

AVK UK

Features and benefits of resilient seated wedge gate valves

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Introduction

Gate valves are widely used for all types of applications and are suitable for both above-ground and underground installation. It is paramount to choose the right type of valve to avoid high replacement costs.

Gate valves are designed for fully open or fully closed service. They are installed in pipelines as isolating valves, and should not be used as control or regulating valves. Operation of a gate valve can be provided with a clockwise to close (CTC) or clockwise to open (CTO) rotating motion of the stem. When operating the valve stem, the gate (or wedge) moves up- or downwards on the threaded part of the stem.

Gate valves are often used when minimum pressure loss and a full, free bore flow path is required. When fully open, a typical gate valve has no obstruction resulting in a very low pressure loss, and this design makes it possible to use a pipe-cleaning pig.

A gate valve is a multi-turn valve meaning that the operation of the valve is done by means of a threaded stem. As the valve has to turn multiple times to travel from the open to closed position, the slow operation also prevents water hammer effects.

Brief history and current status of metal vs resilient seated gate valves.

Before the resilient seated gate valve was introduced to the market (circa 1980's), gate valves with a metal seated design were most commonly used for all sizes.

Since then, resilient seated gate valves have become, by far, the most common choice for water and wastewater applications for sizes up to and including pipework diameters of 600mm.

Metal seated gate valves are still more commonly used for valve sizes of DN700 and above.

However, with advances and improvements in manufacturing processes and equipment, resilient seated gate valves are readily available from AVK in sizes up to and including DN1000, and this will be increased further to DN1200 in the near future.

As you would expect from AVK, these larger resilient seated gate valves are designed, tested and manufactured in full accordance with the relevant standards (BS EN1074-1 & 2, BS EN558, BS EN1092-2 & BS EN12266-1) and are suitable for drinking water applications being manufactured from WRAS approved materials.

This documents describes the various advantages of using resilient seated gate valves compared to the metal seated equivalent.

Features and benefits of resilient seated gate valves

There are several key benefits of resilient seated gate valves compared to the metal seated design. These are discussed as follows:

(A) Sealing performance

The resilient seated design allows the gate valve to be drop-tight with zero leakage in accordance with BS EN12266-1 Leakage Rate A. It is the resilient seal on the wedge that makes contact with the internal surfaces of the body and the compression of the resilient material allows for this zero-leakage sealing performance.

Also, the resilient seated gate valve has a plain, smooth surface on the base of the valve bore allowing free passage for any sand and stones in the valve. If impurities pass as the valve closes, the rubber surface will close around the impurities while the valve is closed. The high-quality rubber compound manufactured and supplied by AVK Gummi absorbs the impurities as the valve closes and the impurities will be flushed away when the valve is opened again. Due to the excellent compression set properties of the rubber material used, the surface will regain its original shape securing a drop-tight seal. The resilient seated design in the fully open and fully closed position is shown in Figure 1.

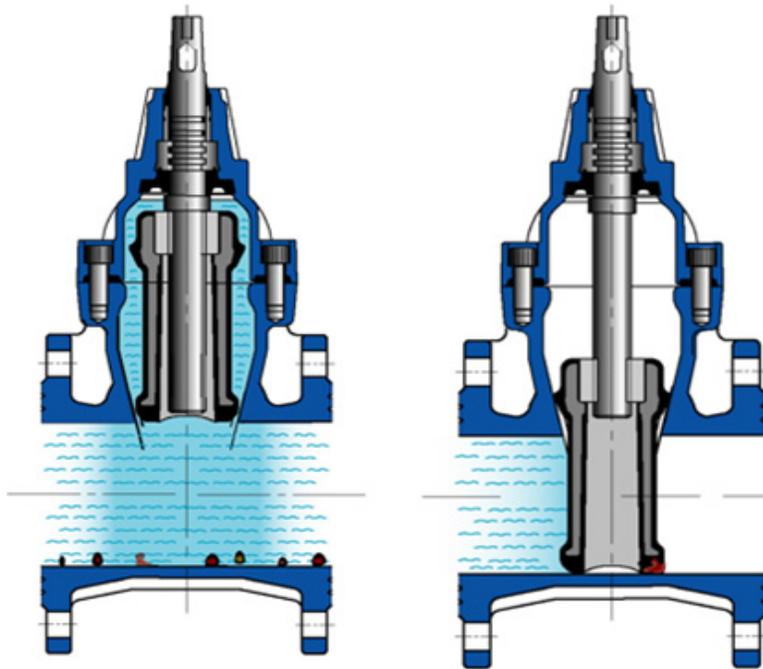


Figure 1 - resilient seated gate valve (smooth base on valve bore)

In contrast to this, the conical wedge design and angular sealing devices of a metal seated wedge requires a sump in the base of the valve bore (see Figure 2) to ensure a tight closure as full circumferential contact is required between the body seat rings and the wedge face rings. Because of this, solids can become embedded in this sump. The pipe system may never be completely free from impurities regardless of how thoroughly the pipe is flushed upon installation or repair. Optional flushing access points are available for metal seated gate valves. There is also potential for wedge over-travel. If excessive torque is applied to the valve, the wedge can become 'jammed' in the closed position resulting in operational issues and potential damage to the stem, stem nut and metal rings. To avoid such operational issues, Jacking or easing screws can be fitted to large metal seated gate valves as an optional extra.

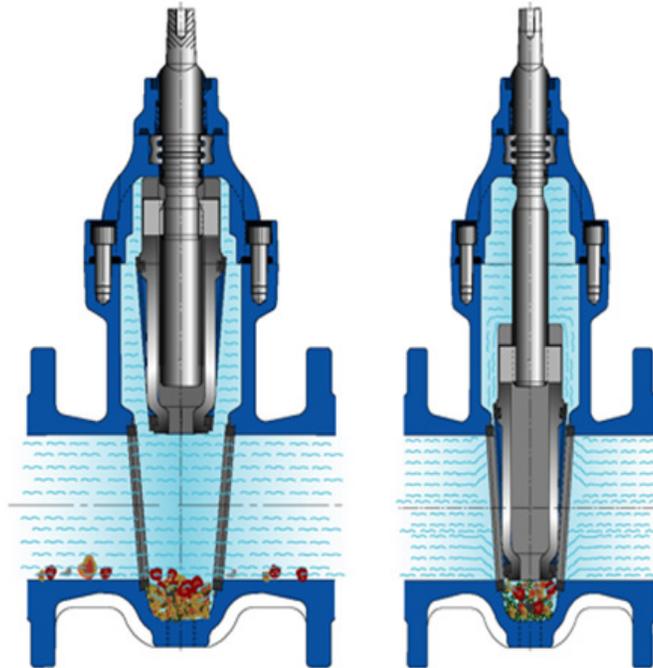


Figure 2 – metal seated gate valve (sump at base of valve bore)

There is a leakage allowance for metal seated gate valves (BS EN12266-1 Leakage Rate B) as it is more difficult to achieve a seal for metal to metal contact – especially on larger size valves.

Leakage reduction is greatly important in any water system and the resilient seated design will reduce leakage, improve system efficiency and reduce overall costs.

As the valve diameter increases, the potential reduction in leakage rates using resilient seated gate valves also increases. As an example, for a PN16 DN1000 gate valve, the allowable leakage rate for a metal seated design (Rate B) is 0.6ml/min. Although this is a small amount, it equates to an allowable annual leakage of 315 litres – the equivalent to 3 filled bathtubs of water per valve. On systems with high numbers of gate valves installed, this annual leakage can be considerable.

(B) Reduced operating torques

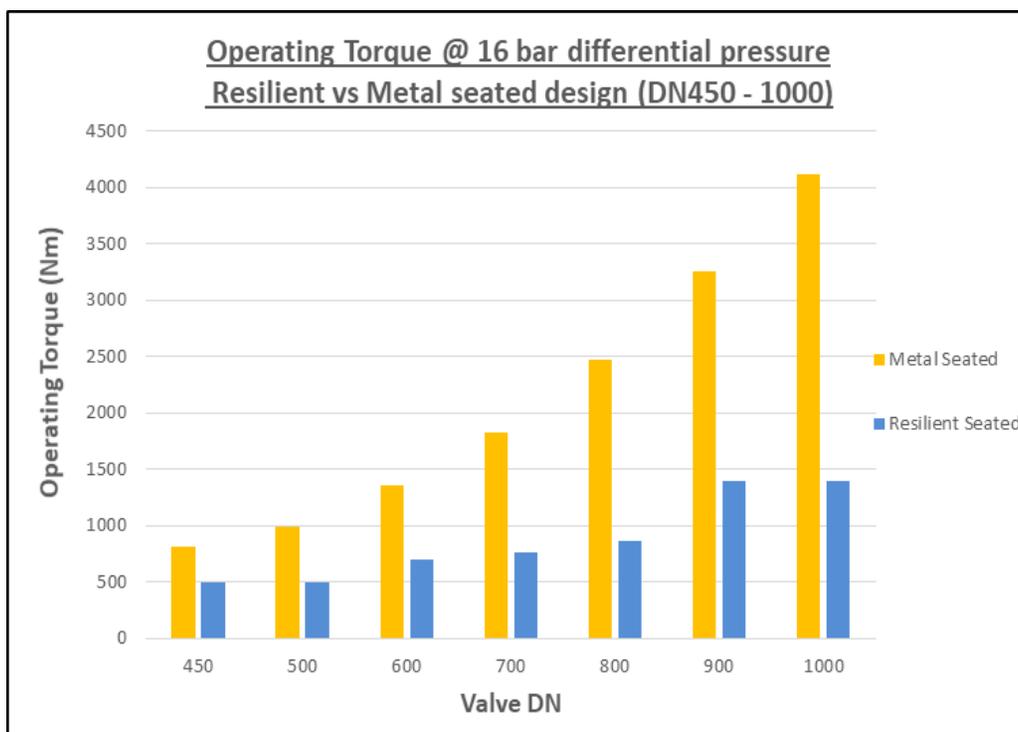
As previously mentioned, the metal seated gate valve requires a sump as shown in Figure 2. To close the valve fully, the metal seated wedge must be forced into the sump to effect a suitable seal. Considerable effort and operating torque is needed as the wedge requires to be compressed adequately into a conical section.

When operating a gate valve, the maximum torque is required at the initial opening (or cracking) of the valve and also the instant before full closure. This is due to the following 3 factors:

- Largest area of the wedge is being subjected to the hydraulic pressure
- Highest pressure acts on the wedge at the fully closed position
- Highest contact surface (friction) between the metal seat and face rings

The wedge of the resilient seated gate valve closed fully onto a plain, smooth surface at the base of the bore as shown in Figure 1. This greatly reduces the operating torque as it is only the compression of the rubber wedge on this plain surface that is required.

Graph 1 shows the comparison between the Series 55 resilient seated and Series 54 metal seated gate valves for differential pressures of 16 bar.



Graph 1 – comparison of operating torques for metal vs resilient seated gate valves

As can be seen, there is a considerable reduction in operating torque requirements for the resilient seated design compared to the equivalent metal seated DN size. These torque reductions range from 39 – 66%.

This allows smaller and more economical gearboxes and electrical actuators to be used.

As an example, for manual operation, the standard bevel gearbox price for a DN900 is 71% cheaper for the resilient seated gate valve compared to the metal seated version.

This point is also important when electrical actuation is required. Reductions in power consumption can also be readily achieved when using electrical actuators on resilient seated instead of metal seated valves. When considering large water networks and systems with many valves, this overall reduction in power consumption is noticeable and would also help to reduce operating costs as well as increasing system efficiency and providing a more environmentally friendly water supply and reducing the carbon footprint of the operating system.

(C) Flexibility of installation

Gate valves are most commonly installed with the stem in the vertical orientation, facing upwards. However, if due to space constraints or operating requirements, a metal seated gate valve requires to be installed with the stem offset by more than 10% from the vertical orientation, consideration to the operation of the valve must be made.

As the size of the valve increases, so does the mass of the wedge. If the valve is installed at an angle or with the stem in the horizontal orientation, due to gravitational effects, the wedge will bear down on one side of the internal body surface. When the valve is operated, the weight of the wedge will be applied to the body resulting in high bearing loads at these contact areas. This results in several detrimental effects including:

1. Accelerated wear and tear of the contact surfaces
2. Increased operating torques due to increased friction between the wedge and body
3. Operational issues due to valve seizures
4. Increased maintenance and repair requirements

Depending on the number of operations, the size and the working pressures of the valve, if consideration is not given to this installation for metal seated gate valves, failure of the valve could be expected.

In order to prevent this issue, optional shoes and channels require to be fitted to the wedge and body of the valve. These components are manufactured from extruded aluminium bronze castings and are mechanically fastened to the wedge and body (see Figures 3a & 3b). They are then machined to a smooth surface finish so that the contact surfaces between the body and wedge are of a hard wearing material, the frictional coefficients are minimised and improved alignment is provided across the full operating stroke of the valve.

As gate valves are generally symmetrical in design, they are fully bi-directional and can seal with flows from either direction. In order to ensure that the valve is protected from the issues relating to off-vertical installations, the shoes and channels require to be fitted on both sides of the body and wedge.

This is a relatively expensive addition to the metal seated gate valve but must be included for non-vertical installations involving valve sizes generally above DN400.

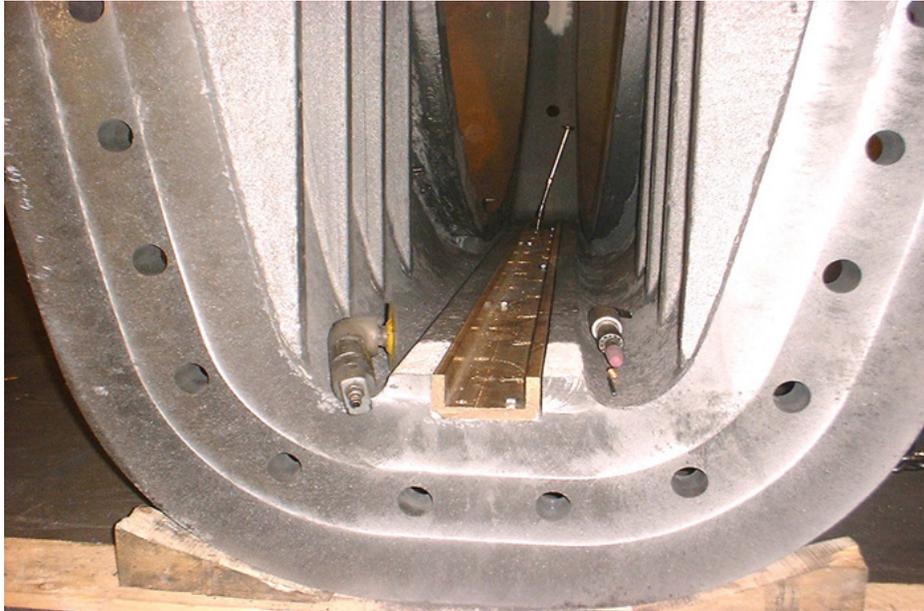


Figure 3a – extruded aluminium bronze channel fixed onto metal seated gate valve body

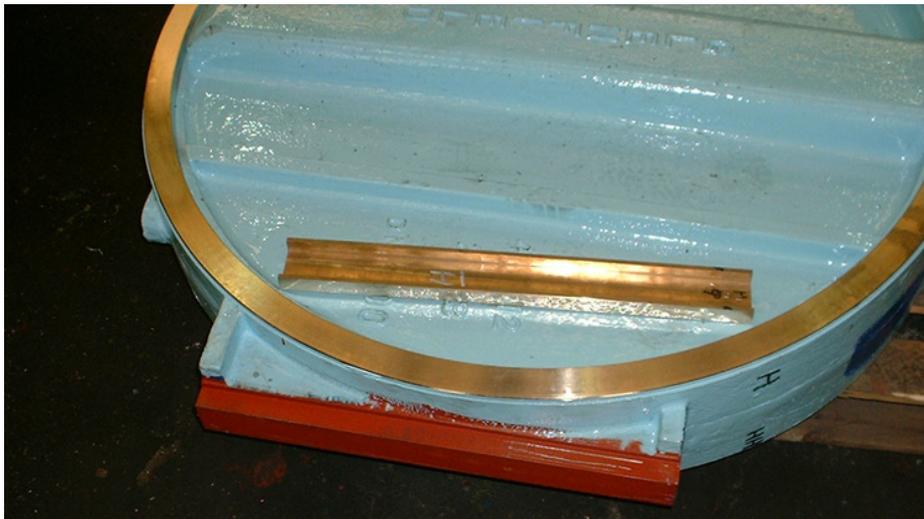


Figure 3b – extruded aluminium bronze shoe fixed onto metal seated gate valve wedge

Because the resilient seated gate valve has a fully vulcanised wedge (see Figure 4), there is no requirement for optional bronze shoes and channels. The rubber wedge contacts the epoxy coated ductile iron of the body without the risk of damage or operational issues associated with the metal seated design.



Figure 4 – cross sectional view of large resilient seated gate valve with vulcanised wedge

Summary

There is a legacy of using metal seated gate valves for water and wastewater applications on sizes above DN600. However, resilient seated gate valves are now readily available from AVK in sizes up to and including DN1000 (see Figure 5) and this size range will increase even further in the near future.

The above report provides the main advantages of using resilient seated gate valves compared to metal seated designs and shows that the following important benefits can be achieved:

- Leakage reduction
- Increase system efficiency
- Reduced operating torque and input effort
- Reduced costs for gearboxes and electrical actuators
- Reduces power consumption for valve operation
- Increased flexibility for valve installation

Depending on the requirements of the valve in terms of size, differential pressure, method of actuation, orientation etc, the resilient seated gate valve can be a more economical solution compared to the metal seated option.



Figure 5 – fully assembled and tested DN1000 Series 55 resilient seated AVK Gate Valves

AVK offer a full range of resilient seated gate valves from DN50 to DN1000 and also offer metal seated gate valves from DN50 to DN1800. A wide range of options are also available.

We would welcome the opportunity to discuss your gate valve requirements. For any further information or technical advice, please visit our website www.avkuk.co.uk