Guidelines for Selecting Valves

There is much to consider when choosing the right valves for an application. Here are some basics, important considerations, and guidelines for energy efficiency.

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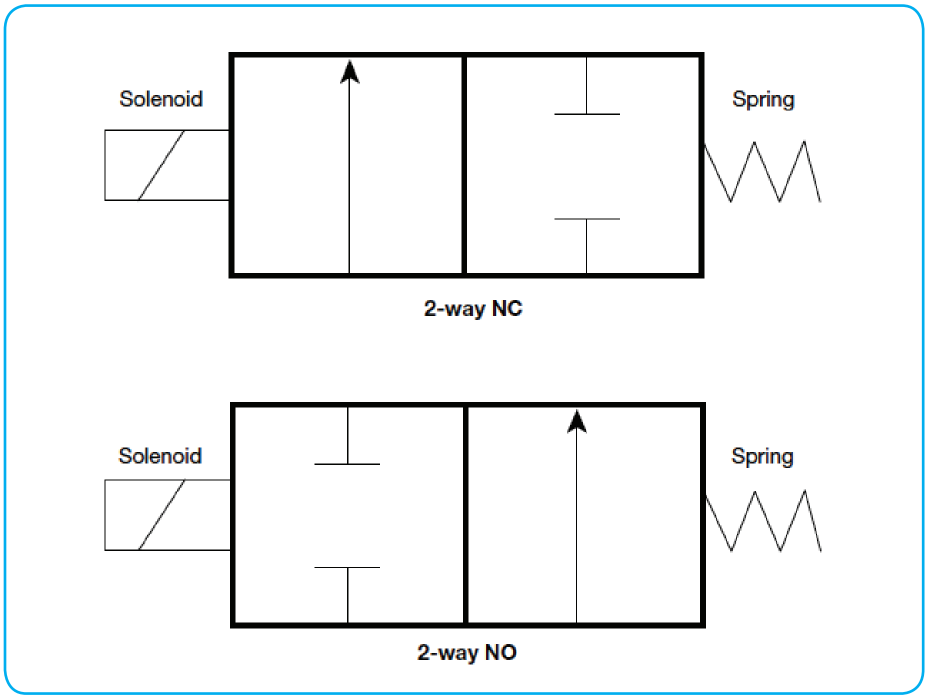
The two primary characteristics for selecting a directional-control valve are the number of fluid ports and the number of positions the valve can achieve. Valve ports provide a passageway for fluid (liquid or gas) to flow into and out of the valve. A valve with only an inlet and outlet port is a 2-port (often called a 2-way) valve. A valve with one inlet and two outlet ports— or two inlet and one outlet port — is called a 3-port or 3-way valve. The number of positions refers to the number of distinct flow paths a valve can provide.

Two-position valves operate either on or off, whereas spool valves use a sliding spool to achieve two, three, or more positions. Two-position valves use a plunger, poppet, or ball that seals against a seat, which provides a positive seal so that fluid does not flow when the valve is closed. However, the sliding motion of a spool can cause wear, which compromises the sealing integrity of spool valves. Therefore, a spool valve may pass fluid even if it is closed.

Basics of Two-position Valves

Two-way, two-position valves can be visualized as a fluid switch; fluid flows when the valve is open, and fluid flow is blocked when the valve is closed. This naming convention is just the opposite of that used for electrical switches — which pass current when they are closed and block current when they are open. Two-way valves are available for either normally open (NO) or normally closed (NC) operation. A NO valve passes fluid when it is not energized. When the valve is shifted, it closes to block flow. In contrast, a NC valve blocks flow when it is un-energized. Shifting a NC valve opens the valve so it passes flow.

Two-position valves are also available in a 3-way configuration. Instead of blocking or passing fluid flow, they pass fluid through two of their three ports and block flow to a third (usually exhaust) when in one position. When shifted (energized), they unblock the third port and block one of the other two. Two-position valves often are shifted manually, especially when used as a shutoff valve. When physical effort would be too great for manual shifting (and in some special-



A 2-way, normally closed valve, top, is held closed by a spring, and opens when its solenoid is energized. A 2-way normally open valve, bottom, is held open by a spring an blocks flow when its solenoid is energized.

indefinitely without drawing power. A brief DC voltage pulse shifts the valve open, and a reverse pulse polarity pulse shifts it closed.

Valve Actuators

Valve actuators are the parts that apply force to shift a valve's flow directing elements, such as a poppet or plunger. The speed and frequency of valve shifting are key factors in fluid power system performance. As long as the actuator produces enough force to shift the valve, the system designer can select any appropriate actuator for the conditions and type of control under which the system will operate.

Actuators for directional-control valves are either mechanical, pilot, electrical, or a combination of these. Different types of actuators can be installed on the same basic valve design. A common valve body often is used that accepts a variety of different actuators.

ized machines), 2-position valves may use compressed air or other pressurized fluid to provide the power to shift them open or closed. However, for most automated equipment, electricity is used to shift valves from one position to another.

Choosing between NO or NC operation is an important consideration for energy efficiency. For example, if a machine only needs to block flow intermittently, a NO valve should be specified because it will only use electric power periodically. During the majority of machine or system operation, it will pass flow without using any electrical power. However, when used in a safety function, the valve may need to block flow if electrical power is lost. In this case, a NC would be specified because it will block flow if electrical power is lost. A third option is a latching valve, which provides an energy-saving alternative. Latching valves use a permanent magnet to hold them open or closed once they've been shifted. This allows them to stay in either state

Solenoids are available in a wide variety of voltages, power ratings, and configurations. Three common construction options are shown here.

With a mechanical actuator, a machine element or person pushes, pulls, or turns the valve's flow-directing element to shift it to another position. Manual actuators include levers, palm buttons, push buttons, pedals, cams, rollers, stems, and screws.

Springs are used in most valves to hold the flow-directing element in an un-energized position. A spring holds the non-actuated valve in one position until an actuating force great enough to compress the spring shifts the valve either open or closed. When the actuating force is removed, the spring returns the valve to its original position.

Pilot-actuated valves are shifted by pressurized fluid (air or oil) that applies force to a piston that shifts the valve's flow-directing element. Pilot-actuated valves can be mounted in any convenient or remote location to which pressurized fluid can be piped. The absence of sparks and heat buildup makes pilot-actuated valves attractive for applications in flammable or explosive environments.

However, solenoids are the most common method of actuation. Simply put, a solenoid is a coil of wire wrapped around a moveable metal core with a small space between them. Running an electric current through the coil creates a magnetic field that moves the metal core. The core is attached to the valve's flowdirecting element, so the valve shifts as a result of the electrical power. When the current is cut off, a spring returns the valve to its un-energized state.

Solenoid valves are especially popular for industrial machines because of the wide availability of electric power in facilities. However, mobile equipment makes extensive use of solenoidoperated valves as well. Solenoids operate from either AC or DC power, and the selection of AC or DC depends on the form of electrical power available.

There is a practical limit to the force that solenoids can generate. This means they cannot directly operate valves requiring high

Opportunities in Energy Savings

To make the most of energy conservation, valves should be selected that will be de-energized whenever possible. The longer a valve has to be energized, the more electrical power it will use. However, when there's no getting around having valves energized continuously for long periods, choosing valves with lowpower solenoids can save enough energy to more than pay for the valve over its operating life. Low-power valves also generate less heat, which can be an importantconsideration when many valves are installed into a small enclosure.

Peter Paul has developed several lines of valves to meet today's demands for economy of space and energy consumption. For hazardous locations, Peter Paul's UL approved, low watt, miniature Series 50 EW hazardous location valve offers minimal space and energy requirements (only 5 W AC or DC) in volatile environments. This valve is the smallest hazardous location solenoid, with the best ambient and high temperature ratings on the market. A NEMA 4 rating is standard. The Series 50 EW miniature valve with encapsulated coil also serves as a general-purpose valve for pneumatic and hydraulic conditions.

Series EL 50 (1.8 W AC or DC) and ELL50 (0.85 W DC) is a line of miniature explosion-proof general-purpose or safety valves for pneumatic and hydraulic applications. The versatility of these valves accommodates the handling of hot air, hot water, refrigerants and many other media by the use of different inserts.

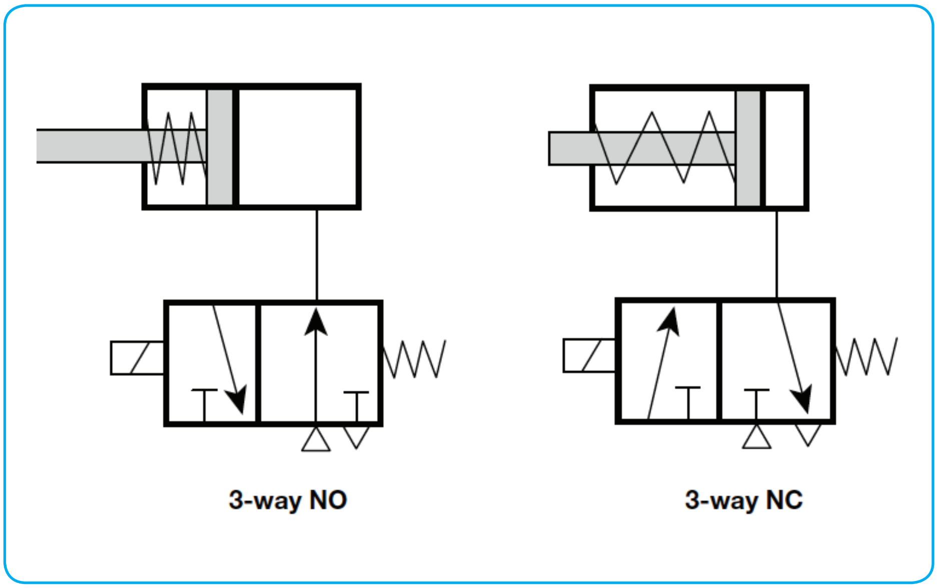
Series ELW and ELLW are also UL approved, low watt, miniature hazardous location valves offering compact design and low energy requirements in volatile environments. The valves draw 1.8 W using AC or DC power, whereas the ELLW version draws only ½ W in from DC. This valve uses the smallest hazardous location solenoid, with the best ambient and high temperature ratings on the market. A NEMA-4 rating is standard. The Series 50 ELW miniature valve with encapsulated coil also serves as a general-purpose valve for pneumatic and hydraulic conditions.

General purpose or safety valves for pneumatic and hydraulic applications, the Series 50 LW valve draws only 2.5 W using AC or DC power. Although not a safety valve, the Series 50 LLW valve draws only 0.65 W using DC. The versatility of these valves is increased to include the handling of hot air, hot water, refrigerants and many other media, by the use of different seals.

General purpose or safety valves for pneumatic and hydraulic applications, the Series 50 SLW valve draws only 1.8 W using AC or DC power. Although not a safety valve, the Series 50 SLLW valve draws only ½ W using DC. The versatility of these valves is increased to include the handling of hot air, hot water, refrigerants and many other media, by the use of different seals.

Finally, although it is not considered a low-watt valve because it requires 10 W power, the Series 20 Magnetic Latching Valve can be a super energy saver. That's because it requires a 10-W switching signal for less than ½ second. In fact, this type of valve is often used in remote areas where continuous power may not be available or with battery-powered portable equipment where power capacity is limited. It is also valuable in equipment such as in medical and chemical analyzers, where coil heating from continuous application of power is undesirable. Magnetic latching valves are available in 2-way NC, 2-way NO, and 3-way NC configurations.

A magnetic latching valve acts as a toggle switch for fluid control. Once shifted openor closed, it will remain in that position untilit receives anelectrical signal of reverse polarity.



Single-acting air cylinders are a common application for 3-way valves. In the example above, left, a normally open valve routes air to the cylinder to extend its piston. Energizing the solenoid shifts the valve and allows the cylinder spring to push air out of the cylinder through the valve. At right, a normally closed valve blocks compressed air flow to the cylinder, so the cylinder's spring keeps the piston retracted. Energizing the valve's solenoid shifts the valve to route compressed air into the cylinder, extending its piston.

shifting forces. Furthermore, valves using large solenoids can require substantial electrical power when valves must remain actuated for long intervals. Heat buildup can also pose problems in these situations. The solution is to use small, low-power solenoids in combination with pilot pressure. The solenoid starts and stops pilot flow, and pilot pressure provides the high force to shift the valve's flow-directing mechanism.

Valve Configurations

In addition to 2-way NO and 2-way NC closed, Peter Paul also offers two-position valves in other useful configurations. Many lend themselves to specific applications.

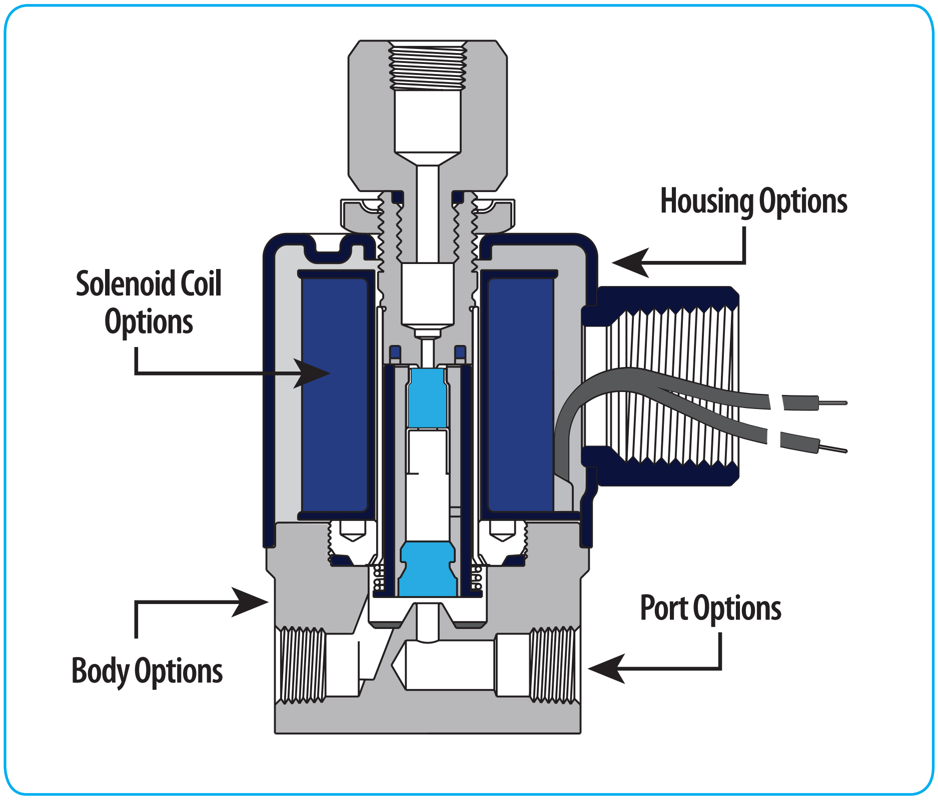
For example, a 3-way NC blocks compressed air from reaching a single- acting, spring-return pneumatic cylinder and vents the cylinder port to exhaust. Energizing the valve blocks the port to atmosphere and routes compressed air to the cylinder port. The valve's exhaust port can simply be vented to atmosphere or to a common air exhaust line.

A 3-way NO valve routes compressed air to a pneumatic cylinder and blocks the valve's exhaust port. Energizing the valve blocks compressed air to the cylinder and opens the cylinder port to exhaust. Again, the valve's exhaust port can simply be vented to atmosphere or to a common air exhaust line

In a 3-way directional control valve, the supply port is open to the first of two outlet ports while the second outlet port is blocked. Shifting the valve routes flow to the second outlet port and blocks it to the first port.

A 3-way multi-purpose valve works like the directional control version, except that reverse flow can occur — inlet to outlet or outlet to inlet.

No matter what the configuration, the valve must be selected based on the cross-sectional area of its internal flow path — known as orifice size. For a given fluid at a given flow rate



Sizing and selecting a solenoid valve requires evaluating several different options to meet mounting, media, and electrical requirements of the application.

Shown here are samples of manifold, manifold mounted valves can save space, reduce potential leakage, cut installation time, and reduce costs over their line-mounted counterparts.

and temperature, the larger the orifice, the lower the pressure drop (ΔP) it will produce. So in addition to the type of valve and configuration, orifice size is an important specification that must be considered. Standard orifice sizes for Peter Paul valves run from 1/32 to 1½ in.

Sizing and Selection

Valves come in many standard port configurations but also can be ordered with ports configured to an application. For example, ports can be placed in line with each other, parallel to each other, next to each other, or at right angles to each other.

They can also be ordered for use where fire or explosion hazards exist due to the presence of flammable gases or vapors, flammable liquids, combustible dust, or easily ignitable fibers. Hazardous location valves are recommended, or in some cases compulsory, where a high level of protection from explosion is required. For applications that require low power, a low watt version is also offered.

An increasingly popular option for general purpose or safety valves in pneumatic and hydraulic applications is valves with a low wattage solenoid. The low power draw of these valves has increased their application to include hot air, other media, through the use of different seals.

Another consideration is highpressure valves, which operate at maximum pressures to 1,000 or even 5,000 psi. Medical, laboratory, instrumentation, industrial, and other companies that require highpressure bottled oxygen, carbon dioxide, and nitrogen use these valves in various applications.

Of course, the type of fluid and its temperature must be considered when choosing the valve's materials of construction. Standard materials from Peter Paul include stainless steel, brass, aluminum, and plastic, each offering unique capabilities of chemical and temperature compatibility.

Mounting and Installation

Traditional valves are built in a configuration for inline mounting, which involves connecting two or three fluid lines to their respective valve port. The labor involved can be time consuming and especially difficult when working in cramped quarters. Therefore, many designers specify manifold mounting to reduce installation time and provide a more compact assembly of multiple valves.

The manifold contains a network of predesigned passageways so that each valve can be installed into a single cavity. In many cases, the valves can be installed and wired in an assembly area, tested, then installed as a single unit. Manifold mounting can dramatically reduce installation time and cost, provide cleaner and more compact designs, and improve reliability.

Selecting the type of valve, function, port configuration, body material, and orifice size addresses the fluid, or wetted, portion of the valve. The exterior of the valve addresses the housing configuration.

What type of solenoid (coil) will be used, and where with it be located? Will a DC or AC coil be used, and at what voltage? How will the coil be connected to the electrical supply?

Conclusion

In summary, choosing a solenoid valve for any application requires evaluating several characteristic of the application. First, what fluid will be controlled, and what is it's temperature, pressure and flow rate? Is a 2-way or 3-way valve needed, and should it be NO or NC? This will help determine what type and size valve should be specified. Will the valve be used in a potentially flammable, explosive, corrosive, or wet environment? What size piping will be used and at what orientation? What control voltage is available, and is the power AC or DC? How will the solenoid coil be connected to the control wiring?

Another important consideration is energy efficiency. Lowwatt valves can save substantial energy over their lifetime, making them a wise investment. They also produce little heat buildup, which can also be important, especially if multiple valves will be located within a single enclosure.