Own-medium controlled plunger valves in water supply

Previously, not all requirements for control and regulation valves in water supply could be met. No automatic control valve operated by the medium present in the pipeline and suitable for larger nominal diameters and higher flow velocities line was available on the market. The essential advantages of a plunger valve (or needle valve) for control tasks could not be made use of either, if no electric power was available on the site of operation.

Now VAG has developed an automatic actuator controlled by the medium present in the pipeline and with integrated fail-safe function as a multi-turn actuator which can also be used for plunger valves. Thanks to this, all advantages of the plunger valve in terms of regulating tasks can now be made use of in areas where no electric power or auxiliary sources of energy are available and/or where higher flow rates and/or larger nominal diameters are required.

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The protection of our environment requires sophisticated plant and process technology. Along with this, the requirements of planners and operators of water supply plants concerning the reliable function and dependability of the valves installed are becoming more stringent. In addition to this, and for reasons of cost-efficiency, planners, contractors and operators increasingly take economic factors and a high level of reliability and safety of operation into account. The highest demands are made in terms of the quality and operator-friendliness of valves. Components must all guarantee absolutely trouble-free and fully automatic operation of water treatment and supply plants. Valves made by VAG meet these requirements and ensure trouble-free operation over decades.

In water supply systems, shut-off valves perform a number of different tasks, such as shutting off pipeline sections, adjusting the pressure or flow rate, preventing back flow, filling and emptying of plant parts as well as venting pipeline sections. The safety and reliability of operation, the availability and economic efficiency of water supply plants are essentially influenced by the use of suitable valves. Depending on the task and field of application, different types of valves are used here.

Now VAG has developed an automatic actuator controlled by the medium present in the pipeline and with integrated fail-safe function as a multi-turn actuator which can also be used for plunger valves. Thanks to this, all advantages of the plunger valve in terms of regulating tasks can now be made use of in areas where no electric power or auxiliary sources of energy are available and/or where higher flow rates and/or larger nominal diameters are required.

With this product, VAG introduces an innovative control and regulating valve which combines the advantages of the plunger valve with the advantages of own-medium control (***Figure 1***).

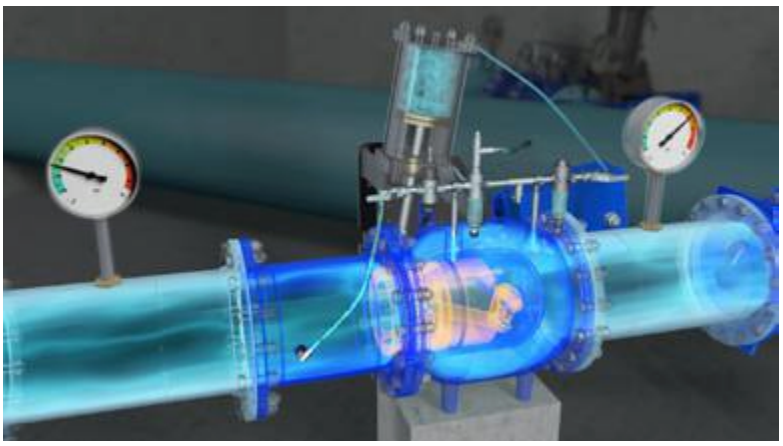

Figure 1: *Own-medium controlled VAG RIKO® Plunger Valve*

Figure 2: Guides of a VAG RIKO® Plunger Valve DN 1600

Figure 3: VAG RIKO® Plunger Valve with fail-safe function

GENERAL

Previously, operating a control valve without an auxiliary source of energy, e.g. electric power, was almost exclusively possible with diaphragm valves or hydraulic valves. These types of valves have their limits in terms of hydraulic behaviour and size. To meet the diverse requirements in the area of control and regulating valves, the VAG RIKO® Plunger Valve now combines all the advantages of a plunger valve with the advantages of an own-medium controlled actuator – and for nominal diameters ranging from DN 150 to DN 2000.

The advantages of the plunger valve include:

- low pressure loss
- excellent cavitation behaviour
- perfect control characteristic
- available in all sizes
- low operating torque
- low maintenance requirements
- reliable function
- operation of several control valves in series without generating hydraulic vibrations

In areas where no electric power for the control of regulating valves was available, it was previously impossible to make use of these advantages.

FUNCTION

The main components of operation include the control circuit with its pilot-operated valve on the one hand and on the other, the brake-and-and-lift unit which has proven itself a thousand times over and which obtains its energy from the most reliable of all sources of energy: gravity. Via the control circuit and two control lines, the pilot valve is connected to the upstream pressure and to the back pressure of the valve as well as to a hydraulic cylinder. The unit consisting of control circuit, drop-weight lever and hydraulic cylinder is directly coupled with the shaft of the plunger valve, which, in turn, moves the plunger inside the valve via the connecting rod.

OPENING

The energy needed for opening the valve comes from the existing upstream pressure which during the operation of a plant is always higher than the back pressure. This differential pressure above the valve is used to overcome the forces of the drop weight and the hydro-dynamic forces inside the valve. In the process, the advantage of the low operating torques of the plunger valve fully comes into effect. The low operating torques are ensured by the bronze-welded guides inside the valve (***Figure 2***).

CLOSING

To close the valve, the drop weight presses the water present on the plunger side (own medium) back into the fluid flow of the pipeline via a piston. Additionally, the design forces of the drop weight ensure that, in the event of a pressure balance, the plunger valve does not remain in the position it was in when the pressure balance occurred, but reliably moves into closed position; this safety function is also referred to as 'fail-safe function' (***Figure 3***).

Due to the combination of the own-medium controlled actuator and the VAG RIKO® Plunger Valve, any control tasks can be performed precisely and virtually anywhere:

- Downstream pressure control (pressure reduction)
- Upstream pressure control (pressure retaining function)

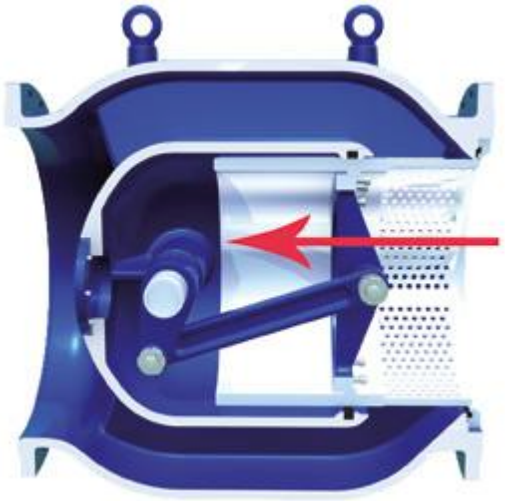

Figure 4: Open plunger

Figure 5: Sectional view of a VAG RIKO® Plunger Valve

- Level control
- Flow control
- and various special control tasks

CONTROLLING WITH PLUNGER VALVES

Plunger valves or needle valves are equally suitable for precisely and reliably reducing and controlling the pressure and flow rate. Unlike diaphragm valves, which are only operated hydraulically, plunger valves need an external actuator that is operated manually, pneumatically, electrically or by the medium present in the pipeline. The pressure and the flow velocity are controlled by varying the inner cross-section of the valve.

Its low operating torque is one of the essential advantages of the plunger valve and is made possible by the open plunger (***Figure 4***). This is why the valve is operated at an almost balanced pressure. This design ensures that even very high pressure differences can be reduced without the risk of cavitation by the use of a suitable outlet type (cylinder). Plunger valves usually consist of the valve body and an axially guided plunger. The linear movement of the plunger results from the conversion of the rotary movement of the external actuator. This ensures a symmetrical annular cross-section in any position (***Figure 5***).

Through its linear control characteristic, the VAG RIKO® Plunger Valve ensures optimum cavitation behaviour and minimum pressure loss in fully open position at the same time. The outlet type is variable and, in the form of a kit, allows a change of the valve characteristic. The cylinders divide the flow into separate water jets which meet again on the discharge side downstream of the plunger in the centre line of the pipe and dissipate energy without the risk of cavitation (***Figure 6***).

Depending on the application and the operation specifications, different types of outlets such as a standard seat ring, orifice cylinder or slotted cylinder as well as various customised cylinders are available to prevent cavitation and to adjust the valve to the most diverse operating conditions (***Figure 7***).

USUAL TYPES OF PRESSURE-REDUCING AND FLOW-CONTROL VALVES

The types of pressure-reducing and flow-control valves most frequently found on the market include ball valves, diaphragm valves and plunger valves. This section explains the functionality of the different valve types and illustrates their most important features, advantages and disadvantages in order to identify which type is most suitable for specific needs.

Figure 6: *Concentric dissipation of energy directly downstream of a VAG Plunger Valve DN 800*

Figure 7: Different types of outlets

Normal control valves In the control valve generally known on the market, the flow is diverted twice by 90° inside the valve. The control cone guides the flow axially and releases the flow volume in dependence of the annulus and the position of the plunger. The most frequent variety is the single-seated valve where the control cone performs a linear movement. Due to the diversion of the flow, this valve has a high pressure loss and is normally used in small nominal diameters only (up to DN 150) and for high pressures.

Diaphragm valves The basic body is also a control valve. In general, it consists of a hydraulically operated shut-off cone and a control circuit. The outlet pressure of the valve can easily be adjusted by turning a screw on the pilot valve until the desired pressure has been reached and fixed. This valve is operated hydraulically as a pressure-reducing valve and does not require external power supply. Its use is limited as regards nominal diameter and rated pressure. The most frequent causes of malfunctions are incrustations caused by corrosion on the connections of the body to the control circuit.

Pilot-operated plunger valves Usually, pilot-operated valves are plunger valves operated hydraulically like diaphragm valves and therefore not requiring external actuators. The energy needed to operate the plunger in the valve is obtained from the valve's own medium and from the pressure difference between the upstream and downstream pressure of the valve. As the inlet pressure is always higher than the defined outlet pressure, a differential pressure is present in general and serves for moving the piston. Control is ensured by way of pilot valve integrated in the control line.

COMPARISON BETWEEN DIAPHRAGM AND PLUNGER VALVE AS REGARDS CAVITATION

Control valves are highly susceptible to damage by cavitation. Due to increased flow velocity, the pressure may drop to critical values in the narrowed cross-section in the sealing seat area. Downstream of this narrowed cross-section, the pressure rises again, generating gas bubbles which collapse afterwards. In this area, the surface of the body can be seriously damaged by the impact of the jet and the shock waves generated by the imploding bubbles.

The annular cross-section of the plunger valve ensures symmetric flow and directs the water jet downstream of the narrowed sealing set towards the centre of the pipeline. This allows an intensive pulse exchange with the surrounding water and thus protects the pipeline. The use of suitable cylinders can reliably prevent cavitation even in case of major pressure differences.

Contrary to this, diaphragm valves are highly susceptible to damage by cavitation even at relatively low differential pressure, but plunger valves easily can handle major pressure differences.

SUMMARY

The plunger valve is a straightway regulating valve which has an annular flow cross-section in any position. Inside the body, the open plunger is moved axially in flow direction by a crank gear towards the sealing seat of the valve. Plunger valves are regulating devices which, by continuous narrowing towards the seat, generate pressure losses in pipeline systems to change the flow rate in dependence of the regulating distance. For this purpose, the nominal diameter of the valve has to be large enough to ensure that the lowest pressure difference is achieved at the highest required flow rate. Additionally, any damage to the downstream pipeline system or the structure by vibration or cavitation must be prevented over the entire regulating distance.

Plunger valves are clearly the more cost-efficient solution for large nominal diameters and high nominal pressures. VAG offers them in all nominal sizes

and nominal pressures and offers the right solution – even without external sources of energy – however complex the application may be.

LITERATURE

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THE COMPANY

VAG's valve and gate solutions cover the entire process of collecting, transporting and storing drinking and industrial water. Moreover the company is a solution partner for leading power station operators and industrial enterprises: chemical or steel manufacturers, conventional or nuclear power plants. Many types of valves guarantee operational safety for example in cooling water circuits, district heating networks or water treatment plants.

VAG Group is a global company with approx. 300 sales representatives taking care of customers on every continent. Since its founding in 1872, the company has been known for its international character and quality "Made in Germany". The head office is in Mannheim (Germany) from where it delivers products all over the world.

VAG is a company with German roots with lots of experience in the design and manufacturing of heavy-duty valves and gates as well as pipe couplings for all kinds of water applications. With more than 1,600 employees worldwide the valve and gate manufacturer is a globally active company and is setting new standards as a solution and system provider in water and wastewater technology. With seven production facilities and additionally 14 sales subsidiaris worldwide VAG is at home around the world.