ASCO *Posiflow®* Valves

ASCO markets a range of proportional solenoid valves under the registered trade name Posiflow®.

1 - Proportional action

Most flow control valves work on an "on/off" basis. They are either fully open or fully closed. Proportional valves, however, operate with a "proportional" action. By varying the electrical input to a proportional valve, the flow of the fluid through the valve can be continuously and steplessly adjusted between 0 to 100% of the maximum rated flow.

2 - Construction

In order to obtain the proportional action, the solenoid operator is modified. The specific parts of a proportional solenoid valve as compared to a conventional on/off valve are shown in **Fig. 1**.

3 - Operating principle (see Fig. 2 on following page)

The flow coefficient Kv of a flow control valve depends on the opening of the valve (displacement or stroke s of the core inside the core tube). **In proportional solenoid valves, the stroke is directly proportional to the current I_s flowing through the solenoid coil.**

Proportional solenoid valves operate on the principle that the pull force produced by an electromagnetic coil increases as the coil current I_s is increased, while likewise the counter-acting springforce increases when the top spring is compressed:

- If the current is less than I_o, the preset tension of the spring F_s is greater than the electromagnetic pullforce F_m and the valve remains closed.
- If the current increases to above I_o, F_m is greater than F_s and the core starts to move. The movement of the core compresses the spring causing F_s to increase. This continues until the new values of F_s and F_m are once again in balance. The process continues so that at any value of I the core moves into a position where F_s and F_m are balanced.

By adjusting the spring set screw in either direction the spring force is either increased or decreased. This allows the valves to be fine-tuned to overcome manufacturing tolerances and produce identical flow characteristics.

4 - Electrical supply

The Posiflow® proportional solenoid valve can be made to open or close infinitely by regulating the current I_s flowing through the solenoid coil. The coil current I_s is mainly regulated by regulating the voltage U_s across the coil.

The voltage across the coil can be derived from various supplies, including:

- a straight 0-24 V DC supply,
- a pulse-width modulated supply.

In order to maintain the valve in a specific position, the coil current I_s should be kept - substantially independent of changes in the coil winding resistance due to temperature variations (caused by power input and ambient/medium temperature) - between 100 (I_0) and 500mA (I_{max}).

5 - Response time

Proportional solenoid valves have a response time which is of the order of milliseconds. This means that there is a very rapid response to any change in the electrical input.

The dynamic response time provides an indication of the dynamic characteristics of a proportional solenoid valve. It indicates the time lapse between the time of a step in the electrical input and the time when the core has reached its new position. For proportional solenoid valves this time is typically in the order of 25-60 ms.

Specific parts of a proportional solenoid valve

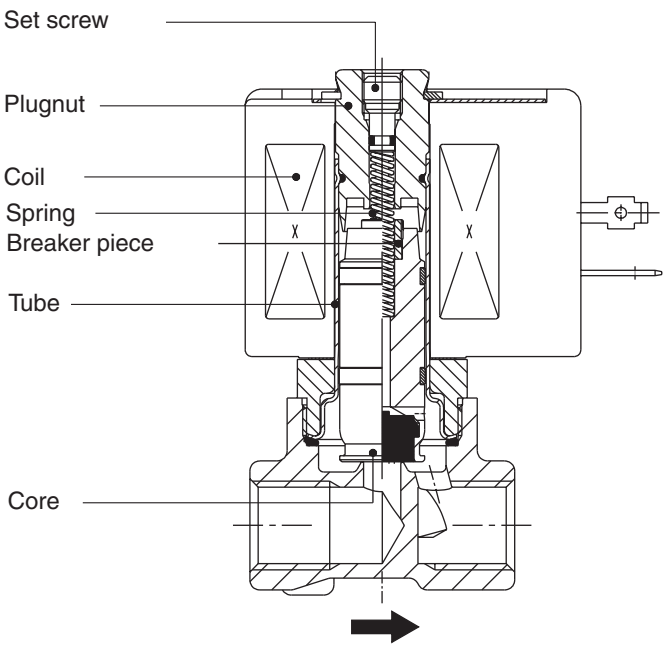


Fig. 1

6 - Flow regulation characteristics (Fig. 2)

The performance of a valve is specified in a number of properties:

Linearity

Flow curves usually show a curvature at both its "bottom" and "top" ends, in between which there is the "lineair" working part of the curve. The "(non-)linearity" is the degree to which the actual flow curve deviates from an ideal straight line (expressed as a percentage within a specified linear region of the curve).

Hysteresis

This is the difference in the flow rate at the same value of the electrical input, depending on whether this set value was reached from "below", i.e. increasing the electrical input, or from "above" i.e. while decreasing the electrical input.
The hysteresis is expressed as a percentage of the maximum flow rate.

Threshold

The electrical input necessary to cause a significant flow rate from the zero position. The threshold is expressed as a percentage of the maximum electrical input value.

Sensitivity

The change in electrical input necessary to produce a noticeable change in the flow rate when the valve is moved from a stationary position in the same direction as the original direction. The sensitivity is expressed as a percentage of the maximum electrical input value.

Reverse sensitivity

The change in electrical input necessary to produce a noticeable change in the flow rate when the valve is driven from a stationary position in a direction opposite to the original direction.
The reverse sensitivity is expressed as a percentage of the maximum electrical input value.

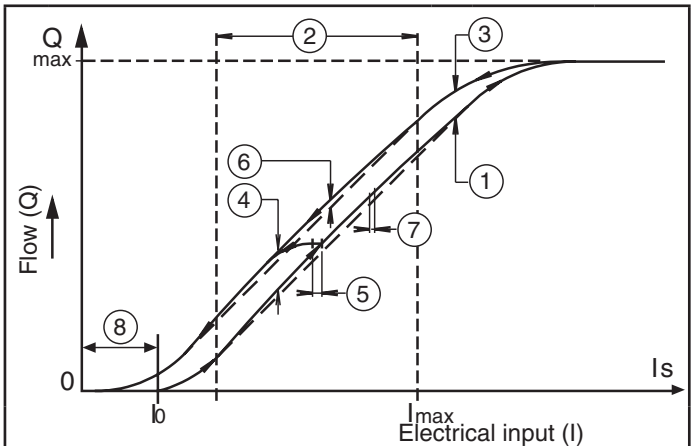


Fig. 2

1. Increasing coil current
2. Linear flow region
3. Decreasing coil current
4. Hysteresis
5. Reverse sensitivity
6. Flow linearity
7. Sensitivity
8. Threshold

The previous mentioned flow regulation characteristics are closely related. They are caused by a number of factors, in order of importance:

- the electromagnetic signal conversion (electromagnetic hysteresis),
- the friction between the moving and static components of the valve,
- the play in the mechanical interaction between the core and the valve seat, and
- variations in the pressure differential (ΔP) across the valve.

Repeatability

The spread in the flow rates is called the repeatability.

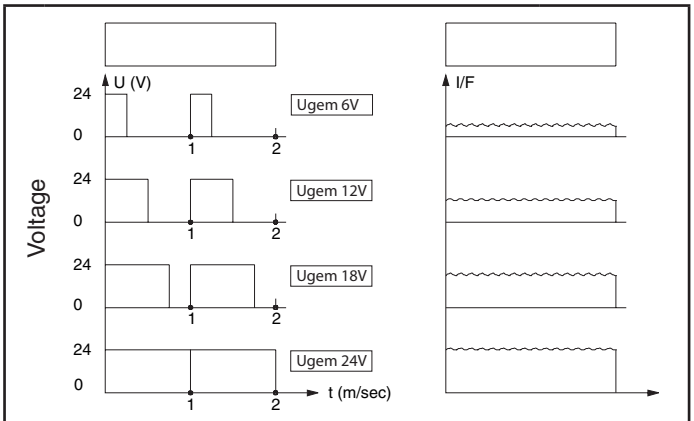
7 - Features of a proportional solenoid valve

- **Closed loop control systems** - The possibility of controlling the valves by means of electrical inputs from sensors allows them to be used in the range of applications with closed loop control systems for fluid control.
- **Safety features** - In the case of a power failure or if the electrical input is interrupted the valves close immediately - in many cases an important safety consideration.
- **Long life, low maintenance** - Proportional solenoid operators have only a single moving part, the core, guided by two high-precision, glass-filled PTFE guide rings.

8 - Electronic control unit (Fig. 3)

The ASCO electronic control unit provides a convenient way of operating the Posiflow® valve. It accepts all the standard control signals from the sensors/transmitters used in modern control systems. The coil voltage supply is regulated by means of pulse-width modulation. An important built-in feature is a function which keeps the current through the coil (at a specific control signal) constant, independent of changes in the coil winding resistance or variations in the supply voltage.
The pulse-width is determined by the control signal U_i (I_i) (either a voltage or a current).
Various control signals can be selected:

. 0 - 10 V DC
. 4 - 20 mA
. 0 - 20 mA



Coil current (~ magnetic force) Fig. 3