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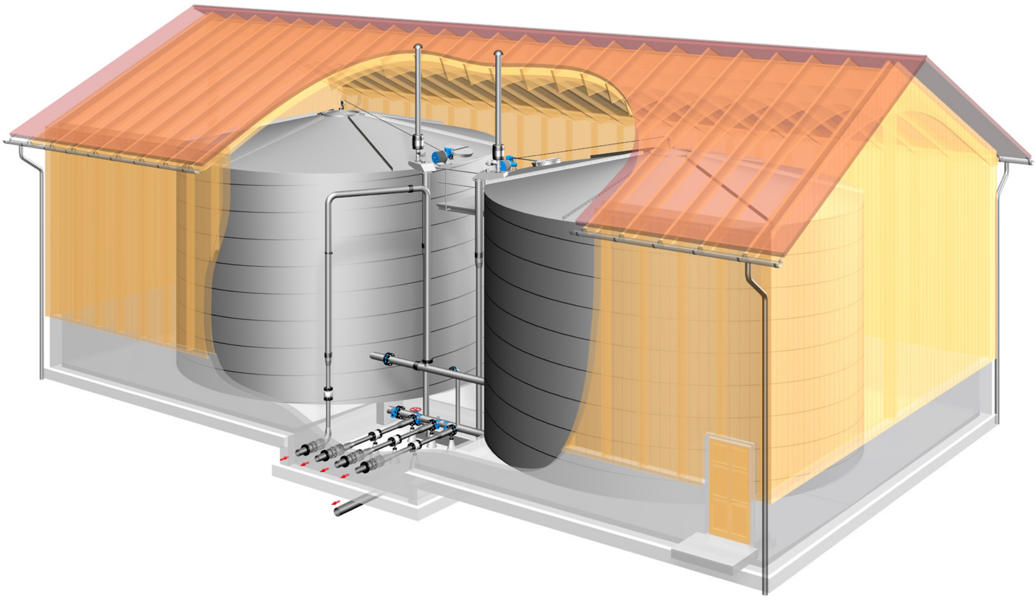
# Stainless steel drinking water tanks for the communal water supply

## HydroSystemTanks® (HST)



EDELSTAHL® Rost frei INOX STAINLESS STEEL

HydroSystemTank® is a trademark of Hydro-Elektrik GmbH

Drinking water storage tanks • High-level tank systems

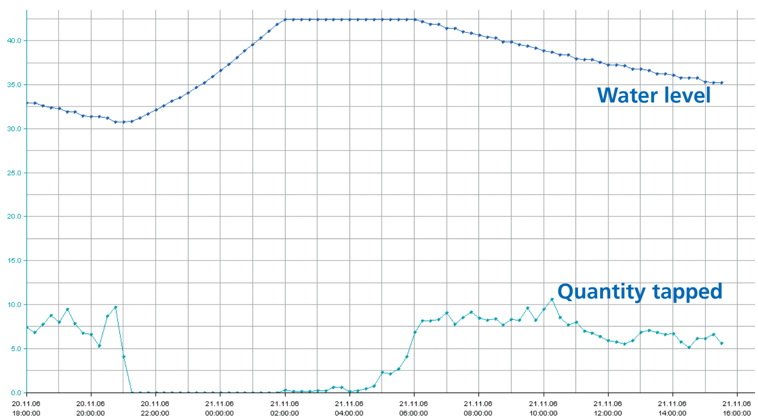
# Water supply system

**A water supply system consists of many individual components and subsystems. Along with wells and pumping stations, water storage tanks are among the most important functional elements in a water supply system.**

**Water storage tanks**

Water storage tanks cover peak demands and downtimes of delivery equipment, thereby ensuring reliable water provision with the most constant pressure possible in the distribution network.

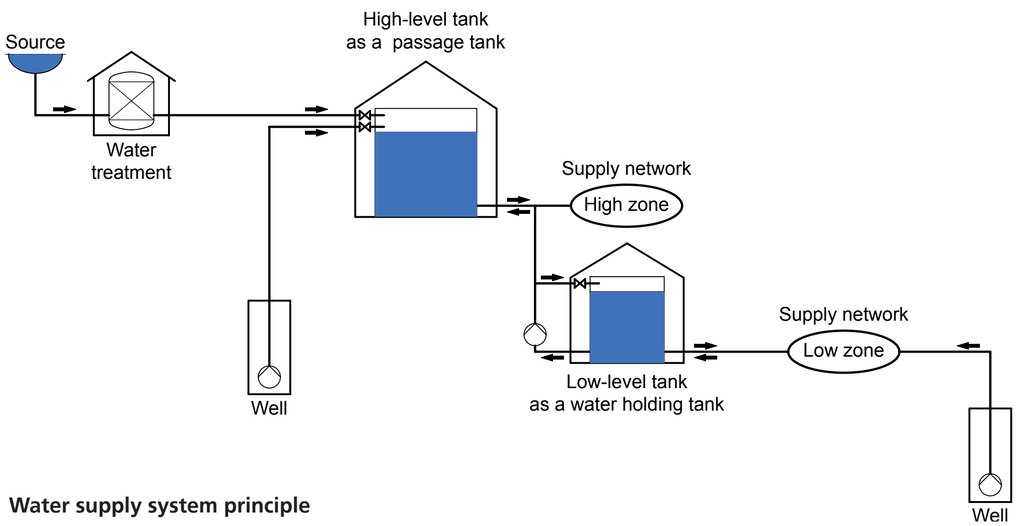
In smaller supply systems in particular, the water storage tanks must in most cases also hold a certain volume of water as a fire-extinguishing supply in addition to the daily requirement. This must not detrimentally affect the water quality. This places high demands on the design and on the quality of the materials that come into contact with the water, as well as on the technical equipment.




**Hydrograph of an high-level tank over 24 h**

**Supply system**

Depending on the topography of the supply area, the water storage tanks are arranged either as low-level water tanks with a pressure booster system (flat land) or high-level tanks. In supply areas with greatly differing terrain levels, different pressure zones (high-pressure, medium-pressure and low-pressure zone) are normally set up, some of which also have independent tank systems.




**Water supply system principle**

**History** The foundations of modern water-supply technology had already been laid as early as the time of the Romans. Walled canals and viaducts, timber and clay pipes lasted over centuries. Today's type of central water supply was introduced in the mid to late 19th century. Steel and above all cast pipes were used, and the first tanks were built in handmade concrete as storage tanks for central water supply systems. As more and more water was consumed, the need arose for larger and larger tanks. Until the recent past, these were built using pre-stressed concrete, and in recent decades there has been a trend towards stainless steel fittings. Corrosion, together with incorrect processing and defective materials, have resulted in and still do result in an enormous demand for cleaning and renovation of conventional water tanks.


**Tank construction in 1926**

For water storage in concrete tanks, factors affecting the water include long-term changes in the quality of materials, interactions between the tank walls and the medium, and also those influences originating in continuous operation, cleaning and maintenance activities. Leaks, long dwell times with inadequate mixing, and also reactions between the atmosphere, the tank walls and the water itself, are not uncommon factors in bacterial infestation and the resulting complaints.


**Heavily damaged tank**

**Today** Stainless steel drinking water tanks using HydroSystemTanks® have interrupted this chain, since the tendency to use stainless steel is applied rigorously and to its fullest extent in the field of water storage. Stainless steel drinking water tanks have now been established for many years, and are far superior in quality to concrete storage tanks.

**Summary** Water storage systems with HydroSystemTanks® (HST) are the ideal solution and are a guarantee of obtaining the highest water quality. They represent the innovative way for the future. Using the current state of the art, volumes of up to 20,000 $m^3$ can be realised economically with this system.

# HydroSystemTanks® – pure innovation

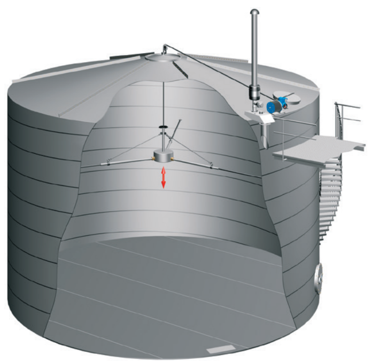
**Advantages**

**Maximum drinking water quality by using high-quality stainless steels and storing in hermetically closed tanks.**

- **Complete system control and absolutely no leaks**
- **Excellent water mixing thanks to a special infeed system**
- **Aeration and venting of the storage tanks via filter systems**
- **Homogeneous surfaces that repel germs**
- **Insulated building ensures a constant water and room temperature**
- **Short construction time and minimal material transport**
- **Minimal incursion into the ground, so ideal in rocky terrain**
- **Low operating and maintenance costs**
- **Very good cost-to-benefits ratio, very economical**
- **Long service life, refurbishment of water chambers no longer necessary**
- **Automatic high-pressure cleaning system for interior cleaning**
- **Economical solution for renovation projects**

**System**

- Tank completely made of stainless steel, tank shell with installations and brackets for external extensions, non-corrugated, smoothly welded bottom with gradient to the tapping connection



- Self-supporting conical roof with domed cover and brackets for attachments
- Integrated connections for overpressure valves / low-pressure valves / safety valves
- Automatic cleaning system for high-pressure interior cleaning (DBP)
- Siphoned overflow system with aeration and venting via replaceable heavy-duty filter systems
- Generous stainless steel operator platforms with curved stairway
- Lower access via manhole with glass inspection ports, pressure doors optional

**Structure**

- Long-lasting, solid and low-cost timber pillar construction, as steel or industrial hall structure, masonry, or with concrete sandwich plates
- Wind-proof, thermally insulated and insect-proof structures
- Roof can be conventional type with pantiles and insulation or with insulated sheet-metal panels
- Concrete insulated in transitional zone
- Concrete construction in trough configuration with recess for pipeline installation

# Planning and construction of stainless steel drinking water tanks

**How the water is actually stored has a considerable influence on the quality of the drinking water. For this reason, of the German Drinking Water Directive requires:**

**Drinking Water Directive**

„The properties of drinking water must be such that its consumption or use poses no risk of harm to human health, particularly harm caused by pathogens. It must be pure and fit for consumption. This Directive also shall be deemed fulfilled when, as a minimum, **the generally recognised technical regulations** are adhered to in the treatment and **distribution of water** and when the drinking water meets the requirements of Articles 5 to 7".

In Europe, DIN EN 1508 and in Germany the DVGW Work Sheet W 300 apply as a technical regulation governing the construction of concrete drinking water tanks. Requirements for stainless steel drinking water tanks are described in W300-6.
**This technical regulation describes additional the current state of the art for the construction of stainless steel drinking water tanks, and indicates the construction-related requirements that must urgently be taken into account when planning, constructing and operating such systems.**

**Basic principles in planning**

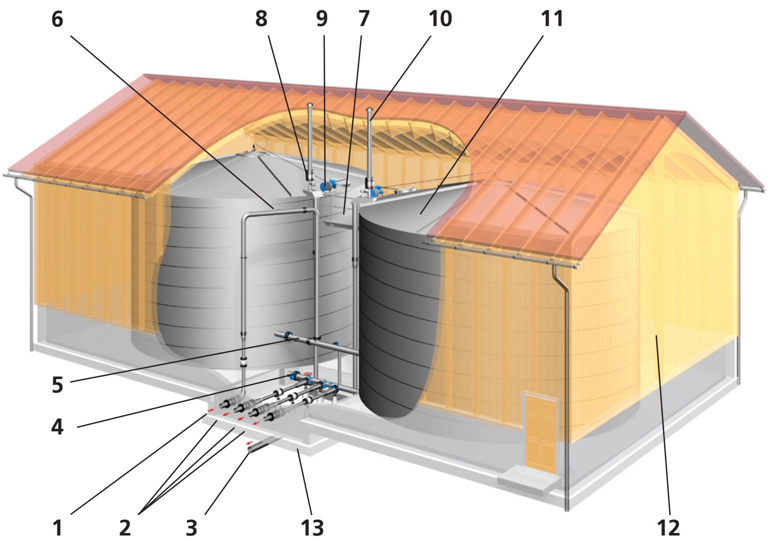
According to DIN EN 1508*:
„Drinking-water tanks should be planned, built and operated in such a way that contamination or other bacteriological, physical or biological influences which have a detrimental impact on water quality are avoided."

* DIN EN 1508 „Water supply requirements for systems and components for the storage of water"

**Stainless steel drinking water tanks**

Stainless steel drinking water tanks are comprised of one or more round stainless steel water tanks (HydroSystemTanks®) that are set up in a simple building with a pipe basement. All main valves, pipelines, pumps, inspection equipment and monitoring equipment can be set up in the building.
This greatly facilitates access to the tanks and operation of the system.

**Schematic layout of a stainless steel drinking water tank**




**1** Inflow from the well / water treatment
**2** Tapping for supply
**3** Emptying
**4** Tapping collector
**5** Inflow collector
**6** Inflow loop
**7** Operator platform
**8** Air filter system
**9** Cleaning system
**10** Venting/aeration line
**11** Stainless steel water tank
**12** Building construction
**13** Pipe basement

# Design requirements

**The wide variety of possible locations for tanks means that it is not possible to describe a standardized building shell which can be used for each and every purpose. Selecting the appropriate structural forms, facade materials and roof materials, variation in height or diameter, number of tanks and the design of the outside systems enables the structures to be optimally adapted to the respective on-site situation and blend in with the landscape.**
**The large roof surfaces of the structures are in many cases suitable for setting up a photovoltaic system. When selecting the location and building alignment, and also when designing the roof, this must already factored in at an early stage along with the need for any future extensions.**

**Building structure**

Basically the structures consist of a concreted lower section and an upper mounted section, which may, for example, take the following form:

- Building of timber pillar construction (universal)
- Industrial hall construction with insulated panels (universal, particularly in large buildings)
- Hall made of prefabricated concrete components (sandwich panels) (most expensive variant)
- Masonry of the type used in general residential building (more usual in smaller buildings)

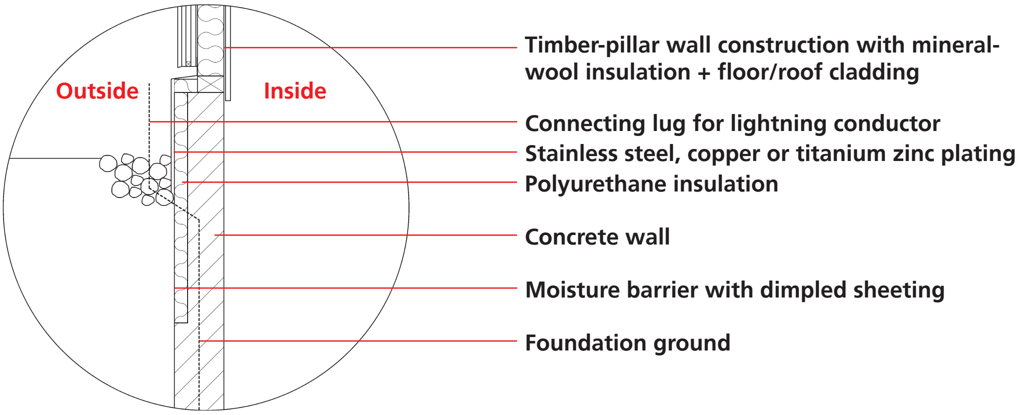
When designing the structures, particular attention must be paid to ensuring that the construction is wind-proof and insect-proof, as well as to the correct static dimensioning (evidence of stability for tanks, making allowance for earthquake zones and snow loads).

The diagram on the next page shows the main features of the wall structure in the case of concrete tank-type constructions below ground level but also timber-pillar constructions above ground level. Where there is a danger of frost damage, the concrete walls have insulation on the outside. The concrete trough is a simple and uncomplicated element. Attention should be paid to correctly locating the wall penetrations and also to the proper installation of the grounding strip (see also the „Lightning protection and equipotential binding“ technical information in the Appendix). Depending on the design, the building walls are constructed with k values between 0.26 and 0.5.

**Wall structure, timber building**

The natural product timber is a renewable raw material that contributes significantly towards the binding of $CO_2$ and requires only a small amount of energy to manufacture and process. From an ecological point of view, using timber means resource conservation and climate protection.

**Wall structure, timber building**




In the case of timber-pillar construction, the inside walls are lined with OSB boards which at the same time also form the interior vapour barrier. The walls are insulated with a layer of mineral wool up to 140 mm thick. The outer skin is formed by a wind-proof sheet that allows diffusion, with ventilated timber cladding (vertical) or weather cladding (horizontal). Untreated, resin-rich indigenous timbers such as Larch or Douglas fir in rough-sawn quality and conforming to DIN 18334 are ideal for this. The surface turns grey over time, without this having any effect on the function of the cladding. Timber buildings must be constructed so that there can be no build-ups of moisture in the lower walls. The building must therefore always have a walkway with a firm surface. A sufficient safety clearance must be maintained when planting trees.

As an alternative to the timber casing, the building - particularly on the edge of a town or in a residential area - can be lined with rendering panels and can be ideally integrated into the existing building with a suitable plaster.
Water running off the roof must be collected and drained away. Suitable metal infeed plates must be installed at the front on panel roofs. Snow guards offer reliable protection against falling snow loads and at the same time protect the gutter systems. The maximum snow loads must be taken into account in the static calculations.


**Photovoltaic system on the roof**

**Roof assembly, timber building**

Besides the traditional variant with a purlin roof, solutions with arched trusses are also often realised. Insulation between the rafters is most often used in conjunction with the traditional purlin roof. This means that in principle, the roof structure corresponds to the wall structure, the difference being that the outer skin is realised using pantiles. In the case of large buildings, preference is often given to a variant with arched trusses. This is for static reasons


**Roof structure**

In the case of roofs with arched trusses, there is normally on-roof insulation with metal sandwich panels. With this type of building, particular attention must be paid to careful realisation and sealing of the transitions between the timber and the metal panels (wind-proof and insect-proof). Flat silicone seals, particularly in the expansion joints of the panels, adhesive tape bondings and timber corner strips, are recommended.

**Industrial hall construction** Different constructions are usual in the case of industrial halls. Prefabricated concrete elements, steel supports (steel skeleton construction) or a combination of both systems are used as supporting systems. Highly insulated sandwich panels are installed as roof and facade elements. The wide variety of constructions does not permit a general system description. The fundamental requirements formulated in the Timber Building section therefore also apply correspondingly to industrial hall constructions.


**System 2 x 500 m³ in the industrial hall construction**

**Internal temperature** Water is one of the substances with the greatest heating capacities. Heating capacity is defined as the ability of a substance to store energy. Due to the enormous quantities of heat that are stored in water, as well as the thermal insulation of the building, the result is a constant internal temperature that is independent of the outside temperature. This also means that under normal conditions, no condensation can occur on the tank walls and on the installation (see the „Climate management in water systems" technical information in the Appendix).

**Calculation example** A tank system with a useful capacity of 400 m³ and a building measuring L = 16 m, W = 8 m and H = 10 m with a maximum temperature gradient of 35 K (-25 °C outside temperature and 10 °C water temperature are assumed). Two thirds of the water in the tank is renewed daily. The surface area of the building interior, including its roof, is 550 m². Heat is transported by means of energy transfer due to molecular collisions. This process is known as heat conductivity.
Since the building is of a wind-proof design, the maximum flow of heat is limited by the conductivity of the air.
In this case, the daily quantity of outflowing heat Q would theoretically be max.
**Q = (35 K * 550 m² * 0.26 W/m² * K) / 1 m * 86 400 s = 432 432 000 Ws** (= J)**.**
This quantity of heat would result in a temperature change ΔT of
**ΔT = 432 432 000 Ws / 400 000 kg * 4 180 Ws/kg * K = 0.26 K**.
However, it would not be possible to detect this change due to the daily replacement of the water.

**Interior climate** Due to the stability of the interior climate and the constant temperature of the interior air (which is always approximately the same as the water temperature), the building materials will experience hardly any stress. This means that the tank system will have a service life much longer than conventional structures.

# Functional requirements

**According to the DVGW work sheet W 300/DIN EN 1508, drinking water tanks must be planned, built and operated in such a way that contamination or other chemical, physical or biological influences which have a negative impact on water quality are avoided. The water tank must also be designed in such a way that the meaning and the value of the foodstuff ‚drinking water' are emphasised. Stainless steel drinking water tanks fulfil these requirements optimally.**

Stainless steel is deemed to be perfect from a hygiene standpoint. Stainless steel also emphasises the value of the foodstuff ‚drinking water' because it is regarded as a first-choice material in the foodstuffs industry.
According to W 300, the design of a drinking water tank must also be such that there is a low possibility of maintenance staff being exposed to radon. The presence of radon in the operating room is prevented by complete hermetic encapsulation and by directly venting the stainless steel tanks to the outside.

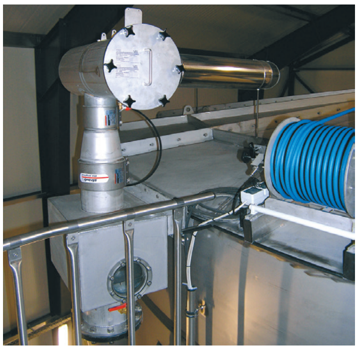
**Infeed with water circulation**

The special infeed system with an aerated inflow loop and tangential inflow provides excellent water mixing both tangentially and horizontally. At the same time, the infeed system minimises troublesome outgassings and keeps the water surface visually clear. To obtain a constant water distribution, the infeed loop must be routed centrally to the inflow collector. Thanks to the excellent mixing of the water, the flow into the tank can be in the vicinity of or near to the tapping outlet. The inflow pipe is routed via the pipe basement, in which a water measuring unit and a bypass to the tapping pipe can also be provided.


**Inflow loop**

**Ventilation**

Every water tank must have its own separate ventilation system. When maintenance and cleaning work are carried out on a tank, this ensures that no detrimental effects can occur. Every ventilation pipe must be routed directly to the outside. Fly screens must be fitted on the outside. Furthermore, the ventilation pipes must be protected against snow and ice, if necessary via frost protection measures such as heating cables etc. Also, at least single-stage, replaceable fine dust filters must be installed in the ventilation pipes (see „Aeration and venting of drinking water tanks" in the Appendix). The ventilation systems must be connected to the tanks so that any condensation occurring is diverted into the overflow and cannot enter the tanks.


**Overflow and air filter system**

The operating room outside the water tank should not be aerated separately due to the constant room climate. The change of air that can be attained through the natural air exchange is sufficient.

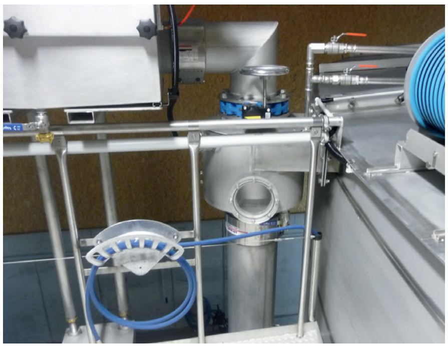
**Safety valves against pressure / low pressure**

Suitable safety measures must be implemented in order to safeguard the tanks against impermissible overpressure and low pressure. An overflow with a siphon is normally sufficient.
Special safety valves on the water tanks and, if necessary, on the building structures are essential in the case of high-level water tanks, large tapping pipes / filling pipes and when water is tapped by using pumps.

**Safety valve and domed cover**

**Overflow**

The overflow must always be designed so that the maximum possible volume of water flowing in can be diverted away without causing any damage. The overflow must be located in the vicinity of the operator platform on the outside of the tank. When dimensioning the overflow edge, make sure that the rated volume is not influenced by the overflow. The overflow pipes must be fitted with a siphon. Possibilities must be created for regularly renewing or changing the water in the siphon. Automatic changing is preferable to manual changing. The overflow pipe must be routed in a shaft in which separation is guaranteed by means of a 300 mm air gap.



**Overflow with siphon**

**Tapping and bottom drain outlet**

The water is tapped from the tanks through a tapping connection welded on at the lowest point under the bottom plate.
The tapping collector connects both tanks, thereby always ensuring the same water level. One or more tapping pipes in the pipe basement carry the water into the supply network via water metering equipment.

Pressure booster systems are also directly connected to the tapping collector.
The bottom drainage is via the lowest point on the tapping connection. This ensures that any deposits in the tank cannot enter the tapping pipe.
If necessary, a detachable sieve can be installed in the tapping connection.

**Installation with pressure booster system**

**Bottom drain outlet**

**Access, safety and lighting**

For visual inspections, the water tanks must have sight glasses and artificial illumination. Ideally, the illumination is provided by one or more spotlights installed in the conical roof, the sizes of which allow good illumination of the completely filled water tank. Also, in the conical roof there must be a domed cover that provides a safeguard against collapsing.

A pressure-tight manhole or a pressure door in the lower part of the tank must be provided for maintenance and inspections.

Manhole with sight glass

Pressure door with sight glass

All stairways, railings and platforms must always be designed in accordance with the valid accident prevention regulations (see the „Safety in water supply installations" technical information in the Appendix).
Roof railings are also possible as an option.

Platform and stairway constructions

**Stainless steels for the drinking water supply**

Water in the tank

Securing the highest drinking water quality on a permanent basis calls for the use of suitable materials with a long service life and inert materials that boast excellent hygienic and corrosion resistance properties. Thanks to their corrosion resistance, stainless steels can be used in a wide range of applications. Besides choosing the correct stainless steel, proper construction, proper processing and careful aftertreatment are also necessary for a long service life (see the „Stainless steel" technical information" and „Cleaning stainless steel" technical information in the Appendix).

# HydroSystemTanks® - Manufacture

**At the factory or on location** The size of the tank is a contributing factor in deciding where it should be built. Tanks with maximum diameters of 4.25 m and capacities of up to approx. 150 m³ can be supplied ready-constructed, vehicular access to their place of installation permitting. Tanks with capacities greater than this are always built on the spot.

**Bottom** Tank bottoms, jackets and roofs are made of stainless steel sheet 3 - 5 mm thick. Normally, a drainage connection is installed in the tank bottom which allows the tank to be completely drained.

**Vessel shell** Depending on the tank dimensions (position, diameter, height), the vessel shell is either manufactured helically in a special process or from prefabricated sheets in one piece and mechanically welded under inert gas. Both the roof and the tank bottom are welded to the jacket on both sides.

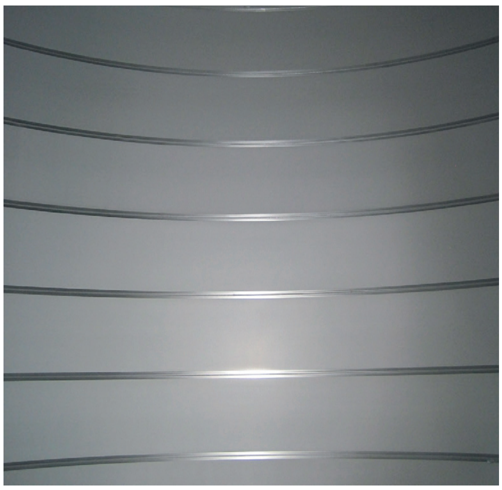

**Tank manufacture**

**Roof**


**The conical type of roof is welded to the tank jacket.**

The tank roof (conical roof) is self-supporting and can be walked on.
Integrated into the roof are the central flange for the cleaning system together with the attachment brackets, a flange for mounting the tank lighting, and a lockable domed cover.

**After-treatment** The plates used have already been pickled and passivated beforehand. During the final treatment, all weld seams are thoroughly brushed, blasted and pickled and passivated using the sputter pickling process. Before final treatment, the tank is provided with all of the pipe connections, manholes and other openings which are required.
Before start-up, the tanks are cleaned and disinfected with special cleaning agents that contain peroxide


**Inside view of a pickled container**

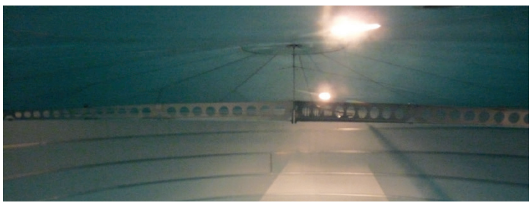
# Semi-automatic cleaning system (DBP)

**Advantages** **The cleaning system has been specially designed for cleaning the entire inside surface of stainless steel water tanks. This system enables the tanks to be cleaned with a high-pressure cleaner and disinfected if necessary, all within a very short time (about 15 to 20 minutes) (see the „Cleaning stainless steel“ technical information in the Appendix).**
**In normal operation, the cleaning equipment is fixed in the tank above the water level. The hose gland is sealed with a spring-loaded gasket.**
**In most cases, cleaning is done using cold drinking water. It is not usually necessary for anyone to enter the tank to clean it.**

**Summary** **Inexpensive solution coupled with the highest level of hygiene.**

**Function** **The drive and control unit** (hose reel, gear motor and associated switching/control equipment) moves the cleaning equipment vertically up and down in cycles.
Adjustable cleaning speed.

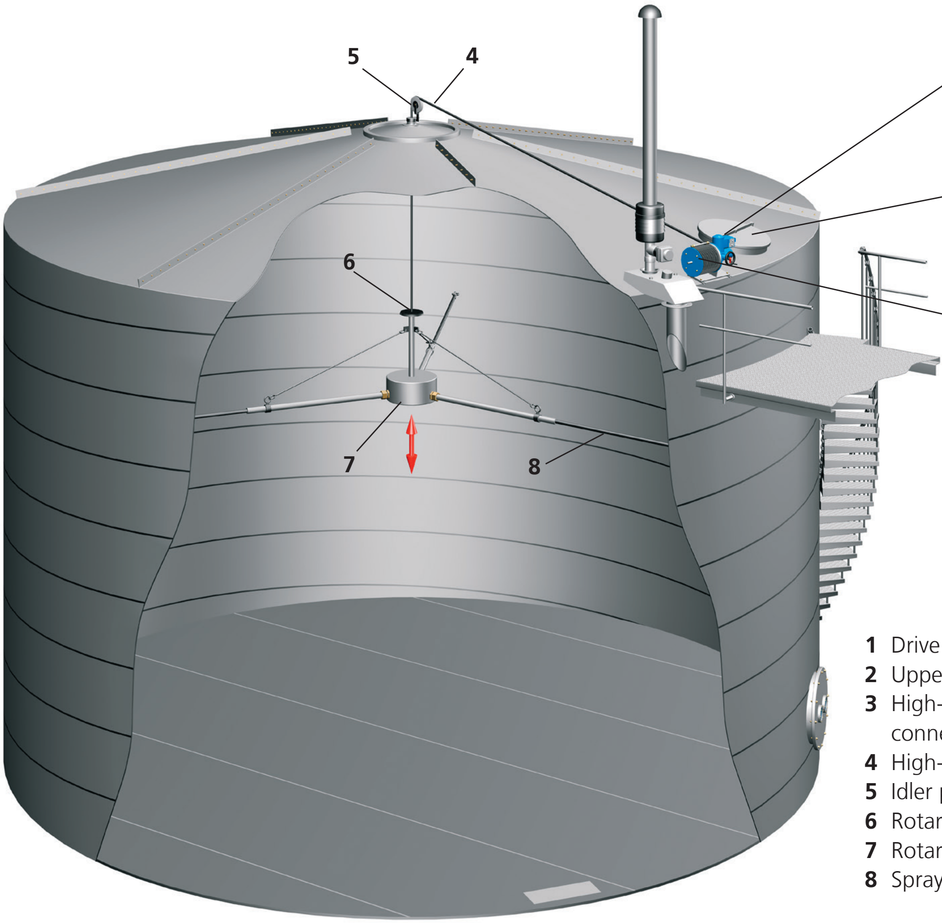
Ideally, the drive and control unit is secured next to **the upper domed cover**. This enables good monitoring of the cleaning operation, and manual intervention is possible if necessary.



The rotary motion of **the cleaning equipment** is initiated by the pulse of the water jet exiting at the steel pipes. To this end, the nozzles have been positioned at a specific angle to the axis of rotation.
The spray pipes are mounted on a central **rotary distributor**, which in turn is attached to the centrally guided **high-pressure hose**.

The hose is routed to **the high-pressure cleaner connection** via **the hose reel of the drive and control unit**. A shut-off device is also installed between the hose and the high-pressure cleaner. During automatic cleaning, the cleaning equipment is moved vertically up and down slowly, thereby achieving surface cleaning over the entire inside wall.

**Normal cleaning system version**




**1** Drive and control unit
**2** Upper domed cover
**3** High-pressure cleaner connection
**4** High-pressure hose
**5** Idler pulley
**6** Rotary coupling
**7** Rotary distributor
**8** Spray pipes

**Floor/roof cleaning**

The cleaning equipment for the floor and roof cleaning has additional spray jet pipes with high-pressure nozzles pointing upwards and downwards. This allows the floor or roof to also be sprayed in the respective end positions. Switchover between the nozzles is done by means of a hydraulic valve in the rotary distributor. Here, the nozzles are arranged so that the spray cones of the nozzles overlap during floor / roof cleaning (at a distance from the plate of approx. 30 cm), thereby ensuring full-surface cleaning.

**High-pressure cleaner**

Different high-pressure cleaners with the following performance data are required, depending on the choice of cleaning equipment.

**Data**

| | Wall cleaning | Wall and floor/roof cleaning |
|---|---|---|
| **Operating pressure** | 200 bar | 100 - 140 bar |
| **Water capacity** | 1000 l/h | 3600 - 6000 l/h |
| **Connected electrical load** | 6.1 kW | 15-19 kW |
| **Connected voltage** | 3 x 400 V/50 Hz | 3 x 400 V/50 Hz |
| **Fuses** | 16 A | 32 A |

# Operational requirements

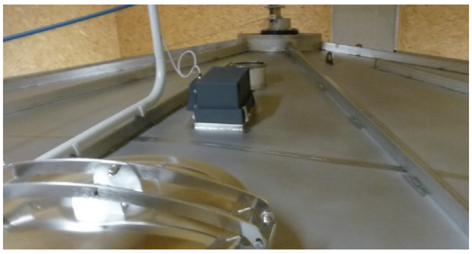
**„Drinking water tanks and all their components must be easily accessible, and must also be systematically monitored, maintained and cleaned throughout the period of their operational use“.**

(G. Merkl, 2001, Trinkwasserbehälter (Drinking water tanks), 2nd edition).

**Personnel** The personnel tasked with these jobs must have received the necessary expert instruction and training, and must possess the necessary knowledge of hygiene and occupational safety.

**Lighting** Irrespective of the time of day, good lighting is always necessary for inspecting and operating a drinking water storage facility. For this reason, electrical lighting must always be installed. Due to the risk of algae formation and in order to protect the building, there should be no windows.

Wall-mounted and ceiling-mounted lights with energy-saving, quick-starting fluorescent tubes are recommended for illuminating the building (due to the low room temperatures). Although these lights are more expensive to purchase, they provide bright room illumination similar to daylight within a short time.



The water tanks are illuminated by spotlights installed on the conical roof. 1 to max. 4 spotlights are required, depending on the size of the tank. The spotlights provide very good illumination of the tank interior.

**Building security** The fully enclosed building allows for excellent electronic monitoring of the entire interior with, for example, active or passive motion detectors. With additional door contacts, this ensures that the interior is almost completely monitored. It is recommended to combine the building security system with an emergency alarm function for personnel protection.

**Control system** Drinking water tanks must be fitted with an electrical measurement and control system (EMC). The control system regulates the management, pump operation and flow into the tank. Volume measurements (inflow and tapping) are evaluated and registered. The use of touch panels with a graphic user interface has proven successful.

**Sampling**

So that water samples can be taken, sampling valves must be installed in every inflow and tapping pipe, as well as on every tank outlet. All sampling points must be identified by the corresponding signs.

**Maintenance and servicing**

Only trained, expert persons may look after a stainless steel drinking water tank. The statutory requirements must be adhered to in all cases. It is recommended to keep an operating log.
The operating log should contain:

- Results of the regular water analyses for documentation
- Results of the monitoring and inspection
- Documentation of the tank cleaning
- Visual inspection of the air filter and documentation of the filter change intervals
- Instructions for putting the tank system into and out of operation
- Instructions for cleaning and disinfecting the system
- Tank cleaning documentation
- Instructions for operating and maintaining the electrical and mechanical equipment

**Cleaning and disinfection**

The entire tank system must be thoroughly cleaned before being put into operation (see the „Cleaning stainless steel" technical information in the Appendix). When chemical agents are used, make sure that they cannot attack metallic materials and, in particular, stainless steel. Only permitted tested agents can be used. Cleaning agents containing chloride must not be used under any circumstances. When using chemical cleaning agents, in particular ensure that all remaining traces of cleaning agent residues are completely removed. A sufficient cleaning result is often obtained simply by spraying down with drinking water.

Hydrogen peroxide is recommended for disinfecting. All inner surfaces of the tank and the associated pipelines must be thoroughly disinfected. Waste water containing disinfectants must not be introduced into the natural water cycle without first being neutralised. The disinfection must be logged.

**Monitoring and inspection**

Regular or scheduled visual inspections of the tank system along with a functional check of all safety-relevant components is recommended. The visual inspection must include an external and internal check of the condition of the water tanks when they are full. Monitoring should be documented in the operating log.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