The What, How, Where and Why of Solenoid Valves

I. WHAT styles of solenoid valves are available?

A. Direct-Acting Solenoid Valves - Direct-Acting Solenoid Valves open and close regardless of the pressue and flow: so long as the published maximum inlet and back pressure are not exceeded.

B. Pilot-Operated (Servo-Assisted) - In Pilot-Assisted Solenoid Valves, a minimum inlet pressure/ differential pressure (typically 5 PSI) is required for the valve to operate.

II. HOW do they operate?

A. Direct-Acting - In Direct-Acting Solenoid Valves the energized coil magnetically pulls-up on the core, which is attached to the shaft and seat, thus overpowering the spring and opening the valve orifice. For closing, the coil is de-energized and the spring now pushes the core, shaft and seat back to the normally closed position. This style valve does not require any minimum line pressures nor differentials to operate. (See below)

Examples of Direct-Acting Solenoid Valves include Plast-O-Matic Series EASXMT/ EASMT, EAST EASMD and EU

B. Pilot-Operated

These valves h seat with corres main valve seat with corresponding orifice and a main valve diaphragm with a restriction orifice. The upper section of the valve consists of the pilot seat and orifice which is actually a small direct-acting solenoid valve. (see below)

The lower section of the valve consists of the main valve seat and orifice which is sealed by a diaphragm that allows liquid line pressure to pass thru a restriction orifice thus pressurizing the valve's upper pilot area (that area above the diaphragm and the pilot seat). This e exerts a downward n the top-side of the agm keeping it in the ion. To open the main oil is energized, lifting the core, shaft and seat off the pilot orifice, allowing the pressure above the diaphragm to vent thru the pilot outlet to the down-stream side of the main valve. With no force now working in the top-side of the main diaphragm, the inlet line pressure lifts the diaphragm and opens the main orifice allowing full flow. To close the valve, the coil is de-energized and the spring pushes down on the core, shaft and seat, closing off the orifice, thus stopping the venting of the pressure, and

therefore, re-pressurizing the top-side of the main diaphragm which causes it to close against the main seat to stop flow.

The new Plast-O-Matic Series "PS" is a Pilot-Operated Solenoid Valve.

III. WHERE would I use a Solenoid Valve?

Typically, Solenoid Valves are specified where:

A. Speed of cycling/operation is required.

B. A fail-safe (normally closed or normally open) bubble-tight sealing valve is required.

C. Physical size (and weight) requires a smaller valve.

D. Lower cost is required.

Keep in mind that solenoid coils are available in a variety of voltages, frequency and class ratings.

IV. WHY would I use a Solenoid Valve versus a Motorized Ball Valve?

A. Speed of Operation - Generally speaking, motorized ball valves have a cycle time of 5 to 6 seconds (full open to full closed) which is nowhere near as fast-acting as a direct-acting solenoid valve at approximately 30 to 40 milliseconds. Therefore, in applications requiring speed of cycling (such as PH control via electronic sensors) to prevent overshooting of chemicals, fast acting solenoid valves are preferred. Although pilot-operated solenoid valves (approximately one second closing time) are not as fast-acting as direct-acting valves, they are still considerably faster than motorized ball valves.

B. Fail-Safe Design - Motorized ball valves are not normally of fail-safe design. Yes, they can be made fail-safe but require a cumbersome and very costly add-on accessory, which is simply not practical. Conversely, solenoid valves are normally of a fail-safe design.

(Courtesy : Plast-O-Matic Valves, Inc. USA)

Glossary for Solenoid Valves

Bubble tight - Ability of the valve to seal against gas pressure and not exhibit a detectable bubble of gas leakage in a one minute period during a bubble test.

Cv, Factor - A value which indicates relative flow capacity of a valve. Cv, is defined as the flow of water at room temperature, in gallons per minute, when the Delta P across the valve equals 1 PSI.

Coil voltage - Voltage at which the coil must be energized if the valve or pump is to perform the required function.

Continuous Duty - A rating given to a coil capable of working continuously under normal operating conditions without overheating or catastrophic failure.

De-Energized - The state of a valve or pump when no electrical current is being applied to the coil. This is also defined as the normal condition, i.e. normally closed, normally open.

Differential Pressure (DP) - The difference in pressure between two points in a fluid system.

Dispensing – To create a specific volume of liquid by pulsing a pump one or more times, until the total volume of liquid required has been pumped.

Fluid – The material being controlled

or dispensed by a valve or pump. A fluid can be a gas, vapor or liquid, Most fluids have friction dependent properties such as viscosity, which affect the way they flow. If the viscosity of a fluid is low enough so that it can be neglected, the fluid can be considered to be Ideal. If the viscosity of the fluid is not negligible but is constant the fluid is said to be Newtonian. If the viscosity is neither negligible nor constant, the fluid is said to be non-Newtonian. The fluid is also referred to as the MEDIA.

Energized - The state of a valve or pump when electrical current is applied to the coil.

Gases - are easily compressible fluids that expand to fill their containers, and expand indefinitely in the absence of boundary restraints, As a result of their compressibility, gases may have large change in volume and density. However, under conditions of relatively constant pressure and temperature, gases will have relatively constant volumes.

Liquids - are relatively incompressible fluids that have definite surfaces. Since they are relatively incompressible, even relatively large changes in pressure and temperature cause little change in density.

Media - The fluid that passes through a valve or pump. Typical media are air, oil, gas, water, etc, See also FLUID.

Metering - To create and maintain a specific flow of liquid by continuously pulsing a pump. A liquid can be metered continuously, or over a specific period of time.

Orifice - A restricted opening through which the media must pass when flowing through the valve. The orifice is opened and closed to permit or stop flow. This is accomplished with a poppet, diaphragm or floating seal.

Port - The opening in a valve or pump, through which the media enters (inlet) and exits (outlet).

Pressure - is force per unit area. There are two ways of expressing pressure:

Absolute pressure - the pressure above a complete vacuum, so that absolute pressures can only have positive values. The absolute pressure of one standard atmosphere at sea level is 14.7 Ib/in2 absolute, or 14.7 psia.

Gage pressure - is absolute pressure minus atmospheric pressure as measured by a pressure gage, so that gage pressures above atmospheric are positive and gauge pressures below atmospheric are negative. The gage pressure of the atmosphere is O Ib/in gage or O psig.

Pressure Head - is the height of a column of fluid that will produce a given pressure:

h =: p/w where

h is the height of the column of fluid

p is the pressure generated by the head

w is the specific weight of the fluid

A column of water 28" high will produce a pressure of 1 PSI.

Response time - The time, usually in milliseconds, required to open or close a valve. The response time is affected by voltage, pressure and media. Typical response times for poppet valves is 15 -20 milliseconds, for diaphragm valves, 25 - 35 milliseconds.

Shading Ring - A silver ring staked into a groove in the stop of all AC valves, Its purpose is to minimize the oscillation or hum usually associated with AC valves. Without the shading ring, AC valves would buzz loudly, and quickly beat themselves to premature failure.

Stop - Part of the solenoid assembly that the plunger impacts upon during the energize portion of the cycle. Also refereed to as the plug nut.

Vapors - are gases which may become liquid or solid under increases of pressure and/or decreases of temperature.

Viscosity - of a fluid is a measure of its resistance to shearing forces. Viscosity generally decreases with rising temperature. While the viscosities of some fluids vary only slightly, the viscosities of other fluids can vary considerably with temperature. Typical units of measure are SSU, Centistrokes, Centipoise.