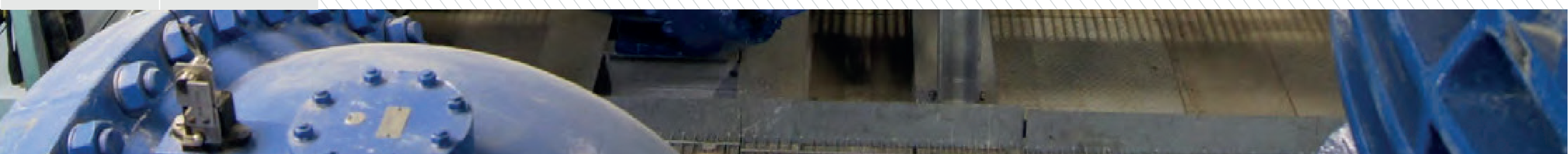
NON-RETURN VALVES

Expect... AVK
الشركة السعودية لصناعة الصمامات المحدودة
SAUDI VALVES MANUFACTURING CO. LTD.



INTRODUCTION

The check or non-return valve is most commonly used in pumping stations and allows the flow in only one (and always the same) direction thus preventing back flow when the fluid in the line reverses direction. The main importance of this function is twofold:

1) To prevent damage to upstream equipment that can be affected by reverse flows such as pumps and measuring equipment.

2) To prevent reverse flow after system shutdown (water hammer).

Check valves are therefore safety critical valves that protect the system and its equipment from damage which can range from accelerated wear and tear to full, catastrophic system failure depending on the extent of the system design.

The importance of selecting the correct type, size and specification of check valve is crucial to ensure the running of the system is smooth, trouble free and provides long-term operation. However, check valves are generally one of the least understood valve types and their importance is regularly overlooked. If these valves are incorrectly specified it can lead to major operational problems. Because of this, check valves are one of the least popular valve types as they can cause extensive system issues which require downtime, cost and labour to resolve. This will also result in loss of revenue while the system is being repaired.

This document has been developed to introduce the phenomena of check valve slam and the associated water hammer. It also hopes to aid with the selection of check valves by providing the reader with an introduction to the various product types available for both water and waste water systems covering the following topics:

i) The valves main components and how it works?
ii) What are the main advantages and disadvantages of each valve type?
iii) What are the applications suitable for each valve type?

It will also highlight the importance of selecting the correct valve type and size based on hydraulic characteristics, closing speeds and available options for these valves.

Reference will also be made to the general installation, operation and maintenance requirements of check valves.

CHECK VALVES – GENERAL INFORMATION

Check valves, also known as non-return, reflux or one-way valves are automatic valve types that do not require any manual or electrical intervention to open and close.
Check valves are used to allow flow in one direction only and prevent the reversal of flow. They are also used to protect the system and it's components from water hammer and pressure surges.

INTRODUCTION TO WATER HAMMER

In a pumped system, the water is forced from a lower level to a higher level by means of a pump. The fluid flows in one direction only when the pump is in operation. When the pump stops, the flow of fluid will reduce until it also stops. Because the overall pipeline will be rising, when the fluid stops, it will then return back down the pipe. To prevent this flow reversal entering into the pump, well or intake, a check valve is installed.

In many cases, the rate of fluid reversal is not a cause for concern and standard check valves will perform well. However, in pumped systems where fast flow reversal can occur, the selection of the correct check valve is crucial.

If a pump stops and the forward flow reverses back down the line towards the pump before the check valve has fully closed, the flow will force the valve door to slam onto its seat. This scenario can almost instantaneously stop the reverse flow and it is this instantaneous stoppage which results in pipeline water hammer. This can produce loud hammer noises which is not the noise of the valve coming into its seated position but is the stretching of the pipe under these conditions.

The consequent pressure wave (surge) can cause considerable damage to the system including pipe cracks, bursts, cavitation and implosion due to vacuum pressures being formed. It is also important to note that these failures may not be due to one single, large surge pressure but by repeated surges which eventually cause fatigue failure of the system.

It is important to note that other factors are required to ensure a safe and trouble free system. The correct number, types and sizes of air valves, closing and opening times of isolation valves, flow control valves etc all require to be considered to protect the system from pressure surges.
To prevent the occurrence of check valve slam, the valve should close either very quickly to prevent the onset of reverse flow or very slowly once reverse flow has developed.

For a check valve to close slowly, this requires additional ancillary equipment such as hydraulic dampers which act to cushion the valve door as it comes into its seated position. However, this slower closure does allow the fluid to pass through the check valve until it closes and consideration must be given to the upstream pump to ensure that it is suitable for reverse spin and flow.

There is a wide range of check valve types available to the water and waste water markets and the main ones will be described here.

(A) Swing Check Valves

Swing check valves are the most common type of check valves used (Fig. 1).

Fig. 1 – Standard swing check valve

The valve consists of a double flanged body and cover which are manufactured from cast ductile iron. The upper part of the body, just under the cover, accommodates the valve disc when in the fully open position. The shaft is positioned above the top of the seat and is installed horizontally, supported at both ends by either plastic or metallic bushes.

The shaft is free to rotate and usually one end protrudes from the body allowing the fitting of optional levers and weights. The disc is circular and is attached to the shaft via hinge arms. A typical cutaway section is shown in Fig. 2. When closed, the disc seals onto the metal seat section within the body. The disc seal can be either resilient of metallic.

In order to ensure optimal sealing performance, it is important that there is some flexibility in the disc sub-assembly so that the disc seal maintains close contact with the metal seat around the complete circumference. The metal to metal seal is usually used for larger size valves and allowance is made for slight leakage rates. The resilient seat design provides fully drop-tight sealing performance and generates less noise during operation.

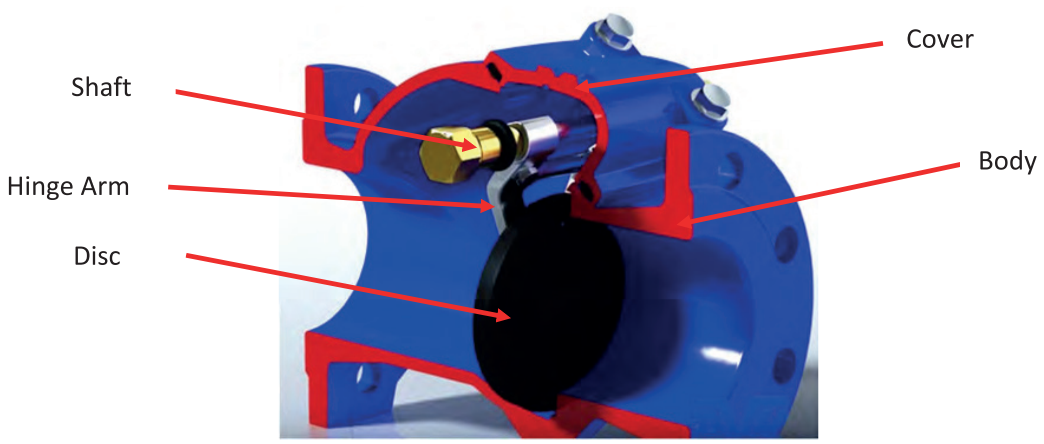


Fig. 2 – Swing check valve internals

The operation of the swing check valve is based on a rotary motion. Under flow conditions, the fluid exerts a force on the disc which causes it to rotate upwards. When the flow reduces, due to gravity, the disc returns back to its closed position. When the flow reverses, the pressure of the fluid acting on the disc forces it onto its seat which seals the valve and prevents flow reversal.

The main advantages for swing check valves are that they can be designed with a full bore design (Fig. 3). This results in very low head loss across the valve during full flow conditions.

This design feature provides an unobstructed flow path which greatly reduces turbulence and also allows this valve type to be used for both water and waste water applications.

These valves can also be designed with relatively low disc weights which reduces the force required to open and close the valve, thus are suitable for operation in both low and high pressure applications.

They are also suitable for installation in the horizontal and vertical orientations although careful consideration is required for the correct positioning of levers and weights when these are attached to the valve. Swing check valves have a good size range available and are commonly supplied between sizes of DN50 – DN1000.

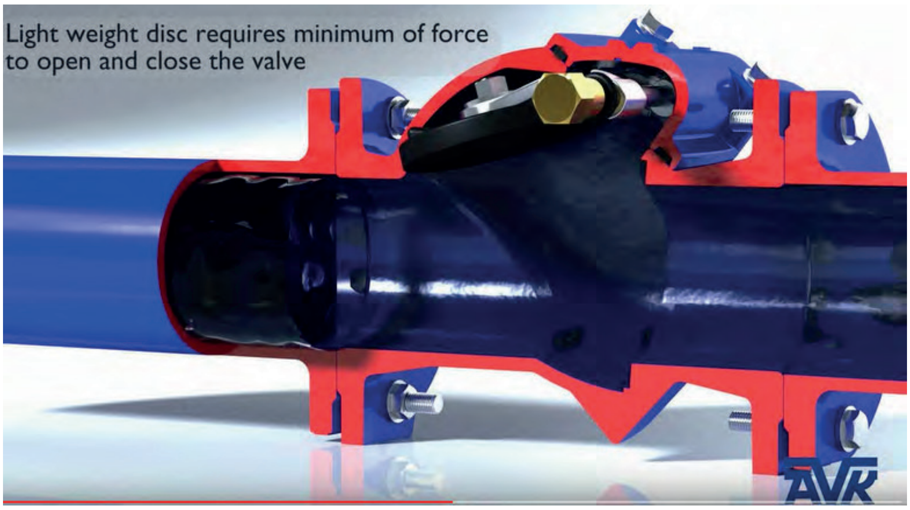


Fig. 3 – Principle of full bore design

Swing check valves are not generally suitable for pumped stations with frequent pulsating flows. Depending on the frequency and severity of these pulses, it can result in accelerated wear and tear of the moving parts within the valve. Because of the disc travel, swing check valves are generally not used for systems in which water hammer is likely to occur.

(B) Resilient hinge check valves

The resilient hinge check valve is a relatively new concept in the non-return valve family. Figure 4 shows an example of this valve type and it can be seen that the valve disc and hinge pin assembly is fully encapsulated with rubber and reinforced with nylon.

As flow enters the valve, the disc opens and bends the resilient section of the disc until it reaches the fully open position. This disc will be constantly flexing during operation so it is of vital importance that the rubber is adequately reinforced with a suitable material to ensure that rupture of the disc is eliminated.

Due to the inclined seating angle (usually 35 degrees), this shortens the operating travel of the valve allowing quicker closure. When fully open, the valve has low obstruction resulting in a low pressure drop across the valve. Unlike conventional swing check valves, the resilient hinge check valve does not rely on rotation around the hinge pin. It is the resilience of the rubber that allows the movement of the disc and because of this, frictional losses between the hinge pin is completely avoided, reducing the time taken to close. Also, the resilient hinge check valve requires no protrusion from the valve body and the maintenance requirements for this valve are practically zero.

Because of this, the resilient hinge check valve is suitable for use in water and sewage applications and due to its quicker reaction times, can be used to prevent valve slam in water and waste water pumping systems.

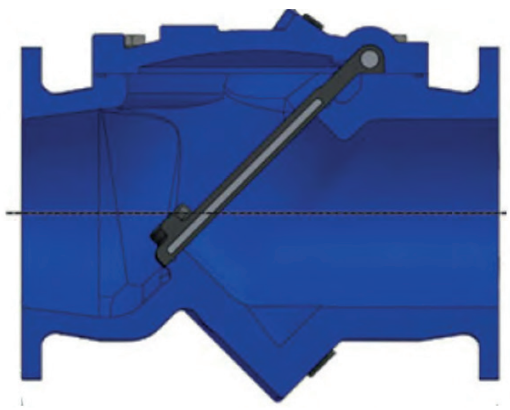


Fig. 4 – Resilient hinge check valve

Another benefit of this valve type is that the valve only has one moving part (the disc) and thus greatly increases the product's longevity as there is no requirement for shaft / bearing connections etc. It is also possible to install these valves in buried applications albeit, where at all practical, access to any valve should be made possible in case of any unexpected operational issues or maintenance requirements.

(C) Recoil check valves

The recoil check valve is one of the oldest and recognized types of high performance check valves.

They are used in pumping systems where high rapid flow reversal takes place. Typically, these active systems are pumping stations which adopt high branch velocities and, in addition, provide automatic stopping and starting, deliver into a vertically rising main and have multi-pump sets delivering into a common main.

Recoil valves are either single (Fig. 5a) or multi-door (Fig. 5b) designs depending on size.

Fig. 5a – Single door recoil check valve

Fig. 5b – Multi-door recoil check valve

The recoil check valve is used for more extreme conditions and is designed to incorporate every mechanical and hydraulic assistance for accelerating the closure of the door(s).

Mechanical assistance is given by a combination of inertia reduction, concentration of mass and ideal suspension of the moving elements. Hydraulic assistance is given by the provision for forward and backward water streams within the body and around the valve door(s).

The cross-sectional details of the fully open single and multi- door recoil valves are shown in Figs. 6a and 6b.

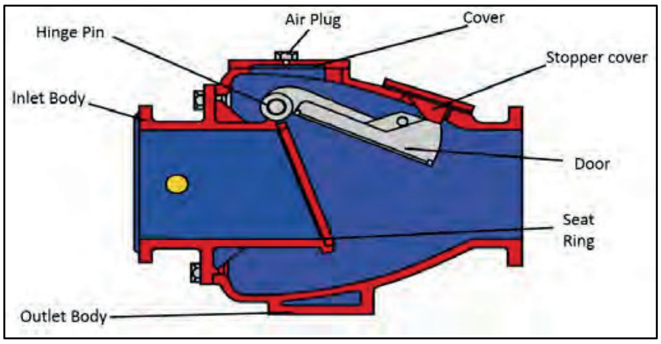


Fig. 6a – Single door recoil check valve internals

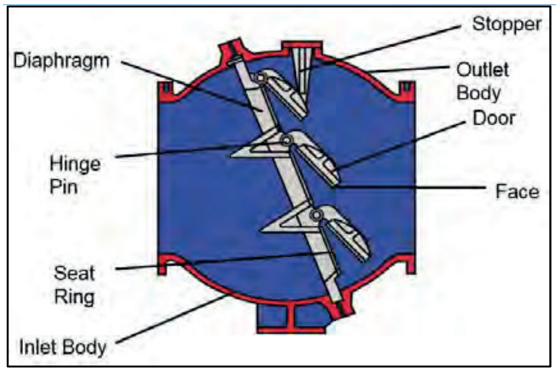


Fig. 6b – Multi-door recoil check valve internals

Each door has an integral concentrated mass which loads the door resulting in faster closure. The seating angle is inclined to reduce angular travel of the door and each door has its own individual stopper which controls and limits the door travel so that under normal flow conditions, the doors are held against the stopper, thus eradicating oscillations with flow, which would otherwise accelerate the bearing wear.

For larger valve sizes, a multi-door design is used. By sharing the volume of flow by two, three or even four doors, this reduces the required angular travel of each door, thus reducing the closure times of the doors.
The recoil check valves have metal to metal seats and an allowable leakage rate is to be considered.

Apart from the fast-acting closure of the recoil valve, because all hydraulic and mechanical features are incorporated into the actual valve, there is no requirement for additional options such as levers, weights, dampers or springs. As such, the recoil check valve is a self-contained product that requires practically zero maintenance. Extensive information is available on the dynamic characteristics of this valve type which is extremely valuable when undertaking check valve selection for systems in which rapid flow reversal can take place.

Due to the internal design of the recoil valve, the head loss characteristics are higher compared to that of swing check valves. However, any modest increase in head loss is more than compensated for the additional safety and security that the recoil valves can provide to the system.
Recoil valves are generally used in water systems and are not recommended for sewage applications due to the potential for ragging within the valve. These valves are suitable for horizontal installations only.

(D) Tilting disc check valves

The tilting disc check valve is similar in appearance to an eccentric butterfly valve. The valve body is double-flanged and of a short length.

The disc is held in place via a shaft which is positioned eccentrically from the body centreline in both the horizontal and vertical axes.

Higher quality products have stoppers attached to the disc which limits the valve opening and ensures that the disc remains in a more static position when subjected to sufficient flow rates.

This reduces the wear and tear of the rotating components of the valve and also provides stable and consistent head loss characteristics during operation.

Figure 7 shows an example of a tilting disc valve in the fully open position.

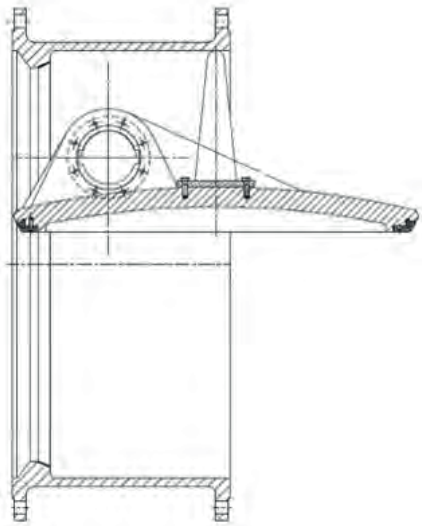


Fig. 7 – Fully open tilting disc check valve

The substantial double eccentricity of the shaft results in the lower section of the disc occupying a greater area in the flow path. Consequently, the disc begins to open at very low flow rates. The tilting disc check valve is therefore commonly used in pumping systems with low flow rates and also for pulsating flows.

During flow reversal, the disc closes due to gravity and the upper part of the disc above the shaft centreline pushes against the flow thus acting as a hydraulic brake which cushions the disc as it returns to the closed position. Tilting disc valves can be supplied with optional levers and weights to adjust the closing characteristics of the valve.

As such, the tilting disc check valves are better suited to reduce the risk of water hammer compared to conventional swing check valves.

Because of the internal shafts which are within the flow stream, the tilting disc check valve is used for water and treated effluent applications.

(E) Slanted seat check valves

Like the tilting disc check valve, the slanted seat offers enhanced resistance to water hammer. The valve has the double eccentric shaft position similar to the tilting disc but it also has an increased seating angle. This yields a shorter valve stroke, thus reducing the time taken for the door to close.

The slanted seat check valve can be installed with an optional hydraulic damper which is located at the internal base of the valve body. Figures 8 and 9 show this device and the mechanism by which it operates.

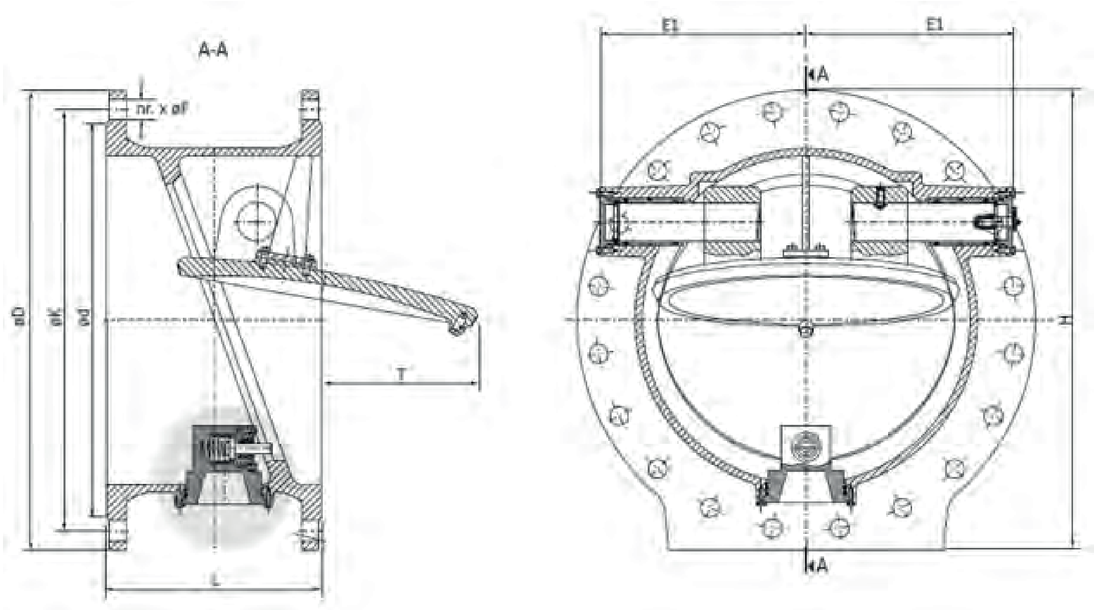


Fig. 8 – Slanted seat check valve with optional hydraulic damping device

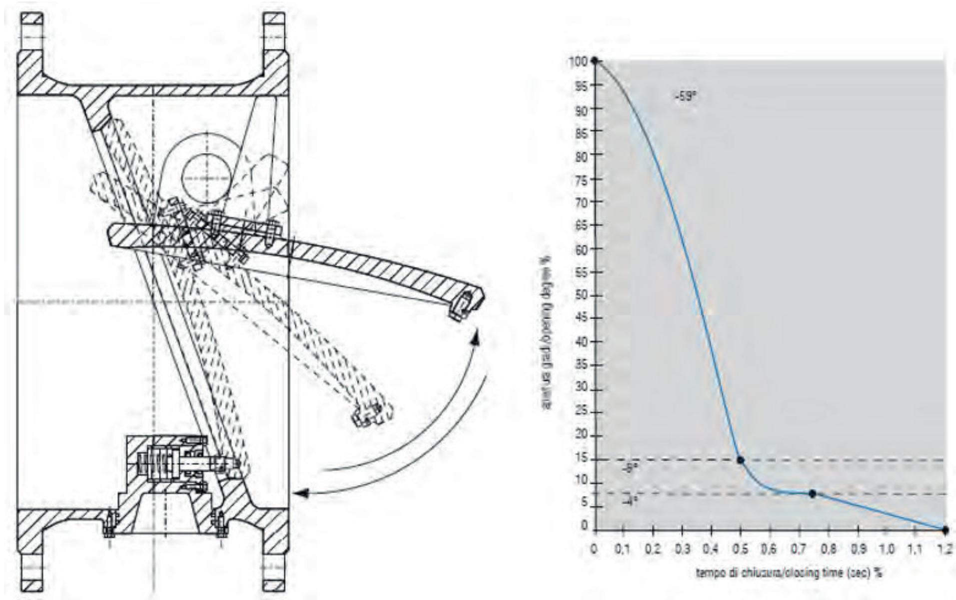


Fig. 9 – Operation and effect of using hydraulic damping device

Figure 9 depicts the typical operation of the damping device. This shows that the valve disc closes quickly over the first 85% of its angular travel before coming into contact with the hydraulic damper. The damper then dissipates the kinetic energy of the disc and forces it to open slightly.

The disc closes until it contacts the damper again and this cushions the disc until it returns to its fully closed position, sealing the valve. This function greatly reduces the onset of water hammer due to the damped and controlled method of valve closure.

Hydraulic dampers are strongly recommended for use on the slanted check valves, especially when they are installed on a pumping station where high frequency opening and closing of the valve is required. Under these conditions, the damper will greatly protect the valve from accelerated wear and tear of the internal moving parts.
The slanted seat design also allows these valves to seal at lower back pressures.

(F) Dual disc check valves

Also known as the butterfly check valve, the dual disc check valve is a maintenance free, self-acting pivoting check valve of the double disc wafer type.
This valve is particularly useful for installation in pipelines due to its compact design and very short face to face dimensions. The short cylindrical body is usually of the wafer type and has a centric shaft design which is inserted into the body.

Torsional springs are fitted onto the shaft which hold the discs in a closed position in zero flow conditions. When flow passes through the valve, the hydraulic force exceeds the spring force and causes the discs to open parallel to the axis of flow. The resilient seal is fixed onto the internals of the valve body so that when the metallic discs are fully closed, they provide leakage-free sealing performance.

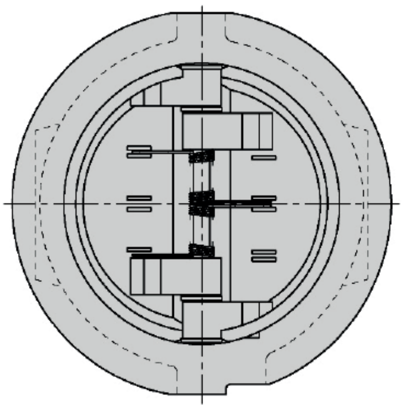


Fig. 10a – Fully closed dual disc check valve

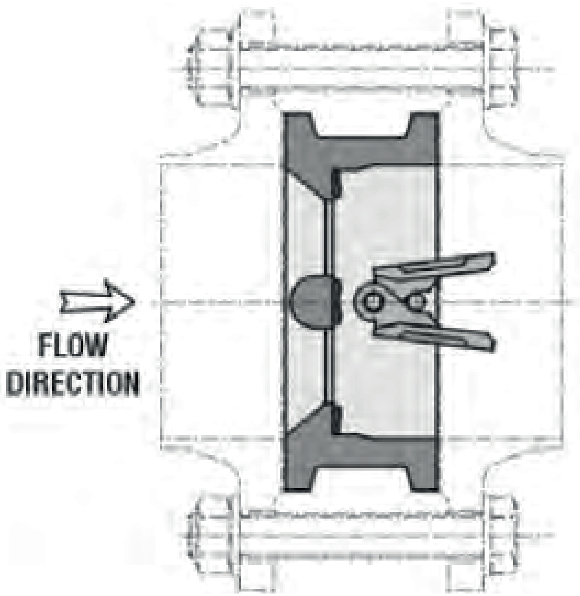


Fig. 10b – Full open valve shown clamped between pipes

Figures 10a and 10b show a wafer type valve in the closed and open positions for a horizontal installation with the shaft orientated vertically. These valves can also be installed in vertical pipelines with the liquid flowing upwards.

The wafer type design generally has a minimal reduced bore and the discs are streamlined resulting in a higher Kv value compared to many other check valve designs. This valve type is mainly used in water applications.

Their compact design is space saving, resulting in potential civil cost reductions of pump houses. Maintenance costs are very low as there are no stem protrusions from the valve body.

Consideration is required when installing these valves. The short face to face of the body results in the discs protruding out with the body space envelope (see Fig. 10b). Connection directly to other pieces of equipment or to pipes with internal diameters less than the diameter of the valve can cause fouling and must be avoided.

(G) Nozzle check valves

The nozzle check valve (shown in Figure 11) has a double flanged valve body with a venturi type internal profile. The valve disc is connected to a stem which is guided on the central horizontal axis. A spring is positioned between the disc and the diffuser sleeve. When flow enters the valve, the hydraulic force exerted onto the front face reacts against the spring, causing the spring to compress and allow the valve to open. When the flow stops, the spring forces the disc to return to the closed position. The disc surface is resilient, providing a drop-tight seal against the body seat.

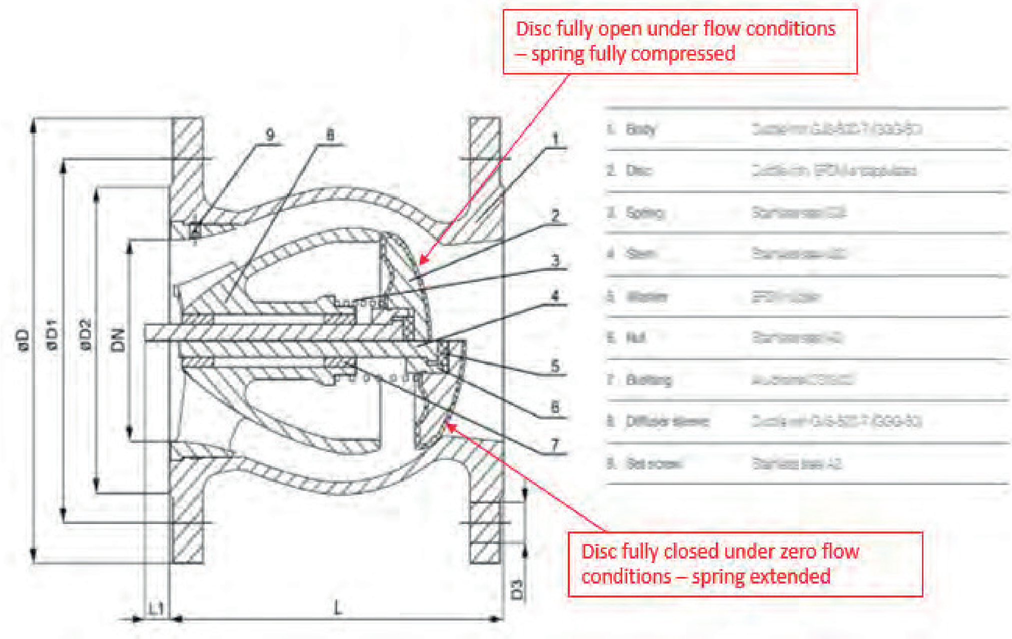


Fig. 11 – Typical nozzle check valve (single stem design)

Nozzle check valves up to around DN300 sizes are generally designed based on a single stem / disc design. Similarly to the aforementioned recoil check valves, larger nozzle check valves tend to have a multi-stem / disc arrangement as shown in Figure 12. This ensures that the disc travel is minimised thus reducing the closure time

Due to the spring-assisted closure and the short linear valve stroke, the nozzle check valve is one of the quickest acting check valves available and is commonly used in pumped systems where water hammer is a potential concern. Because the disc is constantly in the direct line of flow, the head loss characteristics of this valve are higher compared to that of conventional swing check valves. However, in systems with potential water hammer, the superior performance and increased protection to the system that the nozzle check valve offers far outweighs any slight increase in head loss across the valve.

Because of the obstruction in the flow path, nozzle check valves are used in water and finely treated effluent pumped systems.

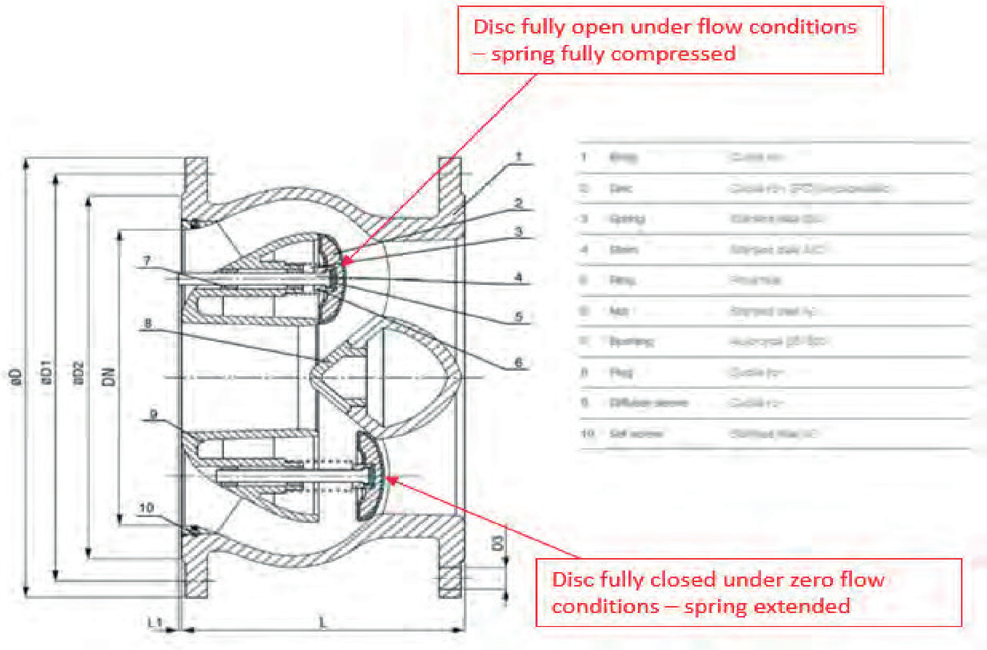


Fig. 12 – Multi-stem nozzle check valve

(H) Ball Check Valves

Because of their clear bore design, ball check valves (Figure 13) are commonly used in waste water applications. This check valve type consists of the following components (see Figure. 14) – the body (item 4), cover (item 1) and ball (item 5). The body is generally flanged but can also be threaded. The internals of the body provide a full and smooth bore ensuring full flow with low head loss across the valve. This design also ensures that no solid deposits can build up at the base of the valve. The ball rotates during operation eliminating the risk of impurities getting stuck on the ball. The ball material is generally manufactured as an NBR lined ball but optional materials such as polyurethane are also available.

Fig. 13 – Ball check valve

Fig. 13 – Ball check valve

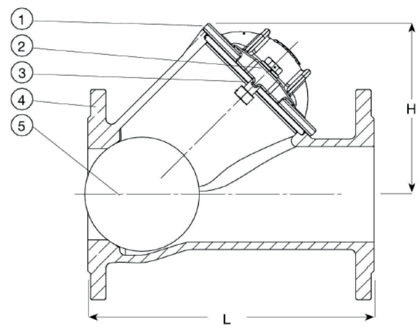
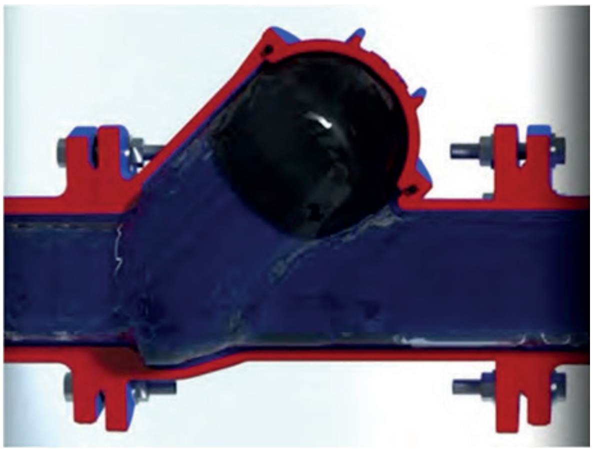


Fig. 14 – Main components of ball check valve

During flow conditions, the fluid makes contact with the ball and is guided up via contours into the top chamber of the body just below the cover (Figure 15a). When the forward flow ceases, the ball returns back to the closed position due to gravity and seals onto its seat preventing reverse flow (Figure 15b).



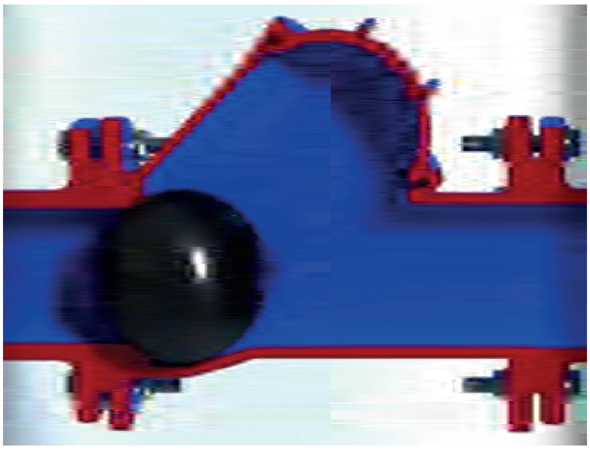


Fig. 15a – Valve fully open

Fig. 15b – Valve closed

Further to the aforementioned low head loss and unobstructed flow path, these valves are also relatively economical and can be installed in both the horizontal or vertical orientations as standard. Due to the simple nature of the operation and the small number of moving parts, ball check valves require very little maintenance. When maintenance is required, the ball check valve can be accessed from the top and can be maintained with the body installed onto the pipe.

High end manufacturers provide balls with different weights. These differing weights can be used to modify the closing characteristics of the valve. Generally, if frequent noise is heard from a ball check valve, it is due to the standard ball weight being too heavy for the flow conditions resulting in unstable operation. By reducing the weight of the ball, this will help the ball to lift more easily and stabilize under the same flow conditions. If the standard ball is too light, it will take longer to close and by using a heavier ball, this will close more quickly, thus reducing the risk of water hammer. These valves are commonly available in sizes ranging from DN32 – 600.

These valves are not used for installations where there is a high risk of water hammer as they are not particularly fast closing compared to other check valve types. This is mainly due to the ball not being in direct contact with the reverse flow.

SELECTION AND SIZING OF CHECK VALVES

As can be seen, there are a number of different types of check valves available for water and waste water systems. Where a check valve is required, it is crucial that the correct type and size is selected so that the system will:

- operate smoothly with optimised efficiency
- have reduced levels of maintenance, repair and shutdown
- have an increased lifetime

The following points should always be considered when selecting check valves:

1. Flow media

- For waste water, it is important that the valve has a full, clear bore design to allow solids to pass.

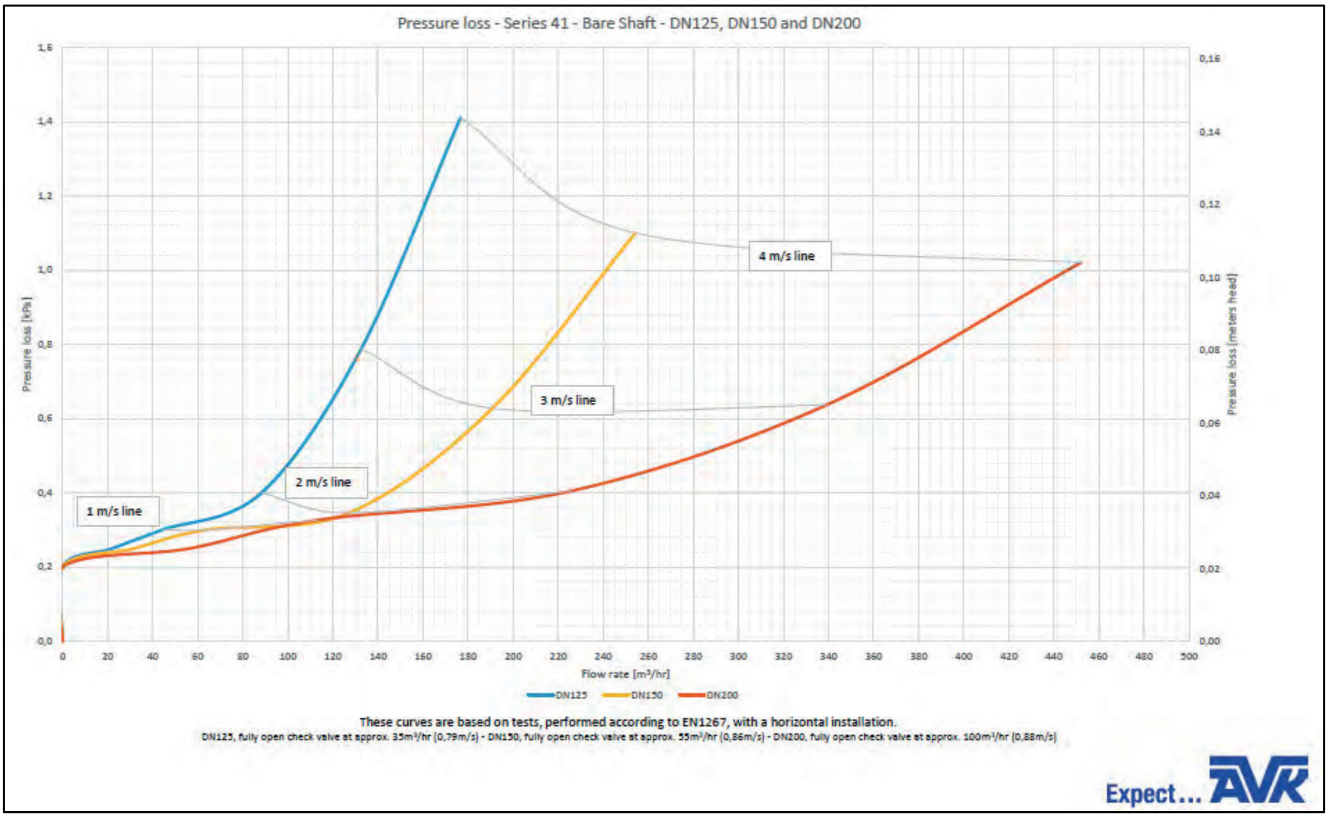
2. Flow rates (minimum and maximum)

This allows the correct valve size to be calculated. Different check valve types reach the fully open position at different flow velocities.

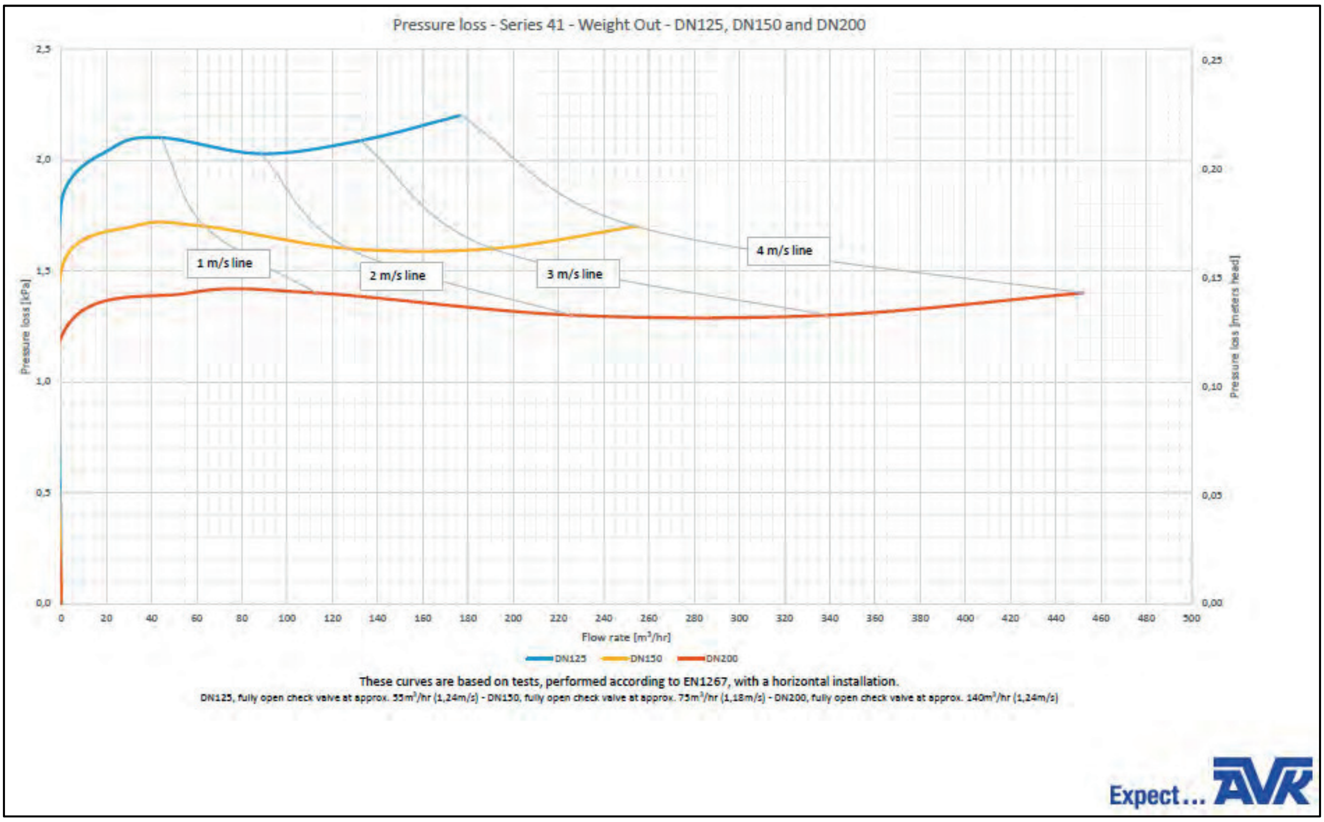
- To optimise system efficiency, it is important that the valve will be in the fully open position under normal flow conditions as this will minimise the head loss across the valve. It also ensures that wear and tear on the internal moving parts are minimised and that it will operate under stable conditions.
- Graphs 1 & 2 show the head loss characteristics of swing check valves with and without lever and weight. As an example, for a DN200 swing check valve with bare shaft, the flow velocity to reach the fully open position is 0.88m/s. This increases to 1.24m/s for the same size valve with additional lever and weight.
- The maximum flow velocity is generally governed by relevant international standards (such as BS EN1074-1) and 4m/s considered the maximum.

3. Working pressures at inlet and outlet (minimum and maximum)

- This will determine the pressure rating of the valve (e.g. PN10, 16, 25 etc)
- It is important to know the cracking pressure of the valve as this is the inlet pressure that flow begins to pass through the valve.
- The reseal pressure (downstream side of disc) is that which provides sufficient force to the disc to affect a seal and is especially important in low pressure systems.
- From Graphs 1 & 2, the minimum pressure to open the valve is increased for the lever and weight version as the hydraulic force required to push the valve disc from its seat is increased. Again, using the DN200 size as an example, the pressure required to crack the bare shaft valve open is 0.02m and this increases to 0.12m for the lever and weight version.



Graph 1 – Swing check valve head loss – bare shaft version



Graph 2 – Swing check valve head loss – lever & weight version

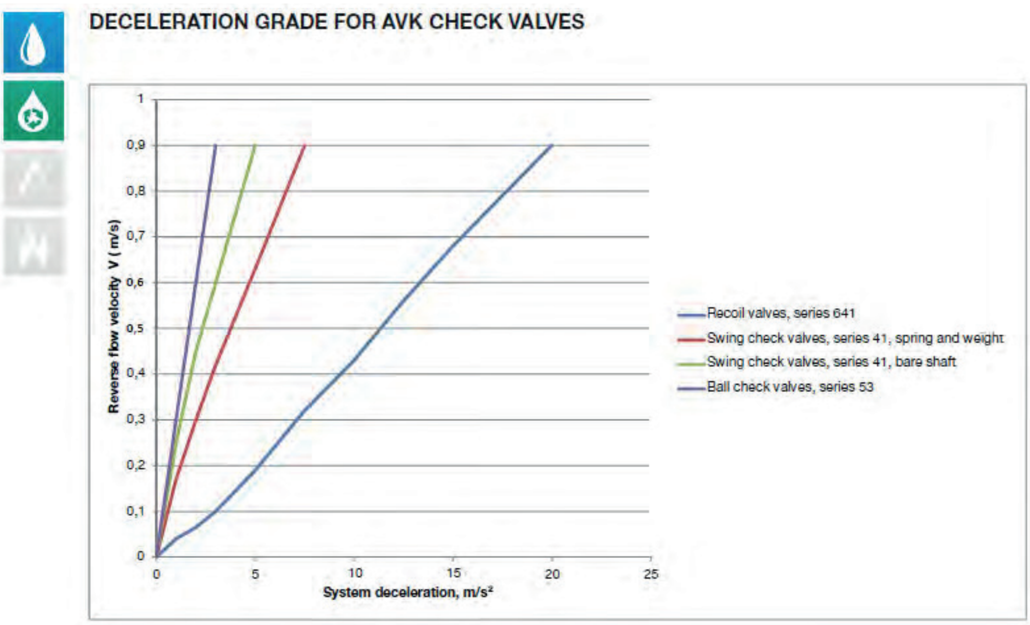
4. Horizontal or vertical installation

- It is more common that check valves are installed in horizontal pipelines.
- Where vertical installation is required, care should be taken to ensure that the check valve type is suitable for this orientation as some are not. Also, the configuration of any external equipment such as levers and weights must be considered as this is usually different compared to the horizontal configuration and will affect operation.
- Check valves with spring assisted closure can close more quickly when installed in vertical pipelines as gravity aids the closure of the disc.

5. Slow, normal or fast acting type required (this is usually based on hydraulic analysis of the system)

- The closing speeds of check valves vary with type and design. Generally, reverse velocities up to 0.3m/s will generate mild slam conditions and this, in many cases, is acceptable and normal check valves can be used. However, where reverse velocities exceed 0.3m/s, the resulting water hammer can be considerable and suitable check valves should be used to minimise the risk of damage under these conditions.
- Fast closure is usually required on multi-pump systems as reverse velocities are generally higher on these installations.
- When fast acting closure is required, suitable valves such as nozzle, tilted, recoil or resilient hinge types should be used.
- The dynamic characteristics of the valve are required to confidently determine if the valve type is suitable for a particular system.
- When slow closure is required, hydraulic dampers should be installed onto the check valve.

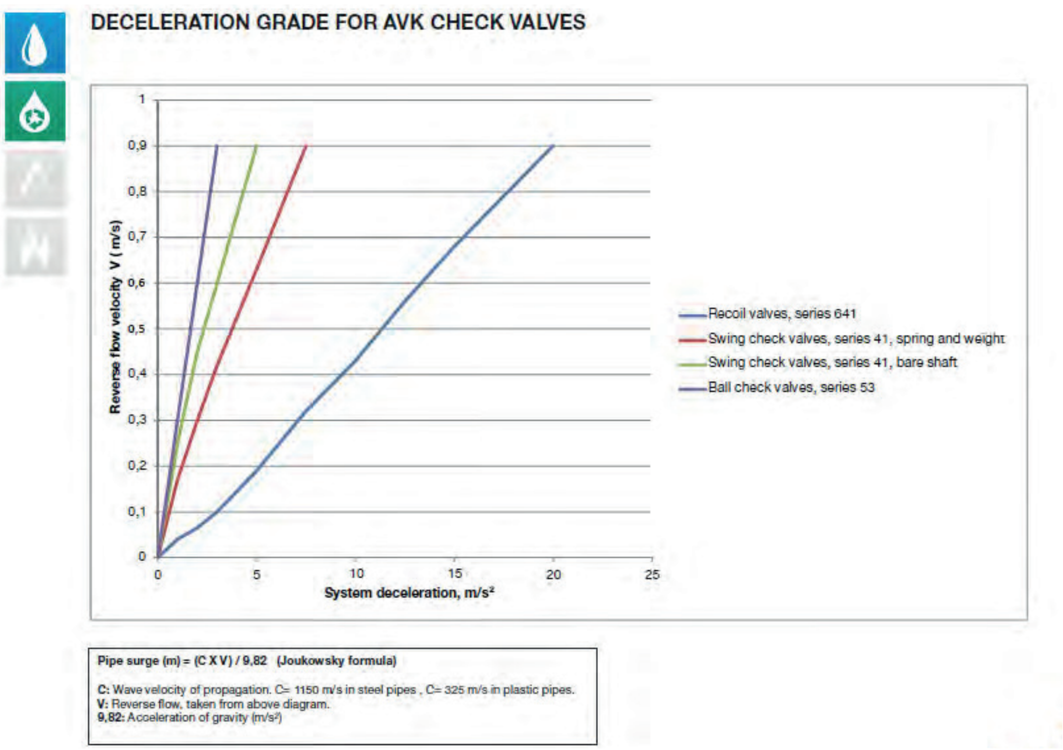
Graph 3 shows a general comparison of reverse velocities between various check valve types. The lower the reverse velocity at a system deceleration, the better the valve is for protecting against water hammer. It is important to note that the exact dynamic characteristics of the valves depends very much on valve size. Graph 3 is for general comparisons only. A worked example using more accurate techniques is provided on the following page



Pipe surge (m) = (C X V) / 9,82 (Joukowsky formula)

C: Wave velocity of propagation. C= 1150 m/s in steel pipes , C= 325 m/s in plastic pipes.
V: Reverse flow, taken from above diagram.
9,82: Acceleration of gravity (m/s²)

Graph 3 – Reverse velocity vs system deceleration curves for various check valve type



Graph 3 – Reverse velocity vs system deceleration curves for various check valve type

Worked Example

In order to help highlight the importance of selecting the correct check valve for systems with higher reverse velocities, the following worked example is provided.

A hydraulic analysis of a multi-pumped clean water system with steel pipe material, a working pressure

32 of 10 bar and a flow rate of 1.1m /s has determined that the maximum system deceleration is 10m/s .

This is considered a severe scenario and one where fast acting check valves would certainly be required to protect the system from surge pressures.

If a fast acting recoil valve was to be considered, firstly, the correct size of valve should be determined. To achieve the flow velocity of 2m/s which is the velocity used to ensure that the valve is fully open, a DN800 valve would be selected.

The pressure head rise (or surge pressure) can then be calculated using the Joukowsky equation

$$h = \frac{a.v}{g}$$

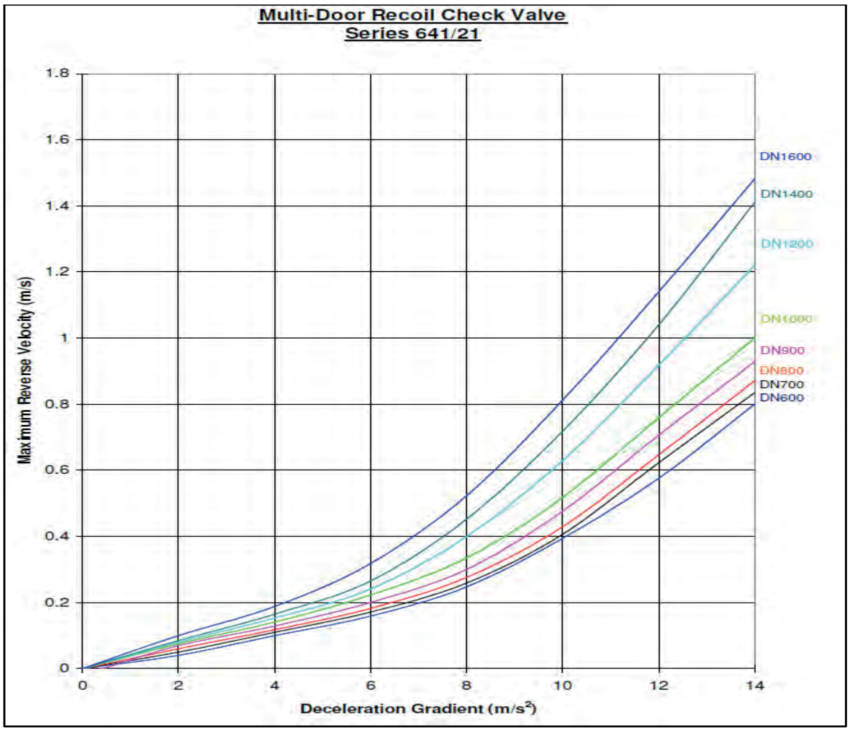
where;

h is pressure head rise (m)

a is wave velocity of pipe (m/s) – (975m/s for steel – material dependent)

v is reverse velocity (m/s) – a function of the valve

g is gravitational acceleration (9.81 m/s2)



Graph 3 – Dynamic characteristics of multi-door recoil valves

Referring to the dynamic characteristics of the recoil check valve (as shown in Graph 3), the maximum reverse velocity for a DN800 valve at 10m/s2 deceleration is 0.42m/s.
Therefore,

$$h = \frac{975\ x\ 0.42}{9.81}$$

= 41.7m

So, for a deceleration of 10m/s2, which is a severe condition, using a DN800 recoil check valve will result in a maximum pressure head rise of 40m (4 bar) which is well within the pressure ratings of the valve and overall system. It is important to note that this surge pressure requires to be added to the maximum working pressure of the system – in this case, this would give a maximum system pressure of 14 bar.

Comparing this to a conventional swing check valve, under exactly the same conditions, a DN800 SCV would result in a pressure head rise in excess of 300m (30 bar) which would very likely cause the valve and system to catastrophically fail.

This shows the importance of selecting the correct valve type for a particular system and the phenomenal reduction in the resulting surge pressure is due to the difference in reverse velocity characteristics of the two valve types.

CHECK VALVE COSTS (AND COSTS OF GETTING IT WRONG)

The selection of any product is almost always affected by the cost. The same is true for check valves. We have seen that there are a number of different check valve types available, each with a different selling price.

As stated previously, compromises are often made when selecting check valves as no one valve type can meet every condition required for a particular system. The closing speed of operation of one valve may be superior to that of another but the head loss may be higher for that valve making it undesirable.

When considering costs, the customer should review the following points:

1. Are energy consumption costs high due to an increased head loss across the valve?
2. Will the valve protect the system and its equipment? – consideration should be given to system downtime, cost of replacement components or full valves, labour, loss of revenue etc.
3. Is the price competitive and are the prices being compared from different suppliers based on similar valve types with similar performance and quality? Failures such as the ones shown in the pictures below were caused by poor manufacturing methods and product design. In order to reduce the material costs, the door designs were weakened, resulting in product failure and considerable associated costs in replacing this DN1200 multi-door check valve.

The picture below, showing another valve failure where no bearing bushes were in place causing misalignment, accelerated wear and electrolytic corrosion resulting in product failure

INSTALLATION AND MAINTENANCE OF CHECK VALVES

The check valve is installed on the discharge or downstream side of the pump to protect the pump from excessive back pressure and the prevention of flow reversal in case of pump failure. It is good engineering practice to ensure suitable isolation of the check valve is provided for maintenance purposes.
It is preferable to use gate valves as isolators as this provides a smoother system flow due to the full bore design of the gate valve and makes this valve type a more efficient isolator as it has a lower head loss, thus providing reduced energy consumption costs. Butterfly valve isolators create some turbulence as the flow passes over the butterfly valve disc and if these valves are used, a sufficient distance should be made between the butterfly and check valves to ensure smooth flow conditions. Butterfly valves are not recommended for water systems with medium to high levels of solid particles.

As a general principle, the check valve should be installed at least 5 x the valve DN from the pump or any pipe fittings which will cause discontinuous flow velocities such as bends. These velocities can cause turbulence which may affect the operational performance of the check valve, the stability of the system, increase the head loss across the valve and accelerate the wear and tear of the moving parts.

For rotary check valves such as the swing check and recoil valves, it is crucial to ensure that the hinge and shaft of the valve is installed perfectly horizontal as any slight angular offset will result in erratic performance of the valve and accelerated wear and tear.

The maintenance for check valves, like any other piece of hydro-mechanical equipment, is important and should be carried out in line with the manufacturer's instructions. Some check valve types require less maintenance than others as explained earlier. However, for any valve type, checking that the valve disc can move completely free will help provide a long and trouble free operation of the check valve. This usually involves periodic checking of the hinge pin, bushes and disc to ensure no sedimentation build-up or excessive wear has taken place.

CONCLUSIONS

Table 1 aims to summarise the above points for all check valves described in this document. This table should be used for general purposes and information only.

		Check valve type							
Function	Description	Swing	Ball check	Recoil	Dual disc	Tilting disc	Slanted seat	Nozzle	Resilient hinge
Flow Media	Water	✓	✓	✓	✓	✓	✓	✓	✓
	Waste water (sewage)	✓	✓	×	×	×	×	×	✓
Speed of closure*	Slow	×	✓	×	×	×	✓	×	×
	Normal	✓	✓	✓	✓	✓	✓	✓	✓
	Fast	×	×	✓	×	✓	✓	✓	✓
Head loss		Low	Low	High	High	Low	Medium	High	Low
Maintenance		Medium	Low	Low	Low	Low	Low	Low	Low
Installation	Horizontal	✓	✓	✓	✓	✓	✓	✓	✓
	Vertical	✓	✓	×	✓	×	×	✓	✓
Relative Valve Price	General (depends on size and spec)	1.0	1.1	2.9	0.9	1.7	1.5	1.6	1.7

* Ancillary equipment may be required to adjust closure speed

Table 1 – Summary of check valve types and their suitability for various functions

AVK offer a vast range of valves for water and waste water applications. All valve types described in this document are available from AVK and we would be happy to discuss your requirements for check valves and associated valves and fittings for your pumped systems.

AVK Saudi Valves Manufacturing Co. Ltd
45st Industrial City, Jeddah, Saudi Arabia
Tel: +966-12 637 1570
Fax:+966-12 635 4750
Email: Sales@avksvmc.com
www.avksvmc.com

Expect... AVK