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Expansion vessels in potable water systems

White paper

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Expansion vessels in potable water systems: flow and materials

Potable water is a vital asset, everyone uses it. Although much of our planet is covered with water, we increasingly hear about impending shortages of clean potable water. One way to counteract some of the wastage of potable water is to use expansion vessels in potable water systems with calorifiers. When potable water is discharged from a calorifier through the pressure relief valve not only is this a waste of water, but energy is also wasted on heating this water.

When a calorifier heats water, the water expands. Water cannot be compressed. If a potable water system does not have an expansion vessel, the pressure will increase during heating and eventually the safety valve present in the installation will open. The excess water, due to expansion, will be discharged through this valve.

Dirt can be left behind on an opened safety valve. The water can also deposit limescale on the valve seat. The consequence of this is that the valve no longer shuts completely. Water will drip constantly from the valve. It is therefore not desirable to allow the safety valve to operate under normal working conditions.

source: werkspot.nl

source: klusidee.nl

In order to counteract this waste, an expansion vessel can be installed in a potable water system. However, if an expansion vessel is installed in a potable water system, this vessel will have to satisfy stringent requirements. Health risks must be avoided at all times.

Requirements for expansion vessels for use in potable water systems

Materials for use in potable water systems are not only subject to technical and mechanical requirements, but must also be absolutely hygienic. In this regard, the following aspects play a part:

1. Protection of human health.
2. Possible transfer of smell and taste to the potable water.
3. Release of (harmful) substances into the potable water.

These aspects cannot be considered in isolation. Apart from the materials used, the design of the vessel, the membrane installed and even the production method of the vessels play an important part.

Materials used

Not all materials can be used if they come or could come into contact with the potable water. Materials to be used must satisfy stringent requirements. They must not release any substances into the potable water. The smell and taste of the potable water must not be affected.

Unfortunately, almost every country has its own specification for permitted materials. Such specifications are minimum requirements. These specifications stipulate which substances are permitted in the materials and in what concentration. The specifications used in Germany and the Netherlands are the most stringent.

The other requirements and tests mentioned in this article are also included in the German and Dutch Standards.

For every material used, it must be demonstrated that it satisfies the minimum requirements of the relevant Standard. Apart from testing materials to meet the minimum requirements, there are further requirements concerning the effect on the smell, taste and colour of the potable water. Such tests must not be carried out by the manufacturer, but only by accredited laboratories.

If a material complies with the minimum requirements and does not affect the smell, taste and/or colour of the potable water, then a **KTW certificate** will be issued for this material.

A second aspect when assessing the materials used involves limiting the growth of micro-organisms. This is also tested in accredited laboratories. If the material in question satisfies these requirements, a **W270 certificate** will be issued.

Flow

Perhaps the greatest hazard in a potable water system is the growth of bacteria. The best-known and most dangerous bacterium is legionella. In order to prevent the growth of bacteria, a number of criteria are important:

- The vessel must be designed to ensure that water can flow through it at all times. The water present in the vessel must be regularly refreshed whenever water is drawn from the system. No water may be allowed to stagnate in the vessel. This flow-through must be ensured not only with a working membrane, but also if the membrane has failed.
- The vessel may only be installed in the cold water supply line. Higher temperatures promote the growth of bacteria. Therefore, the expansion vessel should never be installed downstream of the calorifier or in the heated water line (unless local legislation specifies differently).

Measuring the flow

The method for measuring the flow in a vessel with an intact membrane and in a vessel with a ruptured membrane is described in DIN 4807 part 5. This method is also included in the KIWA guideline BRL-K14201.

For the measurement of an intact vessel, the flow volume is determined first: this is the quantity of water that the vessel can hold between 4 and 6 bar. The vessel is filled with this quantity of water and salt is added to raise its conductivity to 5,000 μS/cm. This vessel is then flushed through 10 times with clean mains water. After each measurement, the water is collected and the conductivity measured. After the tenth cycle, the conductivity of the water must not deviate from the conductivity of the original mains water by more than 50 μS/cm. The water in the vessel is also measured, to which the same requirement applies.

Before performing the flow test with a ruptured membrane, the entire vessel is filled with salt water with a conductivity of 5,000 μS/cm. Depending on the volume of the vessel, a prescribed volume of water must be passed through it. At the end of this test, the conductivity of the water present in the vessel must have reduced by at least 50%.

Other requirements

If steel parts of a vessel come into direct contact with potable water, these parts must be coated. This coating should have a minimum thickness of 200 μm. Of course, the coating used must also comply with the material requirements mentioned above (KTW, W270).

If a membrane ruptures, water will migrate into the air side of the expansion vessel. The potable water will then come into contact with the inside of the air chamber of the expansion vessel. This will therefore also have to be coated. The requirement for this coating is for an overall thickness of at least 70 μm.

Apart from the requirements mentioned above there are also requirements concerning the integration of the vessel into the installation. Care must therefore be taken to ensure the water is held at a constant supply pressure. In many instances, a pressure-reducing valve must be installed for this purpose. The pre-pressure of the expansion vessel will also have to be adjusted to this supply pressure. The pre-pressure should be approximately 0.2 bar below the supply pressure of the water.

All types of rubber are permeable; over time, gas will escape through the rubber. It is therefore recommended to regularly check the pre-pressure (e.g. once per year) and adjust it if necessary. Only when the pre-pressure and the cold water supply pressure are the same can an effective flow through the vessel be ensured.

Vesseldesign

Various expansion vessels for potable water are offered on the market. The main design differences are:

- The flow through the vessels is either full or partial. There are also vessels without through-flow on the market, but these will not have a German (DVGW) or Dutch (KIWA) certificate.
- Welded vessels or vessels with a clamping ring.
- Vessels with a cap-type membrane and vessels with a bag-type bladder.

All of these points have an impact on the vessel's hygienic qualities.

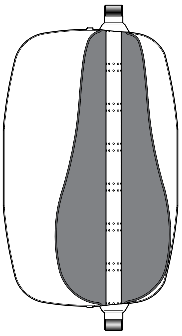
Partial flow or full flow

In the majority of expansion vessels available, only a proportion of the mains water that flows to the calorifier is passed through the vessel. Only in a few types of vessel will all the water be passed through the expansion vessel. It is clear that if all the water is passed through the expansion vessel, the water present in the vessel will be refreshed sooner than in a vessel where only part of the water is passed through the vessel. The following applies to avoiding the growth of bacteria: the greater the flow, the less the bacteria growth.

partial flow

full flow

For vessels through which all the water flows, there is another distinction to make regarding the refreshment of the water in the vessel.

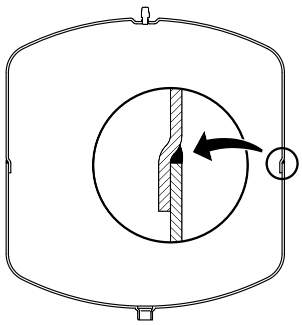


Vessels in which the water flows in at the top and out at the bottom
These vessels provides the opportunity for a large proportion of the water to flow directly through without significant resistance, thereby reducing the effectiveness of water replacement. Only a small proportion of the flow water will replace the water already present in the vessel.

Vessels where the water enters and leaves via a single point
The water present in the membrane is replaced far more effectively. The water in the vessel is also refreshed much quicker with this design.

Welded vessels or vessels with a clamping ring

For welded vessels, the wall thickness can be considerably less than for vessels with a clamping ring. These welded vessels are usually less expensive. However, a welded vessel will always have a seam. In many welded vessels, this means that the air and water halves overlap each other slightly on the inside.
Welded vessels can only be coated after welding. The inside of these vessels will also only be coated after welding. Clearly, it is almost impossible to give the bare steel between the two halves a sufficiently thick layer (minimum requirement is 70 μm). So if the membrane fails, there is a significant chance that the water will come into contact with bare steel.



welded vessel

vessel with clamping ring

If a vessel is made with a separate clamping ring, both halves are coated before the vessel is assembled. This is the only way to ensure that both the air and water sides are fully coated.

Bag-type bladder, bellow-type bladder or cap-type bladder

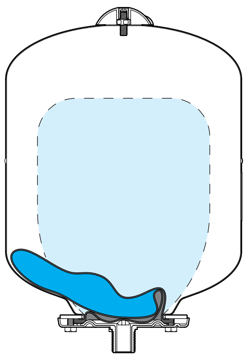
Vessel with bag-type bladder

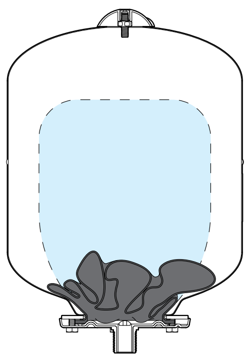
Vessel with bellow-type bladder

Vessel with cap-type bladder

Bag and bellow bladders or cap diaphragms are excellent at accommodating the expansion of the water. Bellow bladders and cap diaphragms do this mainly by moving or flexing; in the case of bag bladders, the material will be stretched more.

A disadvantage of bag bladders, however, is that if the vessel is not installed perfectly upright or as the bladder material ages, these bladders can “fold”. When a bladder folds, water can get trapped inside it. From a hygiene perspective, this is definitely undesirable.





Another disadvantage of a bag bladder is that, should the vessel remain unfilled for a period of time the bladder can end up lying on the bottom as a lump of rubber due to the pre-pressure. This can result in initial damage even before use.
Because a bag bladder stretches more, the wall thickness will reduce (due to the stretching). The permeability of a bladder is proportional to the wall thickness of the material. The thinner the material, the quicker the gas will permeate the rubber.

For a bellow bladder, the surface area is greater than for a cap diaphragm. The growth of bio-film on rubber happens quicker than on plastic or coatings. A larger surface area therefore presents a greater risk of growth. A larger surface area also leads to a greater loss of gas through permeability.

Responsibilities

It is the manufacturer's responsibility to deliver a vessel that complies with all requirements imposed by the government in respect of hygiene for potable water.

However, the installation engineer / user is responsible for the following:

- Choosing the correct vessel. Here in particular, this means that the vessel satisfies all of the points mentioned above.
- Ensuring correct installation of the vessel.
- Ensuring that the pre-pressure is set properly to the cold water supply pressure.
- Ensuring that the pre-pressure remains at the correct value by performing regular inspections.

The best choice from a hygiene perspective is a vessel:

- With a DVGW or KIWA certificate.
- With vessel halves that are fully coated before assembly of the vessel.
- With full flow, whereby the water present in the vessel is replenished as frequently as possible.
- With a diaphragm or bladder that cannot trap any water.
- With the smallest possible diaphragm or bladder that does not stretch when holding expansion water.

If you have any further questions, please contact:

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