How New Low-Power Solenoid Valve Technology Changes The Game

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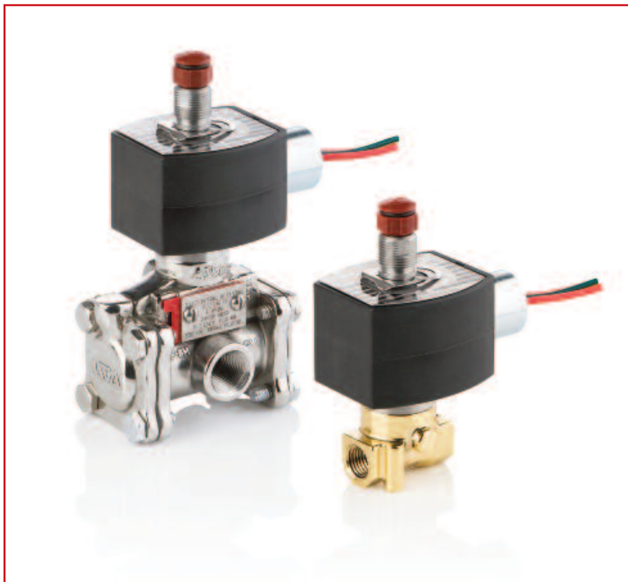

A White Paper From ASCO Valve, Inc.

Introduction

Process plants worldwide often place considerable reliance on low-power solenoid valves. They are used as pilot valves to open and close larger ball or butterfly valves, or on control valves (installed between positioner and actuator) for fail-safe air release if there's a loss of power. They work by pressurizing or depressurizing associated actuators.

A new generation of even lower-power valves is now changing the rules of the power consumption game. These products are of interest to designers working for original equipment manufacturers (OEMs) and valve assemblers, as well as for end-user engineers — anyone who specifies solenoid valves for projects in refining, upstream oil and gas, chemicals, pharmaceuticals and life sciences, food and beverage, and power.

This report taps the expertise of manufacturers at the forefront of low-power solenoid valve technology. It shows how innovation is offering new possibilities — and challenges — via topics such as integrated solutions, clogging and other reliability issues, usefulness in point-to-point and bus networks, other cost savings, remote applications, and relevant industry standards. Finally, it suggests which characteristics buyers should seek out in selecting the newest — and most consistently dependable — low-power valve technologies.

1 How low can they go?

The first class of truly reliable mid power (5-10 watts) solenoid valves was introduced in the 1960s. Many valves of this type are still used today, in less power-sensitive applications. But over succeeding decades, as electronic controls began spreading throughout the process plant, users and manufacturers realized the benefits of decreasing power consumption.

The first truly low-power solenoid valves were intrinsically safe designs debuting in the mid-1980s. They actually reduced power draw to about 0.5 watt — like today's most advanced models. However, they were difficult to manufacture, featured low flow and low pressure ratings. At this point, users had a choice of mid power valves or Intrinsically

Safe (IS) valves. The IS valves, although operating at 0.5 watts, required costly IS safety barriers in the installation.

Some end users realized that they could use IS valves in non IS applications at a greater power consumption of 1.5 watts. This offered them a power reduction compared to mid power valves, but they still faced limitations on flow and pressure.

By about 1995, the performance level was improved by the introduction of a higher flow, higher pressure rating cartridge type valve that delivered acceptable performance at around a 1.5-watt rating.

Lately, efforts toward even greater efficiency and energy conservation — plus the popularity of bus networks and backup power schemes — have increased downward pressure on the power curve. Designs are again approaching the magic half-watt mark, with the newest generation of truly low-power solenoid valves rated at 0.5 to 0.75 watt.

However, not all low-powered valves are created equal.

2 The trouble with integration

Many OEM designers and end users have gravitated toward so-called “integrated” solutions. These feature a low-power solenoid valve built into a position indicator as a single unit. This offers a cleaner package and eliminates the need to source the indicator and valve separately.

Unfortunately, integrated solutions suffer some glaring disadvantages.

First, their “black box” nature makes them difficult to stock, troubleshoot, and maintain. If performance lags or fails, it’s often not apparent which component is at fault, or how repairs or adjustments should be made. In fact, maintenance staff may simply discard the entire package and buy a whole new unit at the first sign of trouble. This adds obvious expense compared to troubleshooting and replacing a single component.

Additionally, the selection of valves in integrated solutions falls to the source manufacturer, who may just adopt valves designed for lighter-duty uses such as packaging lines. Certainly the eventual specifier or end user has little or no say about the integrated valve. Will its flow efficiency, orifice size, operating temperature, response times, pressure ratings, durability, and general reliability match the intended process application?

In addition, special valves usually mean special availability problems. Buyers of integrated solutions can’t just standardize on, stock, and easily replace a single part-number valve with characteristics sufficient to accommodate all of a plant’s applications.

Designers or users forced to use integrated products must discuss the valve component with the vendor. Was it a buy-out item? From which manufacturer? What tests were con-

ducted to ensure that the product would not fail in the field? What is the recommended maintenance schedule? What are its orifice size, pressure rating, reliability record, and other critical characteristics? How do these match the intended application?

3 Clogging and other sticky questions

OEMs and users alike report that integrated solutions — and in fact some non-integrated, separately available valves — may also suffer from other reliability issues.

A chief worry: clogging.

Most valves designed around a 1.5 watt or higher power rating easily comply with the ANSI/ISA 7.0.01 1996 quality standard for instrument air. This calls for clean, dry air or inert gas filtered to a particle size of 40 micrometers.

However, many newer solenoid valves designed for lower power achieve this partially by limiting orifice size. Unfortunately, the smaller the orifice, the greater the chance of operational difficulty or failure due to the entrance of foreign matter into the valve: in other words, clogging.

Most models try to compensate via more complex filtration. Instead of the standard 40-micrometer variety, they utilize nonstandard 5- or 10-micrometer filtration. These special filters demand more complex air line installation. They add substantially to system cost, and increase operating expense due to more frequent maintenance — and shutdowns. Yet all this can't guarantee that their smaller orifices won't still encounter clogging over the course of time.

Clogging — or any other issue that threatens long-term reliability — represents a serious threat to solenoid valve users. In many industries, the larger process valves that these small pilot valves control may remain in the same position (open or closed) for days, weeks, or even months. Yet when required, the valves must operate with unfailing reliability. If not, the consequences could be serious for process integrity, plant investment, or personnel safety.

Basically, redesigning any valve to use less power can mean a series of tradeoffs, with at least a minimal "performance hit." Here these tradeoffs may involve decreases in factors such as orifice size and maximum allowable pressure. (For instance, buyers should confirm that a valve has a pressure rating high enough to avoid the need for add-on pressure regulators.)

However, in top-ranked valves, designed with generous parameters from the start, performance decreases are negligible. And lower power consumption means less heat, for longer life of coils and power supplies — which also means less strain on associated equipment. Since product life cycles may roughly double with every 10° C decrease in operating temperature, these advantages add greater dependability.

So such valves — particularly high-quality, stand-alone low-power solenoid valves rather than integrated solution models — meet almost any real-world process requirements with ensured reliability. Buyers should check with the manufacturer for specific application suitability.

4 Point-to-point savings

Traditional point-to-point wiring schemes often incur greater expenses for a valve's installation (labor, cables and conduits, fittings, connectors, I/O, and plant real estate) than for the valve itself. Solenoid valves configured around the emerging half-watt standard can reduce these installation costs.

Their lower current draw eliminates the need for additional power isolation relays. They permit the use of smaller, less expensive wiring gauges. They also allow the use of downsized, less costly power supplies.

In addition, power is a limiting factor in how many valves may be driven off a single PLC or DCS output card. Using valves that require only 0.5 watt to replace models drawing 1.5 watt, 1.8 watt, or more can double or triple each card's valve carrying capacity. Result: fewer output cards needed. So planners save on card purchase costs — as well as on the costs of associated power supplies and/or batteries.

5 The advantages of taking the bus

Plants considering retrofits or new construction can take advantage of the automation benefits of bus networks to find even greater utility in new low-power valves.

In an older point-to-point arrangement using valves with conventional power limits, a single valve plus installation and equipment might cost $2400. By contrast, experience shows that the latest low-powered valves arranged on an optimized DeviceNet or ASI bus can cut materials and labor costs alone by close to 50%! So that figure of $2400 per valve and accessories would shrink to $1200 instead.

Greater efficiency and "fit" can also be achieved. For DeviceNet, ASI, and other bus network applications in which input and output devices are powered directly from the network, new low-power valves may require only a third the current of their predecessors. So replacing older 1.5-watt-plus valves on a DeviceNet bus with the latest, most reliable models at around 0.5 watt can allow users to "fit" more valves. This maximizes the number of input and output devices on each bus segment, while making the most of the limited current credit available.

6 Substantial savings and future flexibility

Thus for both point-to-point and bus-based configurations, the new low-power solenoid valves offer economies in everything from PLCs, DCSs, and other control devices to the use of easier, less expensive, smaller-gauge wiring.

Yet they are available at the same price as the previous low-power generation. And even more savings accrue due to smaller plant footprints. Finally, planners gain the flexibility of being able to add, subtract, or otherwise reconfigure devices and wiring whenever necessary.

7 Remote possibilities

The new low-power solenoid valve models also present fresh opportunities for process control systems in remote locations. Examples include oil pipelines and remote gas extraction stations. There, planners must choose every device with an eye to minimizing power usage.

Low-powered solenoid valves are an ideal fit.

Designers of remote installations can choose from different savings paths. The lower power drain of the new valves can allow the system to be specified with a smaller battery bank. Alternatively, designers may hold batteries to the same size, but rely on decreased power consumption to optimize the system for longer operation without sunlight.

Planners must also consider environmental needs. For instance, when the local temperature range includes extreme cold, standard low-power valves may require heat tracing or protection. This necessitates added power plus a larger, more costly battery/charging system. Instead, site designers should specify available low-power models rated for -40° F.

Some less remote sites actually on the grid may still deploy backup power arrangements (generators or batteries). These locations include pharmaceutical lines and critical petrochemical lines where the loss of costly consumables, feedstocks, or in-process materials due to line interruption would be especially serious. The latest low-power solenoid valves help ensure less drain on these backups.

Finally, the advent of SCADA systems has enabled monitoring of distant locations via remote terminal units. These communicate back to the production office, saving time and money — and eliminating what once was routine onsite maintenance calls. Using the right high-reliability, low-power valves can prevent even more of these prohibitively expensive, time-consuming visits.

8 There's safety in standards

Industrial standards constantly evolve. Engineers who specify critical equipment for process plants must acquire and apply knowledge of all relevant standards, both current and future.

For instance, process industries worldwide are fast adopting the newer safety integrity level (SIL) requirements described in documents such as IEC 62061:2005 and IEC 61508. SILs provide uniform gauges of risk factors so that designers may rationally allocate equipment purchase costs. The higher the SIL number (from SIL-1 up through SIL-4), the better a device's safety performance, and the safer the system or the safety control loop. Specifically, a higher SIL indicates a lower probability of safety function failure on demand.

Not all manufacturers rate their solenoid valves higher than SIL-2. Knowledgeable designers and users may seek out the exceptions, where a SIL-3-level-capable valve best suits their critical application.

Even manufacturers that offer SIL-3-capable valves can lack other standards. For instance, European makers may not offer certification to U.S. standards such as UL or FM. Designers and users should ensure that all necessary standards such as ATEX, IECEx, FM, CSA, and UL have been met for any valves on their approved product lists.

9 High-performance low-power solutions

As mentioned previously, the newest low-power models from several manufacturers have approached the magic 0.5-watt mark. Example: the broad new line of low-power, high-performance solenoid valves from ASCO Valve.

Such valves represent a comprehensive reengineering of design, supply chain, and manufacturing elements from previous low-power lines, decreasing their ratings from 1.4 watt to 0.55 watt. Valves in this class may be externally identical to their predecessors. However, they incorporate internal improvements including tighter tolerances, greater efficiencies, and other mechanical and magnetic optimizations.

In the ASCO example, since these valves are stand-alone models, they escape the "black box" problems of many integrated solutions. This makes them easy to troubleshoot, stock, and maintain. They utilize larger orifices and standard filters to handle high flows without clogging. They meet most or all traditional process requirements for performance, flow efficiency, ruggedness, pressure rating, operating temperature, and response times. They provide a wide range of popular pipe sizes, temperature and pressure limits, and materials. They comply with relevant global standards, including SIL-3-capable certification. They offer same-day shipment and technical support worldwide. In general,

valves of this type promise to match the newest low-power technological capabilities with time-tested reliability.

Conclusion

Choosing low-power solenoid valves for process industry applications presents several challenges. Designers and users must carefully consider such issues as orifice size and clogging potential, pressure rating and other physical characteristics, bus compatibility, backup power needs, and relevant industry standards before selecting the right valve for the given process industry task. Fortunately, the newest generation of valves offers candidates that combine low power with reliable performance to suit more applications than ever before.

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