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In-House Gas Generation Quells Safety Concerns

In-house gas generators can reliably provide high purity gases for laboratory needs and reduce the safety risks associated with alternative methods, such as high pressure gas cylinders.

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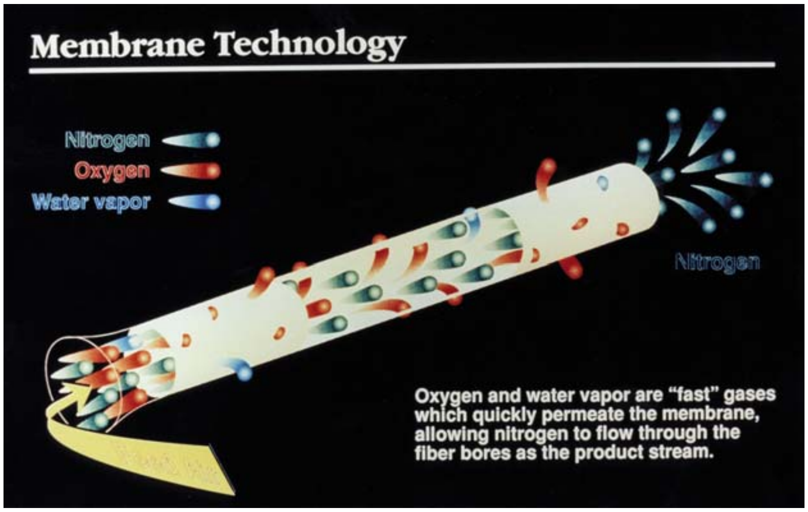

Compressed gases such as zero air, nitrogen and hydrogen are commonly used in the laboratory for a broad range of instrumentation, such as GC with FID, LCMS and FTIR. In many laboratories, the compressed gas source is a high pressure gas cylinder. These cylinders are filled to a high pressure, typically around 2000 psi. The primary disadvantages of gas supply in the form of high pressure cylinders are safety, cost, delivery and service inconveniences.

Precautions must be taken when transporting and handling high pressure compressed gas cylinders. It is possible for serious property damage and/or injury to occur if the individual loses control of the tank. In the same vein, if a leak occurs, it is possible that the air in the laboratory could be displaced by the nitrogen or hydrogen, leading to asphyxiation. Users of high pressure compressed gas cylinders invariably will experience unplanned downtime resulting from an empty cylinder. This may occur in the middle of analysis, overnight or during a weekend. Other inconveniences include delayed delivery, inflexible delivery schedules, price increases, rental fees and long term contracts.

These safety hazards and inconveniences can be eliminated by the use of an in-house gas generator. An in-house gas generator can be connected directly to the instrument and provides the necessary gas at the pressure and flow required by the application on a 24/7 basis with minimum user interaction.

In-house gas generation

The modern analytical laboratory requires highly purified gases to support the various modes of instrumentation that are commonly employed. For example, nitrogen is used with gas chromatography with flame ionization detection (GCFID), thermal analysis (TA), evaporative light scattering detection

(ELSD), inductively coupled plasma spectrometers (ICP), liquid chromatography with mass spectrometry (LCMS) and Fourier transform infrared spectroscopy (FTIR). Hydrogen is used as a fuel and a carrier gas for GCFID, while zero air is used for GCFID, LCMS and other techniques that are used to analyze for aromatic hydrocarbons.

Purified nitrogen and zero air can be readily obtained from laboratory air, and hydrogen can be generated from water in the laboratory using an in-house generator on a 24/7 basis. An in-house generator provides a considerably greater level of safety, convenience and cost savings than the use of high pressure compressed gas cylinders. In-house generators typically operate at low pressures and store small volumes of pressurized gas. This stored volume may vary from less than 50 cm^3 to several gallons as compared to more than 200 ft^3 of gas stored in high pressure gas cylinders. An in-house gas generator eliminates the need to handle heavy gas cylinders, which carry the potential risk of injury or damage caused by lifting, dropping, asphyxiation and potential explosion. Gas generators also provide convenience through the elimination of reliance on an external delivery service. Once the in-house gas generator has been installed, delivery of the desired gas is automatic, reliable and relatively inexpensive. The cost of purchasing and operating a gas generator is attractive as compared to the use of high pressure cylinders.

Paybacks are typically calculated at less than one year, depending on the specific usage and required purity. Most importantly, the cost to operate and maintain an in-house gas generator is very low, especially relative to the cost of ordering, storing and changing high pressure gas cylinders.

In-house generators are available for each gas, as well as generators for multiple gases to support the desired system. For example, a tri-gas generator, which is commonly used to provide nitrogen, zero air and source exhaust air from laboratory air for use with LCMS systems is available.

Nitrogen generation

Nitrogen can be obtained from compressed air in the laboratory using membranes that allow oxygen and water vapor to permeate the membrane, while also allowing nitrogen to flow through the membrane to the end use point. One such system based on this technology is the Parker Balston N2-45 Nitrogen Generator. This system can produce up to 99.5% pure nitrogen at a flow rate of 67 L/min at a maximum pressure of 145 psig. Dust and particulate matter are removed by a pre-filtration system, and an oxygen monitor with an audible alarm is provided to signal a high oxygen concentration. If a high flow of nitrogen is required (e.g. to supply several GCFID systems), pressure swing adsorption (PSA) systems, which use molecular sieves (activated carbon), can be used. The molecular sieve is extremely porous and can retain a significant amount of the pressurized nitrogen, which is then released by reducing the pressure. Flow rates of 99.9% nitrogen as high as 470 SCFH can be obtained with the Parker Balston AGS400 generator.

Hydrogen generation

In-house generation of hydrogen gas is based on the electrolysis of water using either a metallic electrode or an ionomeric proton exchange membrane. When metallic electrodes are employed, a strong, water soluble electrolyte, such as 20% NaOH, and a cathode in the form of a bundle of palladium tubes are used. Only hydrogen (and its isotopes) passes through the cathode, while oxygen and other impurities collect at the anode so that up to 1200 cc/min of hydrogen gas with purity in excess of 99.99999+% can be obtained. Alternatively, a proton exchange membrane (PEM)—an ionic polymer membrane that is designed to conduct protons while being impermeable to gases such as hydrogen and oxygen—can be employed. PEM’s are commonly used in fuel cells to create an electric current (and form water) from hydrogen and oxygen gas. When an appropriate potential is applied to a PEM in the presence of water, the reverse process occurs and the water will be dissociated to form oxygen and hydrogen.

Air generation

Moisture, particulate matter and hydrocarbons can be removed from air using a coalescing filter, a matrix of borosilicate glass hollow fibers in a fluorocarbon resin binder. For instrument grade air, two stage filtration, which can remove 99.99% of 0.01 µm particles and droplets, is used. A three stage filter system is normally used to remove compressor oil vapor. A heated catalysis module and high capacity carbon absorption modules can be used in conjunction with coalescing filters to remove very light methane-based hydrocarbons.

Zero air can be generated by passing compressed air through pre-filters that serve to remove oil, water, dust and particulate matter. Compressor pump oil vapor and other hydrocarbons that may be present in the air are then removed by passing the filtered air through a heated catalytic convertor to form CO_2 and H_2O. The compressed air is then passed through another particulate filter to remove dust and other solids and delivered to the analyzer.

Generating safety

In-house generation of gases provides a significant number of safety related benefits, including the amount of gas that is generated by an in-house system in a given period of time. It is relatively small and can be controlled by the user. As an example, the Parker Balston H2PEM-100 hydrogen generator for GCFID provides a flow up to 100 cc/min at a delivery pressure up to 100 psig. In contrast, when a standard compressed hydrogen tank is employed, a full tank has a pressure that is greater than 2000 psi. If a leak were to occur in the tank or the tubing connecting it, a significant amount of gas would be rapidly expelled into the laboratory. This gas could lead to the asphyxiation of laboratory personnel.

When compressed gas tanks are used, it is necessary to replace the tank on a periodic basis. This means that the tank must be transported from a storage location to the point of use. However, this poses safety concerns. If the individual transporting the tank loses control, the valve could become compromised and the tank would become a guided missile, injuring personnel and/or damaging the laboratory.

An in-house generator ports the gas directly into the instrument or manifold and provides the desired gas on a 24/7 basis with minimal user interaction. In contrast, when a compressed gas system is employed, the possibility exists that the tank may run out in the middle of a run, causing loss of valuable data if the samples are not analyzed properly.

In-house generators monitor the flow and/or pressure of the gas. If there is a significant increase or decrease a signal can be sent to the instrument to stop analyzing samples. This safety feature eliminates the possibility that erroneous data (or no data) will be collected.

Compressed gas tanks must be strapped to a wall or laboratory bench to ensure they are secure. If the tank mounting device fails, a potential hazard exists. This is an especially hazardous situation in laboratories in seismically active areas.

While nitrogen could also be provided by the evaporation of liquid nitrogen, this approach leads to potential hazards, which are eliminated by the use of an in-house generator. The use of liquid nitrogen leads to the possibility of freeze burns as the temperature of liquid nitrogen is -195.8 C, and a potential leak in the system could lead to a significant amount of gas in the laboratory.

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