CSA surge prevention tank with diaphragm S.P.T.

The CSA surge prevention tank contains the devastating effects of water hammer, more precisely the transients coming from the sudden pump failure both for water and sewer systems. The device, fully automatic, is the ideal solution to avoid damages sometimes fatal for our systems as a consequence of uncontrolled overpressures and negative pressure waves.

Technical features and benefits

- Designed for treated water and wastewater.
- Available from 250 up to 25000 litres PN up to 25 bar.
- Produced in different materials, welding in compliance with EN and ASME standards.
- Supported by CSA transient analysis and calculation software.

Applications

- To protect pumping station from negative and positive pressure conditions caused by pump failure and used in:
- Wastewater pressurized main lines.
- Irrigation.
- Water mains and distributions systems.

Water hammer

The term water hammer is commonly used as a synonymous of unsteady flow, suggesting noise and fast changing pressure variations sometimes related to devastating effects on the system.
Pipelines, both for water and sewage, are vital for our modern civilization and their safety and protection should be one of the top priorities. During the studying and assessment of the pipeline network their behaviour under transient conditions will reveal the potential for damages. This involves numerical simulations carried out to reproduce events, planned or accidental, with consequences on the system.

The main causes of transients are :
-sudden changes in demand
-pump start up
-pump failure
-rapid closing and opening of isolation devices
-rapid filling of pipe line and fire fighting installations
-opening and closing fire hydrants
-pipe flushing and draining operations
-feed tanks draining

Water hammer can also be described as a propagation of energy, as in the transmission of sound, and from basic physics as a wave motion the energy is associated with the elastic deformation of the medium.

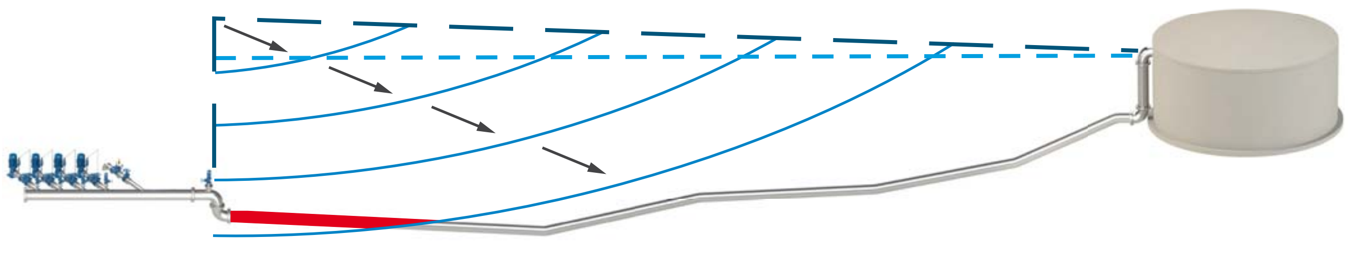
The celerity of sound waves a in rigid pipes is given by

$$a=\sqrt{\frac{\frac{K}{\rho}}{1+K\cdot\frac{D}{E\cdot e}}}$$

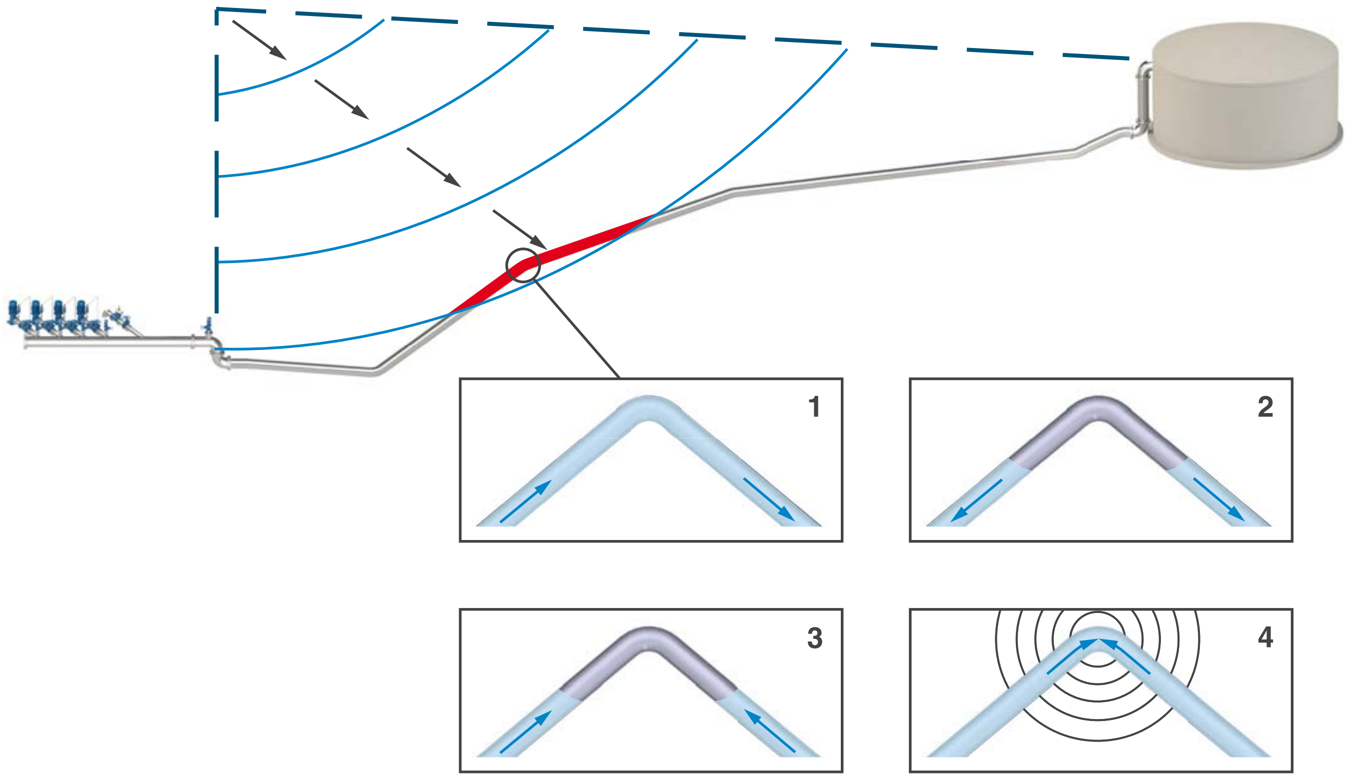
Where E is the modulus of elasticity;
D is the pipe diameter;
e is the wall thickness;
K is the bulk modulus;
ρ is the density of the fluid medium.

Pump failure

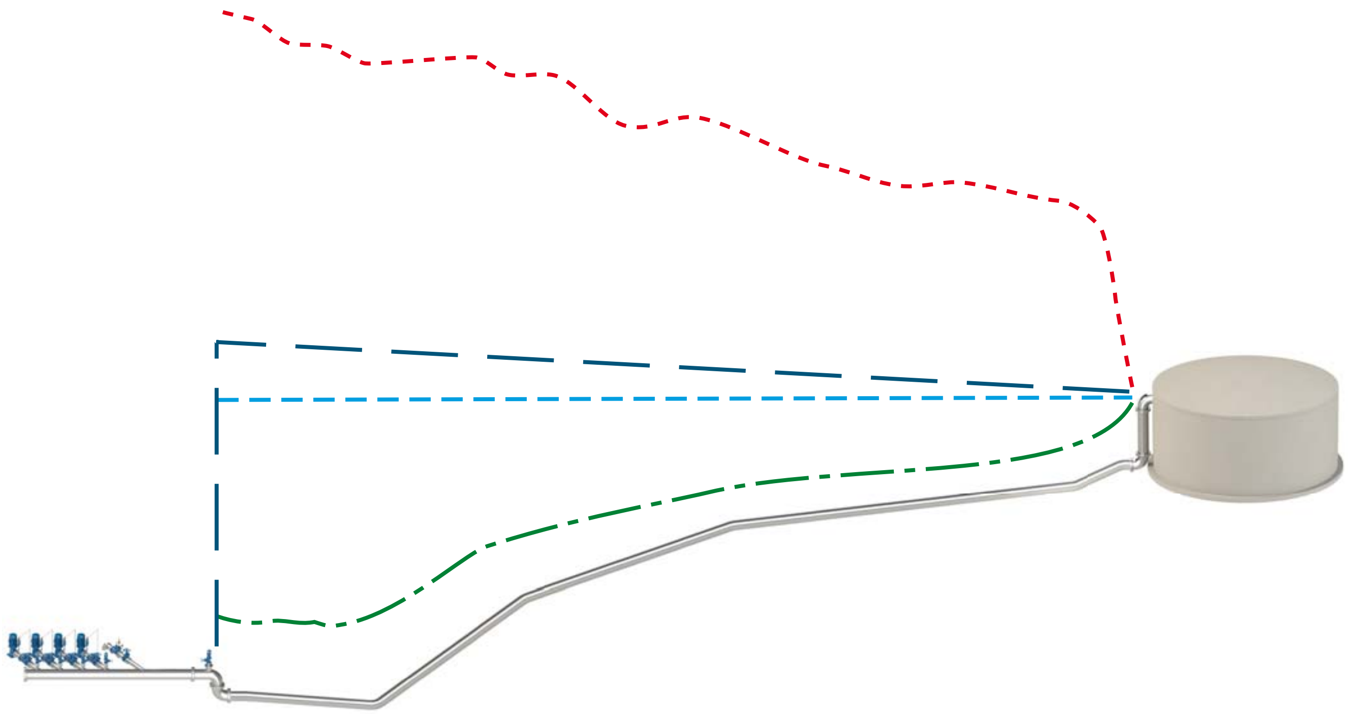
One of the most critical occurrence in water and wastewater system is the pump failure also called pump trip. This definition means actually a full blackout, interrupting the pump's head and causing a deceleration with consequent negative pressure variation propagating with a speed whose value depends on the fluid and pipe properties. Negative pressure is always a problem for possible pipe deformation, collapse, gaskets movements and entrance of contaminated water and pollution through points of leakage. If the hydraulic grade line, during the pump failure, drops to a negative value corresponding to the vapour pressure there is the risk of column separation, generated by the formation and collapse of vapour pockets producing serious and unexpected high frequency rises in pressure, sometimes fatal for the system.



The plot above shows a pipeline profile, with pumps and downstream tank as boundary conditions, where the dark blue dotted line represents the HGL and the light blue dotted line is the static. The picture represents the negative pressure wave propagating downstream as an effect of pump failure, where the red segment depicts the area exposed to negative during the initial phase of the event.



The plot above shows the negative pressure wave propagating downstream, as an effect of pump failure. The red segment depicts the area exposed to severe negative pressure. The change in slope represents a location at risk of column separation, caused by vapour pockets forming and then collapsing creating unwanted water hammer as explained on the 4 pictures.



The results of pump failure can be summarized in a plot showing the envelope of the maximum and minimum pressure values reached during the simulation, in the picture above shown respectively in green and red. It is evident how the system reaches a full vacuum on the entire profile and an extreme rise in pressure due to the column separation, occurred at the change in slope.

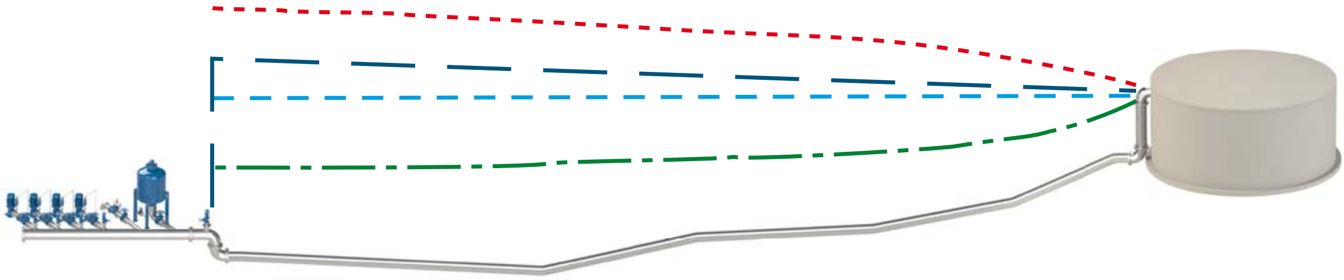
Water hammer prevention

In order to prevent transients and unwanted damages on the pipeline systems we basically have to reduce the variations in velocity of the fluid and, when this happens, try to proceed as slow as possible.

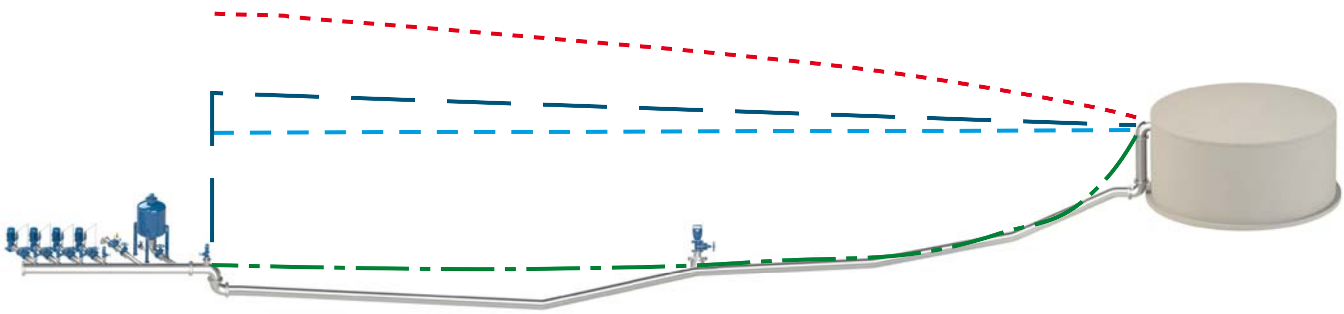
It will therefore be mandatory to:
- operate slowly during valve operations, especially on the final position of the device.
- control the pipe filling through the use of anti-surge combination air valves, example the CSA RFP models.
- introduce air or water into the pipeline, at those locations where negative pressure conditions are likely to occur.
- adopt controlled pump start up procedures to avoid rapid changes in flow.
- carry out detailed computer analysis to evaluate and assess the risk associated to the system and transient events.

One of the best and most reliable solutions to the problem, and working as a standalone or in combination with other devices like anti-shock air valves and pressure relief valves, is the CSA surge prevention tank also called SPT.

This type of anti surge device can be installed in derivation from the main line or directly on top of it, and simply provided with an isolation device to allow for maintenance. No additional check valves, by pass or restrictions are needed.

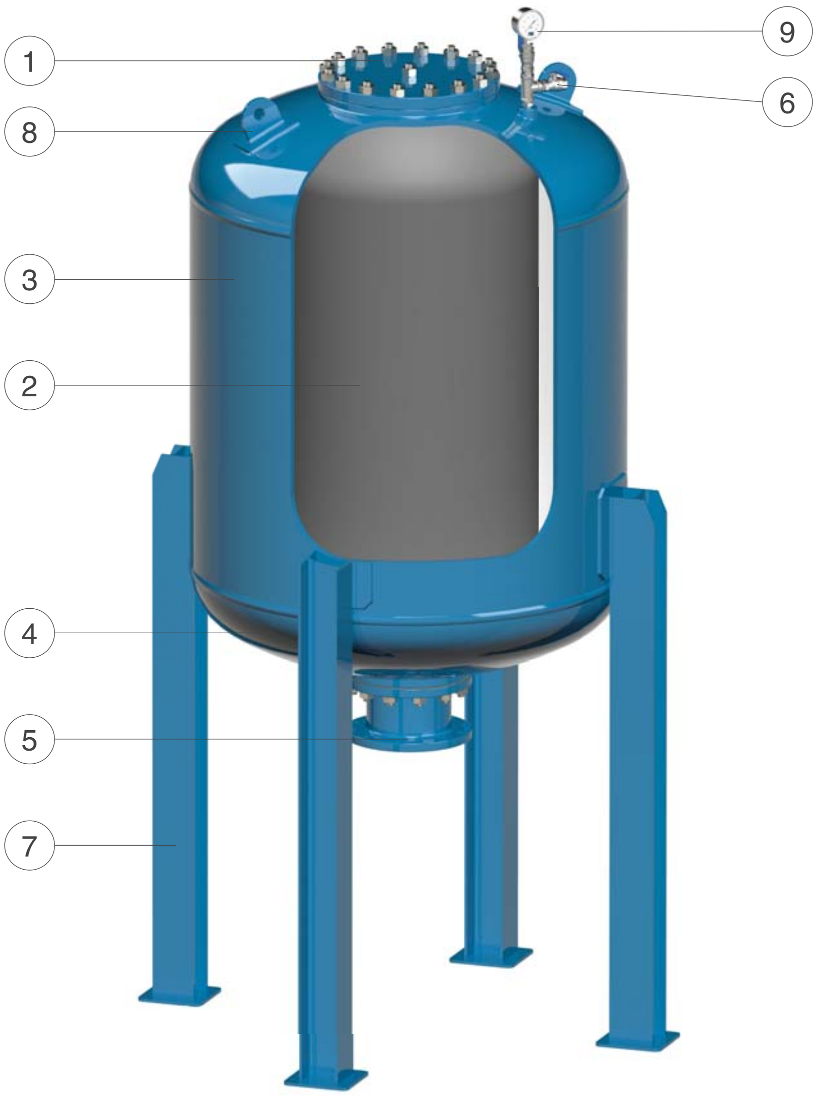


The plot above shows the pressure envelope of the transient event caused by pump failure on a pipeline with SPT. installed as a protection. The red and green are the maximum and minimum pressure values reached during the simulation, it is clearly visible the beneficial effect in terms of negative pressure and consequently reduction of water hammer.



The plot above shows the pressure envelope of the transient event caused by pump failure on a pipeline with SPT installed as a protection, in combination with anti-shock air valves (CSA AS series). In this case the effect of the air valve will help reducing the volume of SPT, containing budget and design requirements. The red and green are respectively the maximum and minimum pressure values reached during the simulation. Depending on the fluid SPT can be placed at the pumping station or along the profile and calculated to perform with air valves and pressure relief valves, CSA VRCA series, if required.

Technical details



N.	Component	Standard material	Optional
1	Upper flange	painted steel	different material on request
2	Diaphragm	NBR	
3	Shell	painted steel	different material on request
4	Base plate	painted steel	different material on request
5	Flanged outlet	painted steel	different material on request
6	Ball valve for air inlet and outlet	stainless steel	
7	Legs	painted steel	different material on request
8	Lifting plates	painted steel	different material on request
9	Pressure gauge		

The list of materials and components is subject to changes without notice.

Working conditions

Treated water / Waste water 70° C max.;
Maximum pressure 25 bar.

Design standards

NDT according to applicable standards to be specified in the order.
Welding and painting according to project requirements.
Outlet flanges according to EN 1092/2 or ANSI;
variations on flanges details available on request.
Wind, seismic events available on request.

Installation layout for water applications

CSA surge prevention tanks SPT represent one of the most effective and versatile means of providing protection at pumping stations. This is because they allow the introduction of flow during pump failure thus limiting the rate of acceleration/deceleration that occurs in the pipe in case of pump trip.
The illustration below shows the use of CSA SPT, in a common water pumping station, installed without the need if any check valves, by-pass and restrictions. In addition to that, the picture shows more CSA equipment for the regulation and control of the system such as anti-shock air valves and anticipating control valves, sized and determined as a result of detailed water hammer analysis part of CSA consulting services.

CSA anti-shock combination air valves are extremely important at the pumping station located before and after the check valve. The first due to their protection against negative pressure on the riser when the pump is turned off, and consequent control of the air outflow at the pump start up preventing overload and rapid changes in flow and unwanted surged. The air valves downstream of check valves, for each pump and/or on the main line, are needed to avoid vacuum and the propagation of negative pressure waves along the system as a consequence of pump failure, controlling and slowing down the returning water approach velocity. CSA relief valves or surge anticipating are sometimes needed to discharge excess in pressure and to reduce the volume of SPT.

Installation layout for wastewater applications

CSA air vented anti-surge tanks SPT represent one of the most effective and versatile means of providing protection at pumping stations. This is because they allow the introduction of flow during pump failure thus limiting the rate of acceleration/deceleration that occurs in the pipe in case of pump trip.
The illustration below shows the use of CSA SPT, in a common wastewater pumping station, installed without the need if any check valves, by-pass and restrictions. In addition to that, the picture shows more CSA equipment for the regulation and control of the system such as anti-shock air valves, sized and determined as a result of detailed water hammer analysis part of CSA consulting services.

CSA anti-shock wastewater combination air valves are extremely important at the pumping station located before and after the check valves. The first due to their protection against negative pressure on the riser when the pump is turned off, and consequent control of the air outflow at the pump start up preventing overload and rapid changes in flow and unwanted surges. The air valves downstream of check valves, for each pump and/or on the main line, are needed to avoid vacuum and the propagation of negative pressure waves along the system as a consequence of pump failure, controlling and slowing down the returning water approach velocity by means of the anti-shock system to prevent water hammer events.