Play It Safe When Selecting High-Purity Gas Distribution Systems

How complex should they be? It depends on many factors including cost. However, even the most advanced system has relatively quick payback potential through increased efficiency and reduced downtime

‘This type of advanced system can pay for itself in less than a year through reduced gas costs alone.’
By Larry Gallagher

The growth and diversity of process and analytical instruments used in modern chemical process units and quality control laboratories have one thing in common, the need for carrier, support, process or calibration gases. Regardless of the analysis being done or the type of instrument being used, the common thread is that the instruments require a continuous supply of high-purity gas or online calibration standards. Not only have the numbers and types of analyzers increased but also the number of carrier, process or support gases and their requirements for flow and delivery pressure. The inefficiency and safety hazard of numerous high pressure or cryogenic cylinders located next to individual instruments needs to be eliminated.
A substantial process unit or quality control laboratory may consist of several gas chromatographs or gas chromatograph mass spectrometers with multiple detectors on each one as well as Fourier transmission infrareds, infrareds, mass spectrometers and inductively coupled plasma units integrated into a data acquisition program. Their smooth and continuous operation depends on the uninterrupted supply of high-purity grades of gases, helium, nitrogen, hydrogen, argon or air, to name a few. Each instrument may require some of the same support gases but at different pressures or flows. The challenge is how to supply the instruments with the gases they require in a safe and cost-effective manner without compromising the purity of the gas.
The answer is a gas distribution and management system that incorporates primary and reserve supplies of the gas, flow capability and pressure control matched to the instruments requirements as well as safety and process features that allow monitoring of the system status and prevent contamination of the process stream. Does this sound like a large engineering task? In some cases, it can be; but in most cases, it can be simplified.
With small numbers of instruments or analyzers that require specific calibration standards, such as with continuous emission monitoring stations, this can be as simple as a protocol switchover station with or without an alarm that incorporates a

wall-mounted pressure regulator with manual valves to select from multiple cylinder sources, high-purity all-stainless steel pigtail with check valves at the cylinder connections and the option for a low-pressure alarm. This setup allows the system to continue to supply gas during cylinder change-outs and minimizes the introduction of contaminants into the system. It can be set up outside the analyzer or laboratory area, which eliminates the hazard of high-pressure cylinders occupying valuable space and allows them to be monitored through a remote alarm tripped by a pressure switch. The material of construction is critical with regard to reactive calibration standards that contain nitric oxide, sulfur dioxide, carbon monoxide or reduced sulfurs such as hydrogen sulfide and carbon disulfides &#151 generally, 316L stainless steel bar with non-reactive inert seat materials such as PTFE.

Instrumentation pressure control equipment should be assembled in a controlled environment to avoid contamination.

As the number of instruments or analyzers increases, the need expands for a more integrated distribution system that can be supplied by multiple high-pressure or cryogenic gas sources. The solution can be an automatic switch or an intelligent manifold system that provides a primary and reserve supply of gas from a remote gas distribution pad or storage area to a common high-purity pipeline. Automatic switch systems operate on a principle of pressure differential where the primary source’s pressure control is set higher than the reserve source’s pressure. They automatically switch over to the reserve source when the pressure in the primary supply drops below the set point. Intelligent systems, as their name implies, operate by monitoring the status of the gas source with pressure transmitters and incorporate a programmed processor-controlled logic that eliminates false and wasteful switchovers that occur when using cryogenic sources of gas supply. Electronic economizers eliminate vent loss from cryogenic liquid cylinders and typically can reduce overall operating costs, which may mean this type of advanced system can pay for itself in less than a year through reduced gas costs alone. Remote alarm functions for these systems are more advanced and more critical to system function and safety because the systems are typically located outside the laboratory or process facility and are at a distance from the laboratory or process operations staff. This remoteness improves safety by removing numerous high-pressure, possibly flammable or explosive gases from the laboratory or process unit and places them in designated areas under the care and control of individuals more adept at handling them than the average analyst or chemist. However, the alarm and status functions of the systems need to be integrated into the facility alarm system by means of contact relays or remote alarms. The less advanced pressure switch or automatic switch systems may only have a contact closure that signals when a low-pressure alarm condition has occurred. The more advanced or intelligent systems can have RS232 or 485 serial ports that communicate more information about system status and function to an overall gas or process management system. This can include the option to activate a phone dialer or initiate e-mail notification and ordering of product as well as bring the real-time and historical status of the system into the computerized process control and management of the facility. Usage trends can be predicted and anomalies can be spotted before critical system or process streams are impacted.

The IntelliSwitch is an example of an intelligent system that uses pressure transmitters and control logic to eliminate false and wasteful switchovers.

The cumulative flow and highest pressure requirement of the instruments or analyzers must be considered when specifying the gas source supply and manifold system. It also impacts the selection of pipeline size as does the total distance and flow path of the piping system through the facility. If the flow capacity of the manifold system is adequate but the pipeline tubing is too small, an instrument at the end of a long pipeline can be starved for adequate gas pressure and flow as a result of pressure drop through a long or convoluted pipeline. For high-purity gas streams, it is always recommended to consider 308L or 316L stainless steel tubing and use high-purity/high-integrity tube or compression fittings. This not only ensures that the gas purity is maintained, but the cost of using and installing stainless steel is also now comparable to or less than using copper. The delivery pressure into the pipeline from the manifold should be at least 50 psig higher than the highest pressure requirement of any of the instruments in the system, taking into account the maximum pressure drop from the supply source to the farthest point in the pipeline. This does not apply to supplying acetylene in a pipeline system since it should be limited to less than 15 psig maximum due to this gas' reactivity in air at pressures over 30 psig.

At the instrumentation or analyzer bench, this higher pressure is reduced to that specific device's requirements by means of a line regulator, sometimes called a point-of-use regulator. Incorporating this device into a panel that also includes traps, filters, check valves and selector valves finishes off the system. The traps or filters at the point of use should not be used as a means to purify industrial gases in instrument applications. They are there only as a means to trap any minor impurities and act as a final process gas conditioner prior to introduction into the device.

How complex and advanced the final selection or design of a high-purity gas distribution and control system is depends on many factors, cost being one of them. However, the investment in even the most advanced system possible has relatively quick payback potential through increased efficiency and reduced instrumentation repairs, downtime, cylinder rental and residual gas loss as well as increased space utilization and vast safety improvements through reduced cylinder handling.

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