Selecting a Stream Selection Assembly for Analytical Instrumentation

Process engineers rely heavily on analytical instrumentation to ensure product quality. Properly designed systems help prevent contaminated fluids and gases from being delivered to consumers or from reaching the next stage of production. Catching any problems as early as possible can yield significant savings in reduced product loss and system maintenance. The efficiency and accuracy of catching these problems lies principally in the method of delivery for the analysis sample.

Sample analysis has moved from the lab to field, bringing efficiencies to analytical operations. To minimize system costs, many facilities utilize a single automated process analyzer to evaluate multiple sample streams in succession. These systems often utilize a stream selection assembly, which selectively directs multiple sample streams to a shared passage line that leads to the single analyzer.

Stream selection assemblies must deliver a representative, uncontaminated sample from a process line to a detector in the analyzer. System designers should carefully select assemblies that:

1. use minimal space to automatically select a given stream;
2. maintain the sample’s integrity by avoiding cross-stream contamination; and
3. quickly purge old sample material while moving the new stream to the analyzer.

System designers have a choice among various stream selection assemblies that is based on double block-and-bleed (DBB) valve configurations. The most efficient of these assemblies are compact with consistent flow characteristics, fast purge times, low valve actuation pressures, and enhanced safety characteristics. In addition, user-friendly assemblies offer visual actuation and flow path indicators, ANSI-ISA 76.00.02 compatibility, and easy maintenance and troubleshooting capacities. These characteristics will be discussed in depth following a brief look at how sample stream technology has evolved into today’s more efficient

Advancements In Sample Stream Assemblies. Recent advancements have led to modular valve assemblies that accommodate multiple process streams in a limited amount of space. Valve modules with DBB functionality control each stream, operating as both shutoff valves and stream selector valves. (See Figure 1)

Based upon a modular technology concept, these valves house multiple functions in one unit. End users can now have double block, bleed, and actuation functions within a single module versus using several instrument ball valves to perform these functions. Combining the DBB functions in a compact module minimizes the total space needed to perform sample stream selection and reduces overall installation time. As system requirements change, modules can be added or removed, which also saves time.

With modular stream selection assemblies, system designers still have a choice. Now it is among a traditional, a cascading DBB configuration, and an integrated flow loop design. Designers should pay close attention to the efficiency of the assembly in terms of sample flow and integrity.
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Modular cascading designs – like their non-modular counterparts – move sample material through the bleed valves of downstream valving on the way to the analyzer passage. This flow path causes inconsistent flow rates from stream to stream. The primary stream has direct access to the outlet. As the streams get farther away from the outlet, the flow path becomes tortuous. Therefore, sample stream flow is diminished the farther the stream is from the outlet. Purge times are also increased for those streams.

The modular integrated flow loop design eliminates the problem of inconsistent flow. A flow loop is integrated in the base blocks of the modules. Double block-and-bleed valves open directly to the flow loop, which provides a direct route to the analyzer as shown in Figure 2. Sampling and purging are streamlined. Regardless of which stream is running, the flow rates of all streams will be consistent.

Consistent stream flow rates allow designers to set a consistent purge time and analysis time for all streams. The varying flow rates found in cascading DBB designs can lead to wasted product, as the system may be set to purge each stream to the length of time it takes to purge the slowest stream.

This increased overall analysis time may also cause inefficiencies in detecting contaminated process streams. The sooner a faulty reading is realized, the sooner a system can be shut down or corrected. A problem may be detected and corrected several minutes sooner in a system with consistent flow rates, thereby minimizing wasted product.

Additional Design Considerations. Additional points of consideration when choosing the best modular device for an analytical instrumentation operation include system compatibility, safety issues, and the assembly’s user-friendly characteristics. Designers may look for:

Low Actuation Pressures. Built-in pneumatic actuators in automated stream selection assemblies provide repetitive shut off with fewer potential leak points than conventional systems. Common industry practices dictate air system actuation pressures of 40 psig (2.7 bar). Therefore, system designers should choose stream selection assemblies with this rated pressure. Otherwise, additional higher pressure air lines will be needed to accommodate actuation pressure requirements that differ from the rest of the system.

Vented Air Gaps. Many sample stream selection valves are used in applications where the combination of the process fluid and oxygen under pressure can create a dangerous situation.
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An integral vented air gap can prevent the mixing of pneumatic actuator supply fluid and system fluid under pressure. (See Figure 3) The area remains void when empty, and the vented air gap allows the actuator air or fluid system media to vent to the atmosphere or to a collection area if one or both of the seals should be compromised. In addition, the vented air gap keeps actuator air from reaching the analyzer.

*Compact Size.* The size of sample stream selection assemblies has been greatly reduced from the days of instrument ball valve systems. Valve designers have saved significant cabinet space by moving DBB functions into small valve modules. However, side-by-side comparisons of modular assemblies show that not all are alike. System designers should compare the footprint of a complete assembly for the same number of streams to determine which design best fits their size constraints.

*ANSI/ISA 76.00.02 Compatibility.* A primary factor in the size reduction of stream selection assemblies is the advent of the ANSI/ISA 76.00.02 specification for miniature and modular analytical systems.

This specification calls for these systems to be surface mounted onto a substrate featuring inlet and outlet connections contained within a 1.5-inch square footprint.

Stream selection valves designed for compatibility with this specification save installation and maintenance time, as engineers are able to quickly mount the valves directly to substrates. (See Figure 4) Systems that require additional tubing and connections to fit into ANSI/ISA 76.00.02 substrates may increase the overall cost of the system in materials, labor, and maintenance, especially when reconfiguring an analytical system.

*Visual Actuation Indicators.* Field engineers have found visual indicators to be a useful means of identifying which stream selection valve is pneumatically actuated at a given time in the analytical process. These indicators provide visual confirmation of the sample system’s operation and improve troubleshooting time. Large, brightly colored indicators enhance the user’s ability to know that the valve is open.
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Stream Identification. Color-coded valve caps may also be used for quick identification of the various process streams in an analytical system. For instance, a system designer could use a green cap to identify a sample stream, a blue cap to identify a zero gas stream, and other colored caps as needed. Color-coded markings make troubleshooting and valve maintenance easier as engineers are better able to track a process stream that is experiencing problems.

Easy Maintenance. By design, modular stream selection valve assemblies offer ease of installation and maintenance. Multiple valve modules and base blocks are connected to create the sampling system, and they are individually replaceable without removal of fluid connections. In addition, vertical disassembly of valve modules from base blocks permits easy maintenance and prevents accidental disassembly of a whole unit. Even small points in the mechanics of assembly, such as independent insert bolts that are captured within the base block, contribute to a system’s ease of use.

Atmospheric Reference Vents. An atmospheric reference vent is positioned between the analyzer and the stream selector system to equalize the sample loop pressure to the atmospheric pressure. Pressure equalization is typically performed just prior to the sample injection to ensure a constant sample pressure in repetitive analysis situations.

High-Pressure Valve Modules. Pressure requirements in some analytical systems may fall in the 250 to 500 psig (17.2 to 34.4 bar) range. These systems will require high-pressure valve modules. The system needs will dictate how these modules will be used within the stream selection valve assembly.

Product Cycle Life. Modular stream select systems are actuated frequently. Therefore, when choosing a stream select system, it is important for the manufacturer to provide typical product cycle life results or mean time to failure (MTTF) for preventative maintenance programs.

Range of Materials. Analytical systems that have wide material compatibility needs may require alternative seal materials. System designers should look for assemblies that offer optional seals rated to handle more corrosive sample streams.

Conclusion. Sample stream selection assemblies have advanced considerably in course with more sophisticated field analytical instrumentation. These assemblies have moved from bulky, maintenance-heavy systems to miniature, modular designs that offer easy maintenance and improved performance. A variety of factors enter into the right system choice for a particular analysis process. System designers should carefully choose the appropriate sample stream selection assemblies to ensure efficient operation of their analytical systems.