

Technical Principles of Valves

Symbols and Circuit Functions

Symbol to DIN-ISO 1219

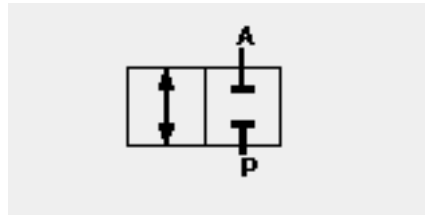
The circuit function illustrations are defined to the DIN-ISO 1219 Standard. These can be used to show other switching processes.

The respective valve ports are specified by letters in the standard where P defines the pressure port, A and B service ports while R and S are vent or exhaust ports. The new illustration of pneumatics is specified with numbers.

Circuit Function

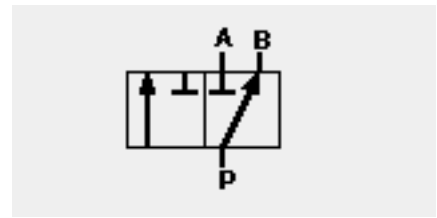
The circuit function of a valve indicates the functions which can be achieved. The circuit function defines whether a valve shuts-off or allows the fluid flow, whether all the ports are shut-off in the de-energized position, or whether some ports are closed and others left open.

Circuit function I



2/2-way solenoid valve; normally closed, flow direction as required

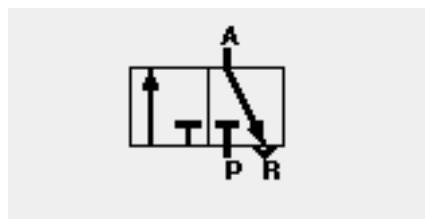
Circuit function F



Distributor valve; when de-energized, pressure port P connected with port B

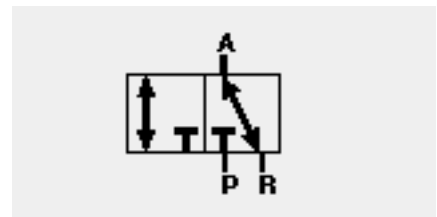
Circuit Functions of 3-way Valves

Circuit function C



3/2-way valve; when de-energized, port A exhausted

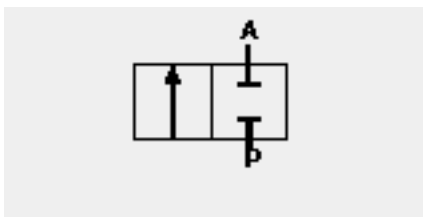
Circuit function T



3/2-way valve; for general use

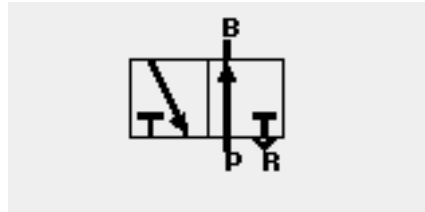
Circuit Functions of Flow Valves

Circuit function A



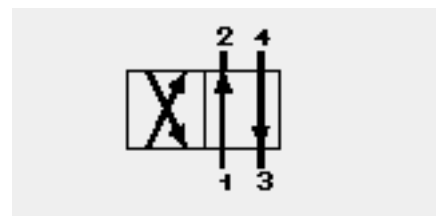
2/2-way valve; normally closed

Circuit function D



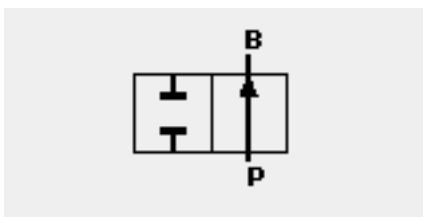
3/2-way valve; when de-energized port B pressurized

Circuit function G



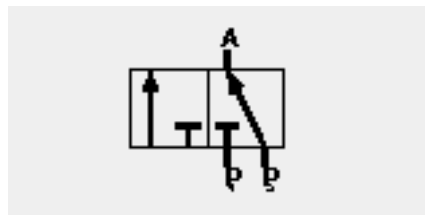
4/2-way valve, when de-energized, pressure port 1 connected with port 2, outlet port 4 exhausted

Circuit function B



2/2-way valve; normally open

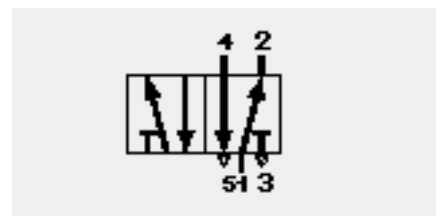
Circuit function E



Mixer valve; when de-energized, pressure port P₂ connected with port A, port P₁ closed

Circuit Function of 5-way Valves

Circuit function H



5/2-way valve, when de-energized, pressure port 1 connected with outlet port 2, outlet port 4 exhausted.

Orifices

The orifices (DN) available are given in mm and correspond to the diameter of the valve seats.

Port Connection

In most cases, ports with threads based on inch-systems (e.g. G 1/2 to ISO 228) or metric threads are used. Many devices are also available as sub-base version. They are space-saving and can be mounted on manifolds or fitted to customer designed products. Manifolds must be ordered separately. Some types are also available with special port connections.

Materials

All materials used in the construction of Burkert valves are carefully selected to suit a variety of applications. Body material, seal material and solenoid material are chosen to optimize functional reliability, fluid compatibility, service life and cost.

Seal Materials

The particular mechanical, thermal, and chemical conditions in an application are determining factors in the selection of the seal material. The standard material for neutral fluids at temperatures up to +90 °C is normally NBR. For higher temperatures and critical fluids FPM (Viton), EPDM and PTFE (teflon) are employed. Steel is used for hot fluids, particularly to reach high cycling rates. The PTFE material is universally resistant to practically all technically interesting fluids. The Burkert product range includes valves with all fluid-contacting parts of this material.

NBR	(standard material) resistant against mechanical wear as well as against oils and fats, -10 to +90 °C
EPDM	resistant against bases and acids up to a medium concentration, for hot water and steam, -40 to +130 °C, not resistant for oils and fats.
FPM	suitable for fluids, where, NBR and EPDM are not resistant, -10 to +130 °C, when steam temperature is higher than

Pressure Ranges

All pressure figures quoted in this catalog represent gauge pressures. Pressure ratings are quoted in bar. Our figures apply for the voltage range ±10 %.

If 3/2-way valves are used in a different circuit function, the permitted pressure range changes.

Care should be taken to ensure that the vacuum pump is connected to the outlet ports of 2-way valves and to the R port of 3-way valves.

The higher pressure, i.e. atmospheric pressure is thus always present at the inlet port P.

+130 °C	FPM swells
PTFE	practically resistant against all the fluids, unflexible, normally
-20 to +180 °C	

Body Materials

Depending on the application, we provide different body materials. The most common materials used are brass, gun metal, stainless steel, PVC, PP, teflon, grey cast iron, steel cast and glass fibre reinforced polyamide.

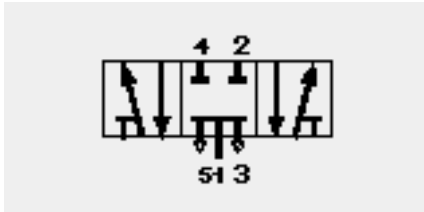
Solenoid Materials

All parts of the solenoid actuator which come into contact with the fluid are made of austenitic corrosion-resistant steel. In this way, resistance is guaranteed against corrosive attack by neutral or mildly aggressive media.

Coil Material

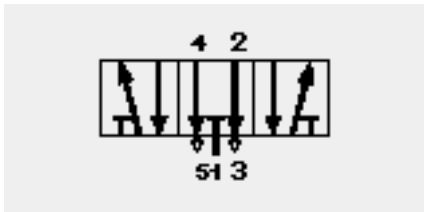
The solenoid epoxy encapsulation efficiently dissipates the heat generated by the coil.

Circuit function L



5/3-way valve, when de-energized, all ports are closed.

Circuit function N



5/3-way valve, when de-energized, outlet ports 4 and 2 exhausted

Flow-rate Values

The size of valve required for a particular application is generally established by the Kv rating to VDI/VDE 2173. This figure is evolved for standardized units and conditions, i.e. flow rate in m³/h.

Kv ratings for each valve are quoted in the catalog.

For valves which are also used for pneumatics, the air flow is also indicated in QNn.

Kv-Value: measured with water at inlet port with free outlet at 1 bar and +20° C. Indicated in m³/h

Cv-Value: Cv in USG/in min=1,165 Kv m³/h

QNn-Value: (for gases) Indicated in liter per minute (l/min) measured with air at + 20 °C and 6 bar pressure and a drop of 1 bar across the valve.

Fluid Viscosity

The technical data given is valid for viscosities up to the figure quoted. Higher viscosities are permissible, but in these cases they change the Kv-value, the pressure range, the cycling rate and the permissible undervoltage.

Solenoid Valves

Solenoid Systems

The Burkert coils are available in all the popular used AC and DC voltages. The low power consumption, in particular with the smaller solenoid systems, means that the control via solid state circuitry is possible. The magnetic force available, increases as the air gap between stopper and armature decreases, irrespective whether AC or DC is involved. An AC solenoid system has a larger magnetic force available at a greater stroke, than a comparable DC solenoid system. The characteristic stroke - force graph indicated in Figure 1 clarifies this relation.

At the moment of being energized, i.e. when the air gap is at its maximum, AC solenoid valves draw much higher currents than when the armature is in

the energized position, i.e. air gap is closed. This results in a higher output and increased pressure range. In DC systems, after switching on the current, flow increases relatively slowly until a constant holding current is reached. These valves are therefore only able to control low pressures, unless they are provided with smaller orifices. A time-based comparison of the energization characteristics for AC and DC solenoids is shown in Figure 2.

As well as the Burkert solenoid valves with standard coils, we also have valves available with high voltage, impulse and explosion-proof coil systems.

Most Burkert solenoid valves have been designed for continuous operation, i.e. they can stay energized.

Temperature Range

We have listed the temperature limits for several different factors. Various factors, e.g. ambient temperature, cycling rate, operation behaviour, voltage tolerance, installation details can however influence the temperature performance.

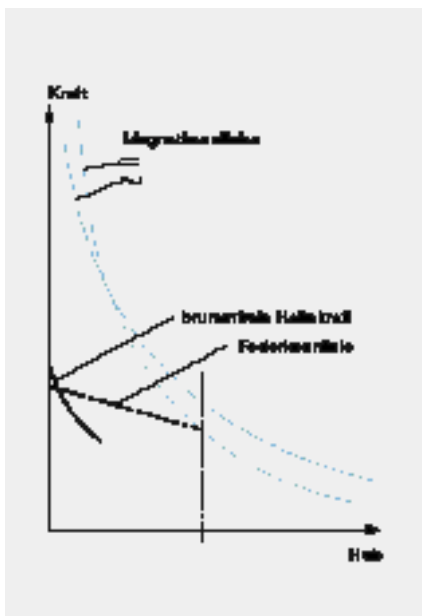
The values quoted by us should, therefore, only be used as a general guide. In cases where operation at extremes of the temperature range are involved, you should seek advice from your nearest technical sales office. The admissible fluid temperatures depend upon the seal and body material used and may, with some of the Burkert valves, amount to up to +250 °C. Ambient temperatures up to +55 °C are generally permissible.

Response Times

The small volumes and relatively high magnetic forces involved with Burkert solenoid valves enable rapid response times to be obtained. The response time is defined as the time from electrical switching to the pressure rise of 90 % or pressure drop to 10 % of the max. possible operating pressure. If the operating pressure exceeds 6 bar, the response times have been determined at 6 bar.

The response times are depending upon the respectively prevailing atmospheric pressure, the viscosity of the fluid and the system configuration. For special application requirements Burkert provides valves with adjustable switch-on times.

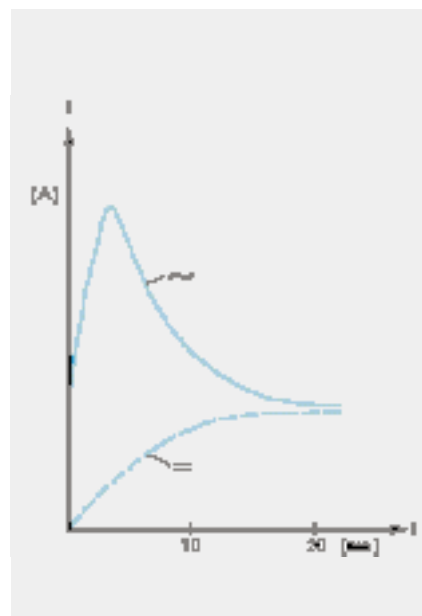
Figure 1



Electrical Connection

The solenoid systems of the Burkert standard program provide one plug-type connection. The cable plugs, which in most cases are provided with the product are suitable for connections with a diameter of 7 mm. Other versions of electrical connections are available on request.

Figure 2



On Period

The on period is defined as the time between switching the solenoid current on and off. The total time of the energized and de-energized periods is the cycle period.

The relative duty cycle is the percentage ratio of the energized period to the total cycle period.

$$DC = \frac{\text{energized period}}{\text{total cycle period}} \times 100 (\%)$$

Solenoid Valves

Direct-acting Solenoid Valves

Direct-acting 2-way Solenoid Valves (Plunger-type Principle)

The 2-way valves are shut-off valves with one inlet port and one outlet port, which control the flow of neutral gases and low to medium viscous liquids (Figure 3 shows a valve in circuit function A, i.e. normally closed). The permissible differential pressure decreases with the static solenoid coil performance and increasing orifice diameter.

3-way Solenoid Valves

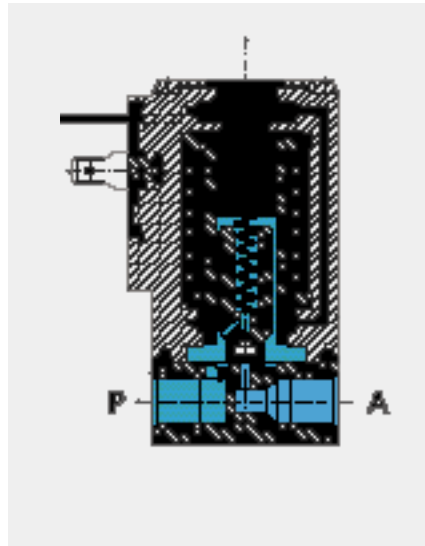
3-way solenoid valves have three port connections and two valve seats. One valve seat always remains open and the other closed.

Various circuit functions can be obtained according to how the fluid medium is connected to the working ports.

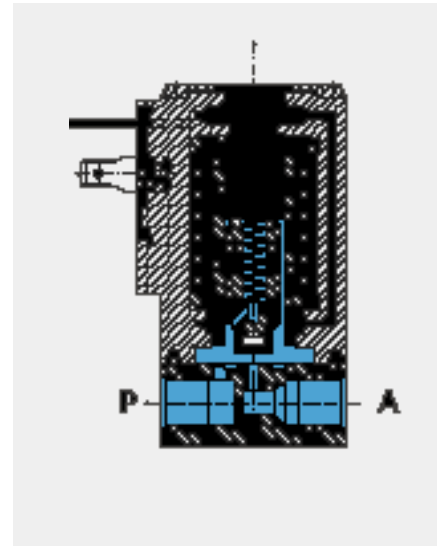
3 way Pivoted Armature Valves

Compared to the plunger-type versions, the pivoted armature valves of Burkert have all three port connections integrated in the body. An isolating diaphragm ensures that no fluid is allowed to enter the armature area. This technical solution makes the pivoted armature valve more resistant to contamination than the plunger-type valve, offers a higher resistance against aggressive fluids and provides a longer service life. All the 3-way switching functions can also be realized with pivoted armature valves. Figure 4 shows the fundamental principle of this valve.

Figure 3: Plunger-type Principle

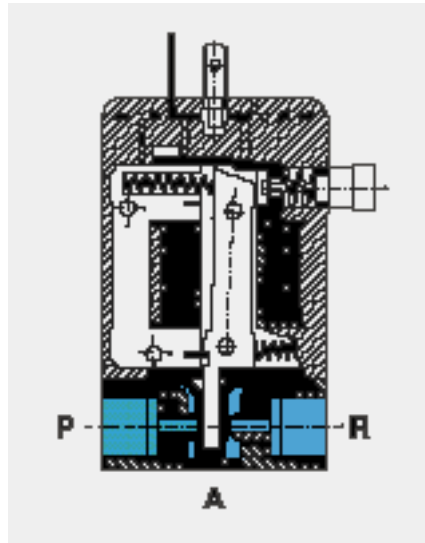


Closed position:
When de-energized, the armature spring, assisted by the fluid pressure, holds the valve seal on the valve seat to shut off the flow.

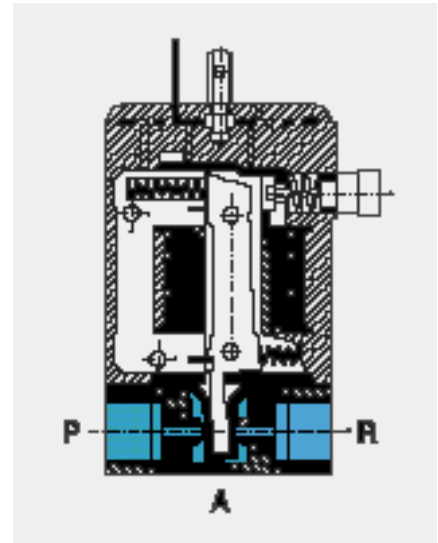


Open position:
When energized, the armature and seal are pulled into the solenoid coil to open the valve.

Figure 4: Pivoted Armature Principle



Closed position:
The diaphragm has been designed to simultaneously serve as the seat seal. When the coil is in the de-energized condition, the service port (A) is connected to the exhaust port (R). The pressure port (P) is shut off against the fluid pressure by spring action.



Open position:
When energized, the armature seals off the exhaust port (R) by the solenoid force. The service port (A) is pressurized.

Servo-assisted Solenoid Valves

With direct-acting valves, the pressure range decreases with increasing seat diameter. Servo-assisted solenoid valves are therefore employed to switch higher pressures in conjunction with larger orifice sizes, where the fluid pressure is used to open and close the valve.

- Servo-assisted valves require a min. differential pressure of 0.2 to 1 bar between the inlet and the outlet port of the valve
- Servo-assisted valves control higher operating pressures with lower electrical power consumption
- Servo-assisted valves require a longer switching time than direct-acting valves. Some of the versions allow opening and closing times to be adjusted
- The max. permissible pressure of a servo-assisted valve is subject to the pressure of the pilot valve.

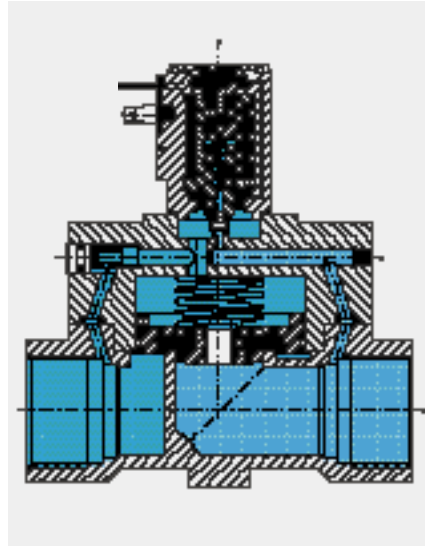
Notes

Do not select servo-assisted valves with larger orifices than their pipe cross section. (Figure 5)

Assisted Valve Lifting

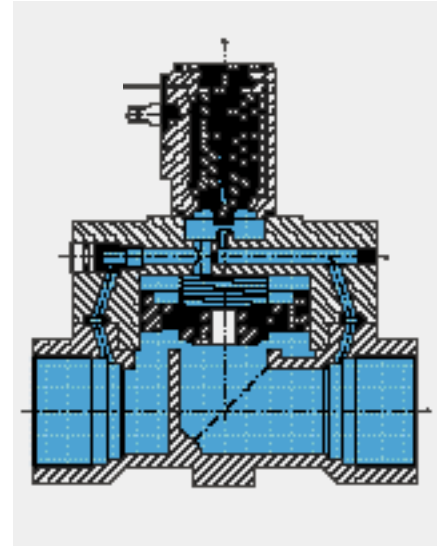
The Burkert product range also includes servo-assisted valves with coupled solenoid armature and diaphragm. The nominal pressure rating of these versions starts at 0 bar (see Types 407 and 290).

Figure 5: Servo-assisted Solenoid Valve



Closed position:

When the pilot valve is closed, the pressure builds up via a bleed hole above the piston. The piston is additionally closed by spring action.



Open position:

When the pilot valve opens, a bleed channel is released effecting the pressure to be relieved from the top of the piston. The fluid pressure lifts up the piston to open the valve.

Proportional Valves

Proportional flow valves consist of a control element, the actuator and control electronics. The appropriate dimensioning of these modules allow a large stroke, strong magnetic field densities, as well as a high sealing pressure. The actuator, being standard signal controlled via the electronics, effects a relative movement of the armature, opens a cross section, which allows variable fluid flow.

Pneumatics

Servo-assisted Solenoid Valves

Servo-assisted 4-way Solenoid Valves

Servo-assisted 4-way solenoid valves are used mainly in pneumatic applications to actuate double-acting cylinders. A min. differential pressure between 2 and 2.5 bar is required to provide a reliable switching function. The 4/2-way valve is a combination of two 3/2-way valves. The main valve contains two servo pistons providing seat seals for the pressure and the exhaust port. A 3/2-way pilot valve pressurizes or exhausts the the servo pistons via control channels. The epoxy-encapsulated servo piston has a manual override as a standard feature.

Servo-assisted 5-way Solenoid Valves

Can be used in pneumatic applications. The valve functions are similar to the 4-way valve, but have separate exhaust ports for each service port.

Pneumatic Cylinders

Pneumatic cylinders are suitable for lifting, lowering, pushing, conducting, hitting, pulling, toggling, pressing, locking, flapping and targeting processes, as well as for valve operations. The Burkert product range comprises plastic (DN 12 to 50 mm), steel and aluminum, up to a piston diameter of 125 mm. They are corrosion-resistant.

Pneumatic cylinders make straight movements. They transmit control forces of up to 11000 N (1100 kp). The operating pressure lies within a range of 1 to 10 bar. In special cases, it may be used to 16 bar. The stroke lengths can be selected from 5 to 300 mm. Most versions are available with integrated, contact free operating limit switches. The Burkert cylinder bodies are known for their long service life.

Process Valves

Externally Piloted Valves

With these valve types, an independent pilot medium (air, water) is used to actuate the valve. In most cases, these are piston or diaphragm controlled valves.

Advantages of an externally piloted valve:

1. High flow rate (large valve stroke)
2. No differential pressure of operating fluid required
3. Option of reversed flow direction to reduce water hammer
4. Use in hazardous areas (e.g. as pilot valve in the control room)
5. Control of higher pressures with larger orifices.

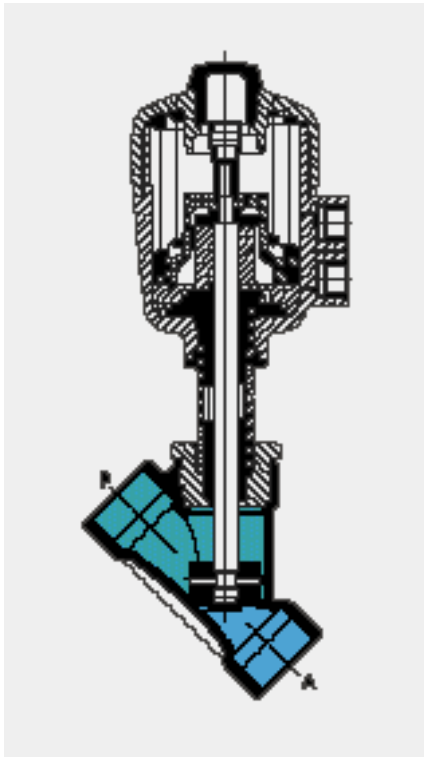
The independent medium is controlled by a 3-way solenoid valve, which can be fitted to the actuator.

Piston-controlled Angle Seat Valves

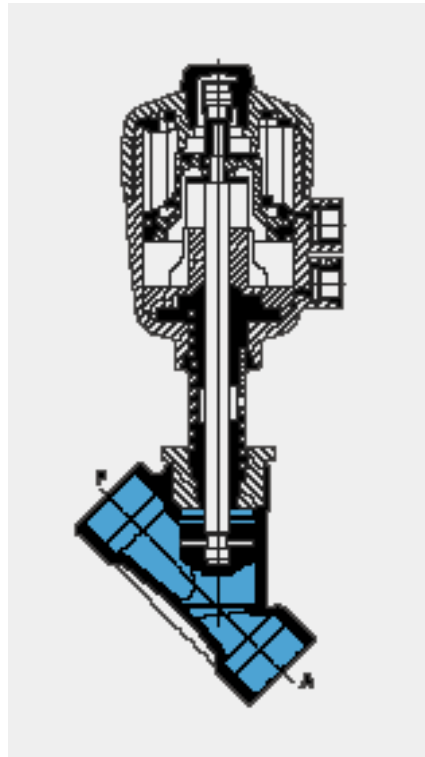
The angle seat design (Figure 6) provides a very favourable flow rate and the design reduces the possibility of dirt being deposited in the valve.

There is a wide choice of actuator sizes and body materials to suit different applications with hot, highly viscous and aggressive fluids.

Figure 6:
Piston-operated angle seat valve



Closed position:
When de-energized, the valve is closed by spring action.



Open position:
If the actuator is pressurized by the control pressure, it lifts the control piston and the valve spindle to open the valve.

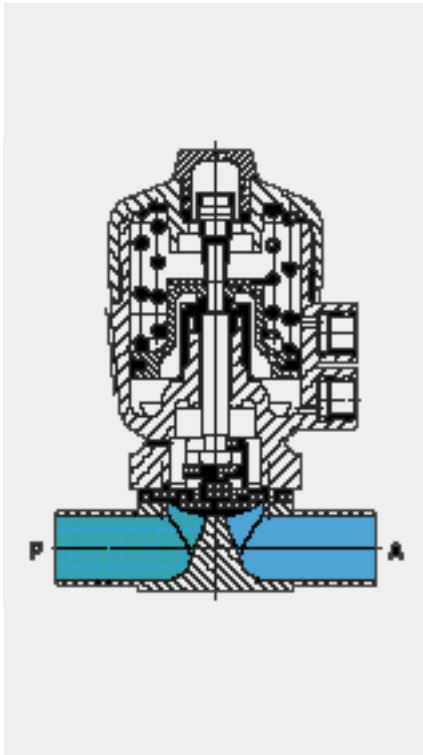
Piston-operated Diaphragm Valves

The PVC or stainless steel 2-way valve bodies

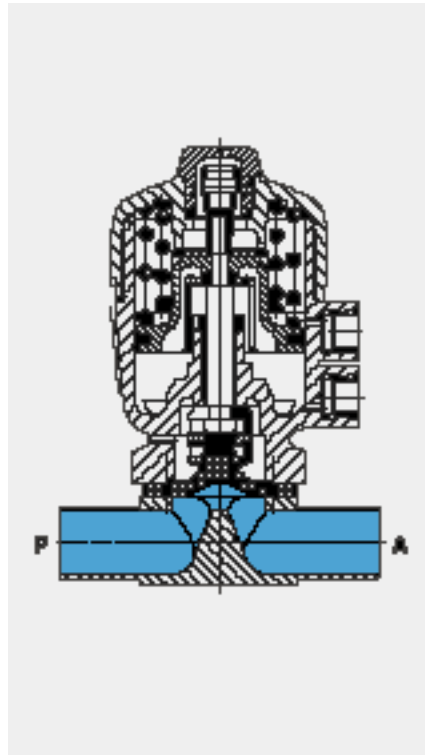
provide high flowrates and are available in a number of surface finishes to suit different applications. The diaphragm between the actuator and valve body hermetically isolates the fluid from the actuator (Figure 7).

The valves are maintenance-free and extremely robust and can be retrofitted with a comprehensive range of accessories, e.g. electrical position feedback, stroke limitation or manual override.

Figure 7: Diaphragm Valve



Closed position:
When de-energized, the valve is closed by spring action.



Open position:
If the actuator is pressurized by the control pressure, it simultaneously lifts the control piston and the valve spindle to open the valve.

Approvals

Explosion Protection to Eurostandard

Burkert has many years experience of the development and production of explosion-proof solenoid valves. We have summarized all the important details for you in a special Ex-brochure.



DVGW

On request, the German Association of the Gas and Water Industry (DVGW) examines control devices for gaseous combustibles. Their registration ensures that the devices provide the highest possible degree of safety.



Valves with the following approvals are available on request:

Underwriters Laboratories Inc.



Canadian Standards Association



Factory Mutual Research



GL-Approval



VDE-Approval



Norske Veritas

