure and store very low volumes of gas within. One of VICI DBS market-leading hydrogen generators, for example, maintains just 50 ml of stored gas at a maximum of around four times atmospheric pressure. There is not enough pressure to create a "missile," nor is there a large volume of stored gas that could suddenly

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vent into the atmosphere. Thus, gas generators pose no risk of a potential explosion or deficiency of life-supporting oxygen.

Additional safety features are also incorporated in the design. For example, VICI DBS hydrogen generators have both internal and external leak detection combined with automatic shut-off devices. Another safety risk with gas cylinders occurs when they must be replaced. A replacement cylinder must be collected and moved into place and the old cylinder removed. Each of these activities brings with it manual handling and safety risks.

THE CONVENIENCE OF GAS GENERATORS

Life in the lab is more convenient with a gas generator. For one thing, there's no unplanned downtime. Analytical gas generators require only simple, quick maintenance at predictable intervals—they don't unexpectedly run out of gas halfway through analysis. By contrast, high-pressure gas cylinders require regular replacement, and they can run out part way through analysis, causing unplanned downtime. After the new cylinder has been connected, the instrument needs to be restarted, a stable baseline obtained and possibly even re-calibrated; only then can samples be run again. With a gas generator, no replacements are required, and the instrument can be run without interruption except for brief, scheduled annual maintenance.

COST BENEFITS OF GAS GENERATORS

High-pressure gas cylinders can prove to be a costly ongoing expense. Typical payback periods on analytical gas generators, however, are short—sometimes less than one year. The cost of using high-pressure cylinders is not only the price of the gas itself, but can include other charges, some seen and some hidden. For example, cylinder rental and delivery charges are readily apparent, however hidden costs might include staff labor and system downtime, which are not a factor with analytical gas generators.

In comparison, generators carry no recurring costs: no ordering replacement cylinders, no storage costs for the spare and empty cylinders, and no cost in lost productivity due to the need to stop and replace cylinders.

VICI DBS Analytical Gas Generators are renowned for their reliability, dependability, and long life. Since commercializing our first laboratory-scale analytical gas generator in the 1990s, we now serve an installed customer base of thousands of satisfied of gas generator users globally.

ADVANTAGES OF VICI DBS ANALYTICAL GAS GENERATORS

A key reason for the adoption of VICI DBS gas generators is the innovative technology we employ—from our proprietary hollow fiber nitrogen-generating membranes to the use of titanium to ensure the highest levels of hydrogen purity.

Nitrogen. Providing nitrogen for uses such as LC/MS, VICI DBS hollow-fiber membrane nitrogen generators represent state-of-the-art technology. The proprietary membrane simply and efficiently separates compressed air into nitrogen and an oxygen-rich permeate stream, which contains other unwanted impurities such as water vapor. The membrane achieves this because it has selective permeation rates for different gases—oxygen and other unwanted constituents of the compressed air simply pass through the membrane at a much faster rate than nitrogen. Hence, you're left with a stream of very pure nitrogen.

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When connected to an existing compressed air supply, VICI DBS nitrogen generators will provide a constant supply of high-purity nitrogen. They contain no moving parts, thus are very quiet to operate with practically no items to wear out and need replacing. The only consumable item is a pre-filter that protects the membrane; it can be changed in five minutes and only needs replacement every six months.

Hydrogen. Hydrogen offers advantages for GC users when used as a carrier gas. The Van Deemter curves illustrate the wide range over which high-efficiency is obtained, making hydrogen the best carrier gas for samples containing compounds that elute over a wide temperature range.
The potential risks associated with high-pressure hydrogen gas cylinders, however, are significant, as outlined above. A gas generator is by far the smarter, safer choice for supplying hydrogen gas. The optimized design of VICI DBS hydrogen generators takes deionized water and separates the hydrogen through electrolysis. It is then purified using a unique GLS (gas liquid separator) and subsequent high-efficiency membranes. For ultra-high-purity hydrogen, a state-of-the-art heater-less dryer is used.

CONCLUSION

Analytical gas generators offer clear improvements in the areas of safety, purity, convenience, and cost compared to high-pressure gas cylinders. With recent innovation and advancements in gas generator technology and performance, there is little reason to continue using high-pressure gas cylinders with instruments such as GC-FID and LC/MS. VICI DBS nitrogen, hydrogen, and other gas generators provide safe, consistent, and reliable performance. The range of our analytical gas generator product line also extends our innovative solutions and approach to other applications such as TOC and FT-IR.

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