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Precise control of water supply systems by plunger valves

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Precise control of water supply systems by plunger valves

Plunger valves are special control valves, designed specifically for control tasks in water supply. Unlike gate valves and butterfly valves, which are mainly used as shut-off valves only in pipeline networks, plunger valves meet the special requirements of control operation. Plunger valves are mainly used where volumetric flow rates need to be precisely apportioned or where water pressures have to be accurately controlled or reduced.

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As early as in the 1930s, the performance of water supply systems and hydropower stations was increased in a way that made the requirements in terms of pipeline diameters and pipeline lengths as well as operating pressures and flow velocities higher as well. The shut-off devices used at that time, mostly wedge gate valves, had to be optimised and adapted to the increased demands. Wider sealing rings were used, wedge guides were reworked or also extended, but in the end the gate valve was not a suitable control valve.

At that time, the annular slide valve constituted a special type within the valve group. However, the round cross-section of the annular slide valve was transformed into an annular cross-section by an internal body, which turned into a round cross-section again at the outlet of the valve. This was how the annular slide valve got its name. In the course of the years, the annular slide valve evolved into the annular piston valve and/or the plunger valve (**Figure 1**).

The plunger valve is a straightway control valve, i.e. it has an annular flow cross-section in any position. Inside the body, the plunger (also referred to as piston) is moved axially in flow direction by a crank gear towards the sealing seat of the valve. Plunger valves are control and regulating devices which generate different pressure losses in pipeline systems by way of continuous narrowing towards the seat

to change the flow rate in dependence of the regulating distance. Depending on the application, the nominal diameter of the valve has to be large enough to ensure that at the lowest pressure difference the highest required flow rate is achieved and/or that maximum differences in pressure are reduced without causing cavitation. Additionally, any damage to the downstream pipeline system or structure by vibration or cavitation must be prevented over the entire regulating distance.



Fig. 1: VAG RIKO® Plunger Valve

VAG has evolved the plunger valve, proven for decades, to make it suitable for control tasks in water supply systems. Today's VAG RIKO® Plunger Valve is available in almost all nominal diameters between DN 150 and 2000 and in pressure ratings ranging from PN 10 to 40. Meanwhile a great number of plunger valves are in use world-wide, even valves of sizes DN 250, DN 600 and DN 800 with a nominal pressure of PN 100. In all sizes and pressure ratings, the compact body is made of premium-quality ductile cast iron EN-JS 1030 (GGG 40). Up to DN 600, the inner parts are made entirely of grade A2 stainless steel as a standard. For all nominal diameters up to and including DN 2000, the piston is guided by bronze-welded longitudinal guides (**Figure 2**). This ensures optimal longitudinal guiding and thus the backlash-free sliding of the plunger with very low operation torques at the same time.

The body consists of one piece and the inner body is connected to the outer body by ribs. On the inlet side, the inner body has a spherical shape. The design of the annular space results in a continuous narrowing towards the seat. The piston or plunger is moved by an internal crank drive. New sealing systems for the body seat, the plunger and the shaft bearings guarantee absolute corrosion protection, excellent performance and a long service life. Due to the fully enclosed bearing, no fluid (water) can penetrate into the bearing, which ensures high durability. The sealing of the shaft was adopted from the proven sealing principle of the VAG EKN® Butterfly Valve, i.e. the shaft is sealed by a double O-ring seal. Inside the valve, between the body and the plunger, a quadring seal sealing on four sides is used as a double seal. It is resistant to twisting and ensures permanent tightness even under high stress cycles. The valve seal at the sealing seat was arranged in the no-flow zone in a way that prevents stones and pebbles from causing damage to the valve seal and minimises wear of the seal. All seals are approved according to the German regulations for potable water W 270, which allows their unrestricted use with drinking water.

FIELDS OF APPLICATION

VAG plunger valves are suitable for use with raw water, drinking water and cooling water with temperatures of maximum 50 °C. The main fields of application of plunger valves include:

- Conveyance of water in catchment basins and dams
- Bypass lines of hydropower stations
- Long-distance pipelines
- Water treatment in waterworks
- Water supply in pump stations

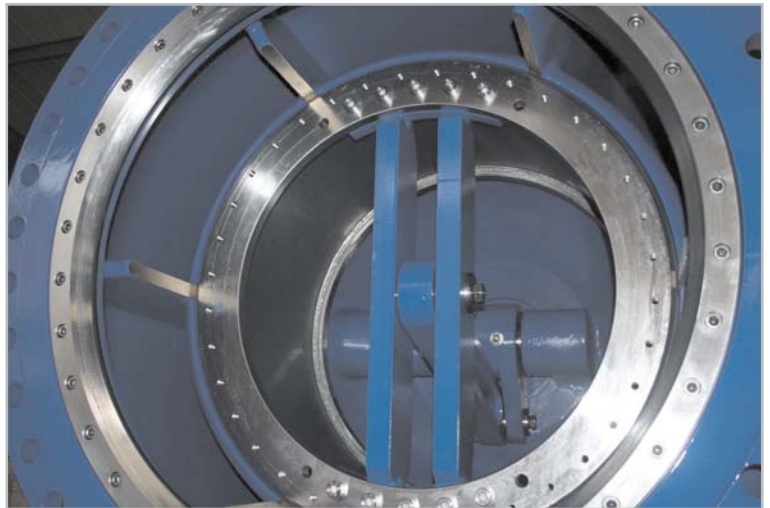


Fig. 2: Bronze-weld guides of a VAG RIKO® Plunger Valve DN 1600

- Supply control of elevated tanks
- Drinking water networks
- Cooling water circuits of industrial and power plants

Here, the VAG plunger valves have stood the test of time for decades in many projects all over the world. Furthermore, plunger valves can also be used in inlet control systems of activating basins in waste-water treatment plants as notably better control characteristics than with gate valves or butterfly valves can be achieved.

PLANNING AND DESIGN

Plunger valves are modulating valves which, according to the throttling principle, generate pressure losses in pipelines to change the flow rate according to a desired characteristic in dependence of the regulating distance. The nominal diameter of the plunger valve and its regulating behaviour are always dependent on each other. However, they can only be determined one after another and then have to be adjusted to each other. Their regulating behaviour is always influenced by the resistances present in the entire plant. This means:

- The longer the pipeline, the higher the resistance
- The larger the total of the resistances present in the plant is in relation to the resistance of the open plunger valve, the lower the throttling effect will be.

Outlet type/Seat Due to its linear control characteristic, the VAG RIKO® Plunger Valve ensures excellent cavitation behaviour and very little pressure loss at the same time. Its outlet type is variable and, coming as

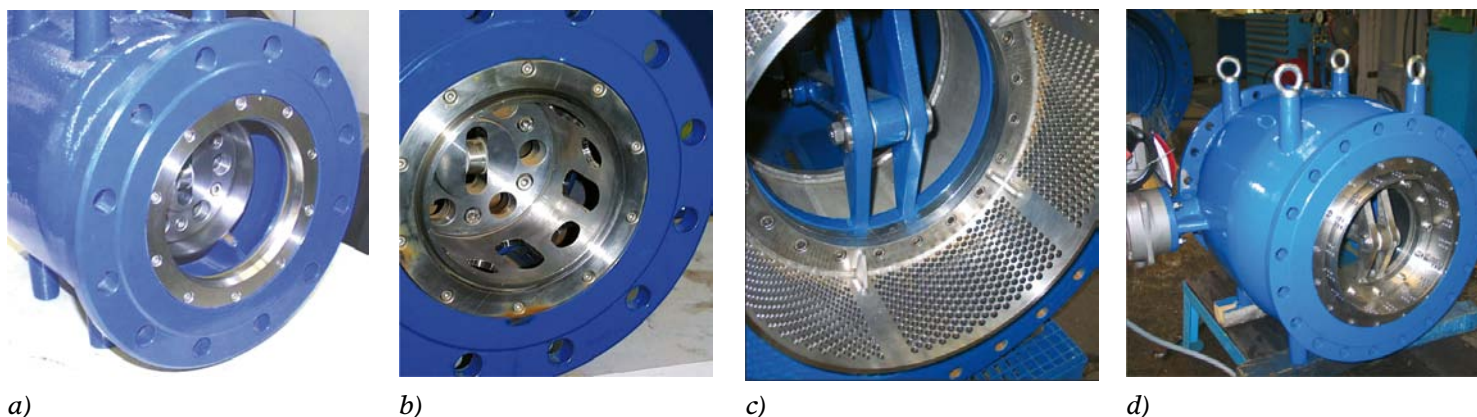


Fig. 3: Different types of VAG RIKO® Plunger Valve:
 a) standard type E, b) slotted cylinder SZ, c) orifice cylinder LH, d) control device (short type)

a kit, allows the change of the valve characteristic. This is an essential advantage as the valve can be adapted to changed operation conditions even after its delivery. Depending on the application and the operation specifications, different types of outlets such as standard seat ring, orifice cylinder or slotted cylinder as well as various customised cylinders to prevent cavitation are available (**Figure 3**).

PLANNING AND DESIGN OF PLUNGER VALVES WITH THE VAG USECAD® DESIGN SOFTWARE

The individual design of the control valve and its various outlet types can be realised using VAG's proprietary UseCAD® software tool. The specifications needed for reliable design include the dynamic pressure upstream and downstream of the control valve as well as the desired flow rates Q_{\min} and Q_{\max} . This allows the accurate determination of the control behaviour. Cavitation-free control behaviour should always be aimed at.

The wide range of applications it provides makes the versatile VAG UseCAD® software interesting to the most diverse groups of users. It helps users to find the right valve for the intended application purpose, to determine suitable nominal diameters for specific flow rates and to design plants so that they are free from cavitation.

Departure to the third dimension In the past few years, VAG has continuously extended and updated the software and has adapted it to the requirements of practice. The highlight of the most recent version VAG UseCAD® 6.1 is the automatic generation of

3-D images of various types of valves. Where some years ago, 2-D drawings were the most commonly used planning format, design work is now moving increasingly to the third dimension. Monitoring of collisions, planning of plants and many other tasks ask for three-dimensional valve models today. The 3-D solid models generated with VAG UseCAD® 6.1 can be exported into all common 3-D formats such as dwg 3D, IGES 3D, SAT 3D or STEP 3D. Thanks to this they can be read into diverse user planning systems and be aligned there. Special attention has been paid to the so-called critical valve components as their movability can have a decisive influence on the alignment of the plant. Besides the 3-D generation novelty the VAG UseCAD® 6.1 supports all areas of conventional valve planning and supplies valve knowledge in a condensed form. The electronic valve catalogue provides extensive technical information. Besides technical data sheets, sales texts and valve symbols, the VAG UseCAD® naturally also supplies 2-D projections of the entire range of valves for conventional 2-D planning.

Selection of 2-D-images Here, too, the user first selects the valve type, makes further selections via the nominal diameter and type of actuator and then receives the matching 2-D image (**Figure 4**). Depending on the type of valve, the software generates up to four projections in the dwg or dxf formats. The integrated viewer allows the user to view the drawing also without CAD software. Via the export function all required 2-D views can be saved and can be retrieved in the planner's individual software program.

The function of pressure loss calculation rounds off the valve catalogue. This additional program allows

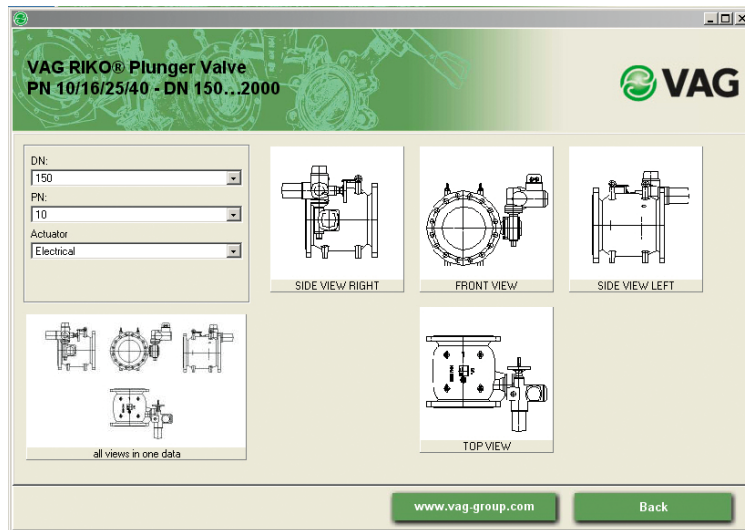


Fig. 4: VAG UseCAD® 6.1 Design
Software: selection of 2 D projections

the calculation of the pressure losses developing during flow – over the entire range of various pipeline elements. With its user-friendly addition of the valves and pipeline components used, such as elbows or dividers, the program calculates the resulting pressure loss. The results can be exported and can thus be adopted into the user documentation fast and easily.

INSPECTION AND OPERATION INTERVALS

According to the German regulations for potable water W 392, plunger valves should be checked for tightness, operability and condition of the corrosion protection at least once per year. In case of extreme operation conditions, these inspections should be performed more frequently.

SUMMARY

The plunger valve is a straightway regulating and control valve which has an annular flow cross-section in any position. Inside the body, the plunger (also referred to as piston) is moved axially in flow direction by a crank gear towards the sealing seat of the valve. Plunger valves are regulating and control 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. The nominal diameter of the valve has to be large enough to ensure that at the lowest pressure difference the highest required flow rate is achieved. Additionally, any damage to the downstream pipeline system or structure by vibration or cavitation must be prevented over the entire regulating distance.

VAG supplies the entire range over all nominal diameters and pressure ratings and offers the right solution – however complicated the application may be.

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THE COMPANY

VAG's valves and 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 250 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 for all kinds of water applications. With more than 1,200 employees worldwide the valve manufacturer is a globally active company and is setting new standards as a solution and system provider in water and wastewater technology. With seventeen subsidiaries and four production facilities VAG is at home around the world.