ISSF
INTERNATIONAL STAINLESS STEEL FORUM

Stainless Steel in Drinking Water Supply

Cover picture courtesy of Baosteel Stainless Steel

Disclaimer

Why stainless steel in drinking water supply?

Its inert and corrosion-resistant nature makes stainless steel an ideal material for contact with drinking water in all stages from extraction to domestic plumbing. Stainless steel is the only metallic material that is suitable for any usual drinking water composition.

Whilst the drinking water delivered by waterworks has defined contents of chlorides and other corrosive constituents, the original feed water is much less predictable. From ground water to sea water, there is a wide range of compositions. Whatever the corrosion challenge, the wide range of stainless steel grades provides solutions. For pipework and tanks, standard grades of the 306 and 316 families are by far the most usual grades; however, super austenitic and duplex grades can even defy the corrosive conditions that are found in the seawater intakes of desalination plants.

Besides corrosion resistance, the mechanical properties of stainless steel make them attractive for water applications. The ductility of stainless steel is an asset. In contrast to brittle materials like ceramics or cast iron, austenitic stainless steel can absorb considerable deformation without breaking. This is an advantage in seismic conditions. Duplex stainless steels combine a high level of corrosion resistance with exceptional strength, which can be used to reduce wall thicknesses of tanks and pipes – sometimes by 30 %. For mechanical parts like valve balls, hard martensitic grades ensure long-term reliable service.

For the fabricator, formability and weldability are important. Austenitic stainless steels are among the most malleable volume engineering materials. They are formable enough for tubes to be shaped into bellows, which serve as compensators for thermal expansion or absorb seismic movements. The outstanding weldability of most standard grades makes it easy to weld components on site, where conditions are more difficult to control than in a workshop environment.

Stainless steel surfaces can be made very smooth to reduce the adherence of particles and micro-organisms. Cleaning is possible by simple mechanical means. Applied protective coatings, which become susceptible to deterioration over time, can be dispensed with because the bulk material is intrinsically corrosion resistant.

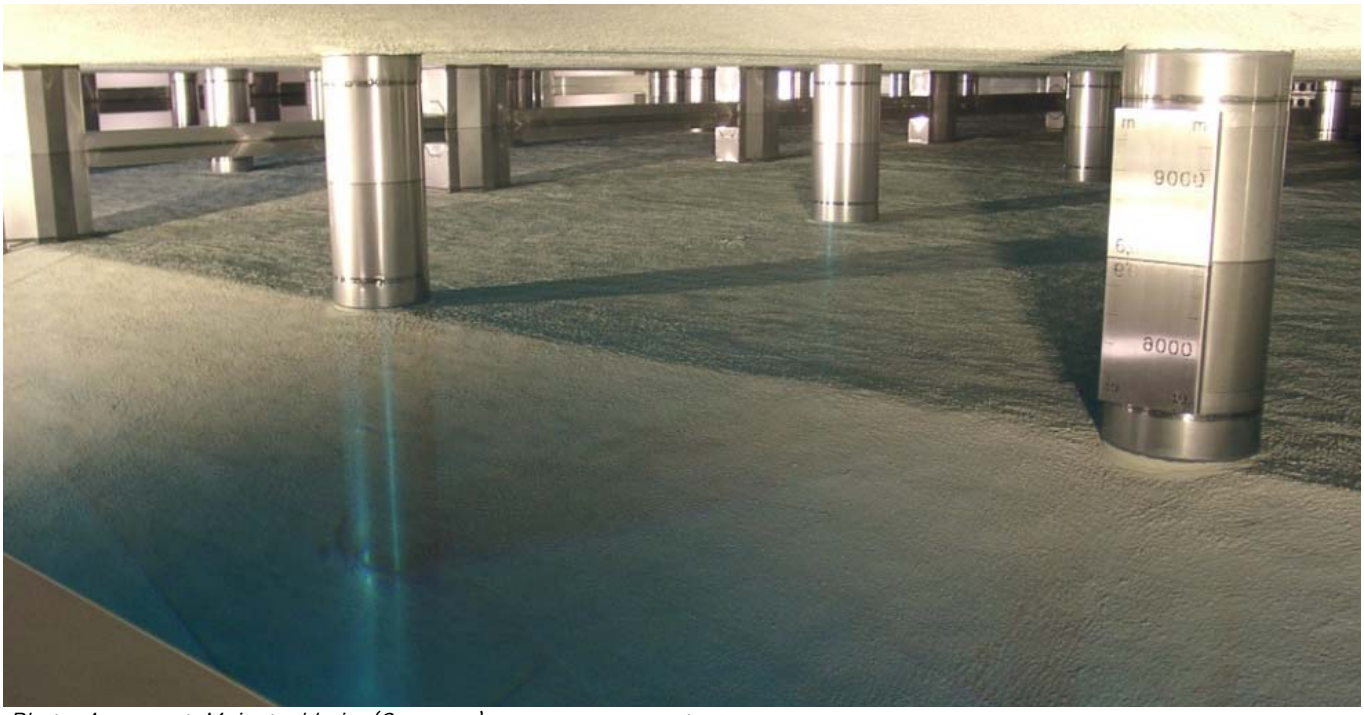


Photo: Aqua-met, Mainstockheim (Germany), www.aquame-met.com

Water intake

For the direct extraction of feed water from the water table, rivers and lakes or for the use of river bank filtrate, tubular stainless wedge-wire filters are a common option. They consist of V-shaped profiles, which are welded onto transverse supports. Not only does this design lend stiffness to the filters, it also provides non-clogging properties. The filter can efficiently be cleaned mechanically or by back-flushing.

Water intake filter made from stainless steel wedge wire.
Source: Sanya Wedge Wire Factory (PR China), www.wedgewire.org

In water extraction, stainless steel wedge-wire filters hold back coarse particles. The smooth stainless steel surfaces make it more difficult for micro-organisms to survive than on materials which are porous. Stainless steel is biologically inert and does not release contaminants into the water or ground. The filters can easily be cleaned, which, together with their longevity, makes stainless steel solutions particularly cost-effective.

Intake for river beds.
Source: Euroslot Kdss (UK), www.euroslotkdss.com

Water preparation

Stainless steel is a standard option for pipes in waterworks. Also the outer surface remains corrosion-free over time without the need for applied protective layers, which are vulnerable, can age and eventually fail.

Type 316 stainless steel for the City of Lake Worth reverse osmosis water treatment plant.
Source: Mock & Roos (USA), www.mockroos.com

Pipes can be custom-made to meet the needs of specific process technologies. The photo below shows fabrications for a hydrogen sulphide removal facility. The fabricator used an automated, high-deposition submerged arc process to weld all circumferential and longitudinal seams on the pipe. The pipe was 100 percent X-ray tested with no failures and was passivated with citric acid solution. It was delivered in 80-ft. sections, with additional 90-degree elbows.

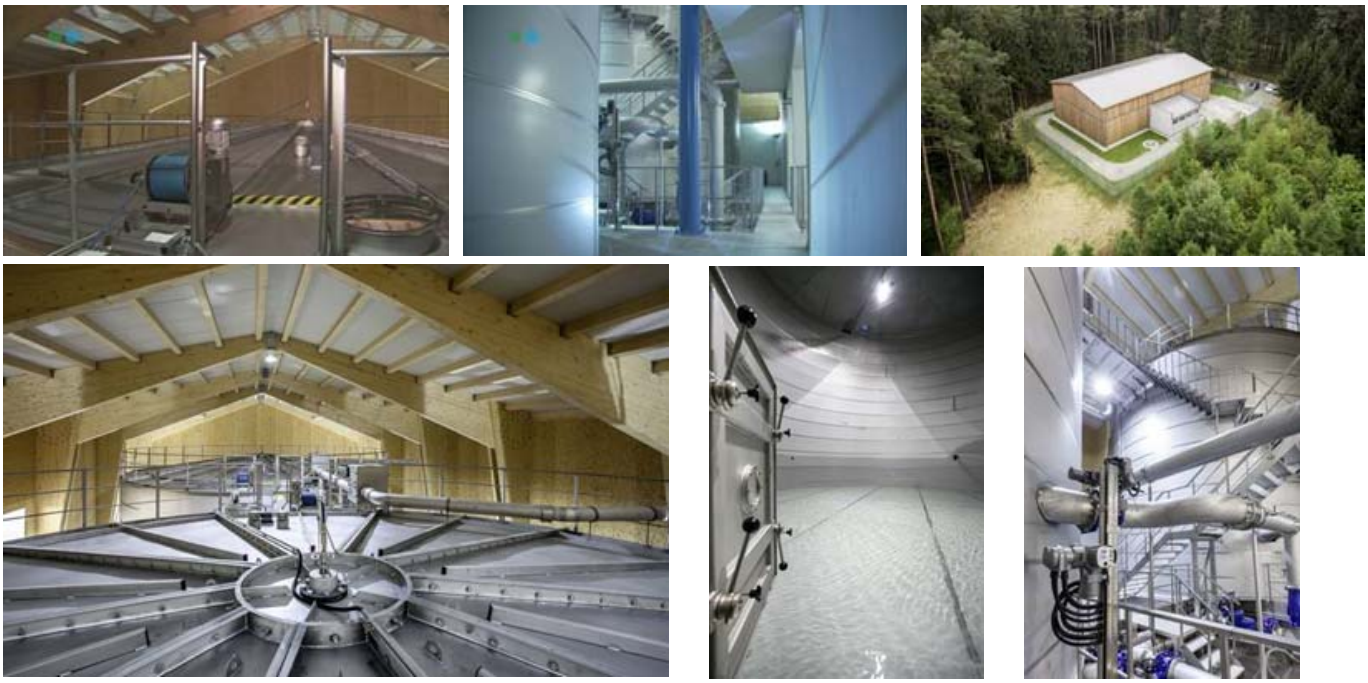
Pipework for the hydrogen sulphide removal stage of water-works.
Source: Dixie-Southern Duelle, Fla (USA), www.thefabricator.com

Stainless steel in municipal waterworks.
Source: Schenke Anlagenbau, (Germany), www.schenke-anlagenbau.de

Stainless steel in a typical mixed-material installation can be combined with coated steel and cast iron parts provided the connections are properly designed and the flow direction is taken into account.
Source: Wasserverband Südliches Burgenland (Austria), www.wvsb.at

Water storage

Water can be stored in underground reservoirs, water towers or free-standing tanks. In the project shown below, two tanks with a capacity of one million litres each were spiral-welded on site. It took about one month for them to reach their final height of nine metres. The tanks are housed in a wooden building, which blends nicely with the surrounding landscape. However, there is primarily a technical reason for this design. In contrast to conventional buried concrete tanks, the structural function and the water-containment function are separated. This principle makes it possible to inspect and, if necessary, repair them independently of one another. Potential future work on the building can be performed without emptying the reservoirs. As the stainless steel tanks are essentially maintenance-free, the life-cycle cost of this solution is expected to be lower than for the integrated concrete design.



Spiral-welded stainless steel reservoirs erected on site.
Source: Bayerische Staatszeitung / Wasserversorgung Bayerischer Wald (Germany), www.bayerische-staatszeitung.de

Stainless steel is also used for the cladding of concrete underground reservoirs and water towers. This technique has become an established refurbishment solution. Grade 316L is a proven option for this application. Conventional concrete reservoirs age; their surfaces crack and need to be coated periodically. Repair coatings on damaged surfaces, however, tend to develop blisters and other defects. In contrast, a welded, continuous stainless steel skin is durable and hygienic. Stainless steel is insensitive to permanently wet conditions. This is not only important for the water contact side; also the rear of the stainless steel skin, which is in contact with the concrete and exposed to a poorly ventilated space between the two materials, requires a high level of corrosion resistance.

Stainless steel linings of concrete reservoirs.
Source: http://www.forstenlechner.at/index.php?id=80

Pre-fabricated and custom-made units are available for smaller reservoirs in locations, which are difficult to access. Stainless steel doors have an additional safety function and efficiently protect the reservoir access against hooliganism and tampering.

Stand-alone stainless steel units are also available for small installations.
Source: Harasser (Austria), http://schlosserei-harasser.at

In Japan, modular tanks have been made from stainless steel since the 1970s. One of the reasons is the excellent behaviour of stainless steel in earthquakes, when the elasticity and ductility of the material absorb shocks without the material breaking or cracking. Even in catastrophic situations, drinking water is not lost and continues to be available.

The wall elements of stainless steel modular water tanks are strengthened by beads. They provide the required stiffness and keep wall thickness to a minimum. Modules can be combined into tank units of nearly any geometry – square, rectangular, L or U shaped. Sizes of up to 3,000 m³ have been manufactured. Good long-term experience led to this design principle being used also in other countries.

Modular water tank system made from stiffened stainless steel panels.
Photo: Morimatsu (Japan), www.morimatsu.co.jp

Distribution

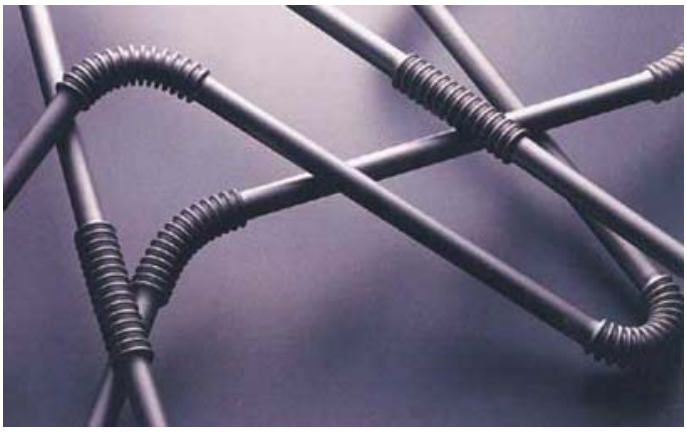
Stainless steel is also an ideal material for the distribution of drinking water. In most environments, stainless steel is corrosion resistant to the ground and concrete. However, where the ground contains corrosive substances like chlorides or stray currents are present, it is recommended to apply an additional PE wrapping.

Unprotected type 304L drinking water pipe in the city centre of the Swedish capital Stockholm.
Source: Euro Inox, Brussels (Belgium), www.euro-inox.org

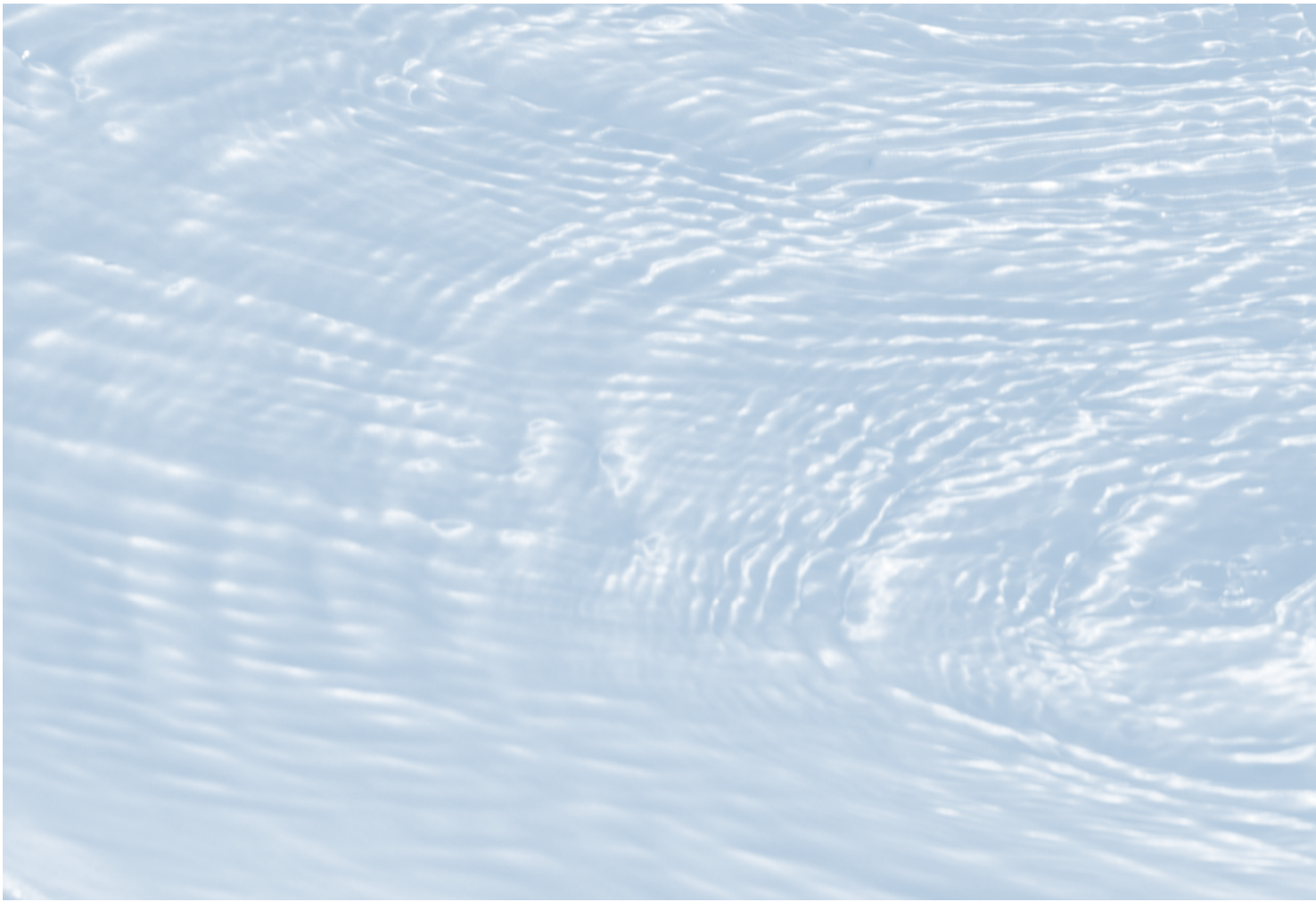
In contrast to ceramic materials and cast iron, stainless steel is exceptionally ductile. It can undergo strong deformation without cracking or breaking. Technically, the elongation at fracture is a measure of a material's formability. Among the candidate metallic materials, stainless steel is a champion: stainless steel of the usual types 304 or 316, for instance, can be stretched by nearly 50% and often even more before it breaks.

Stainless steel inserts as a repair solution for underground main supply lines.
Source: Centro Inox (Italy), www.centroinox.org

The city of Tokyo has taken advantage of these properties for the last 20 years to cope with seismic activity. Earthquakes can make classic water pipes break and leak. The increased use of stainless steel and flexible connectors enabled Tokyo Water to reduce their water losses from previously 30 to less than 5% over the last 20 years.

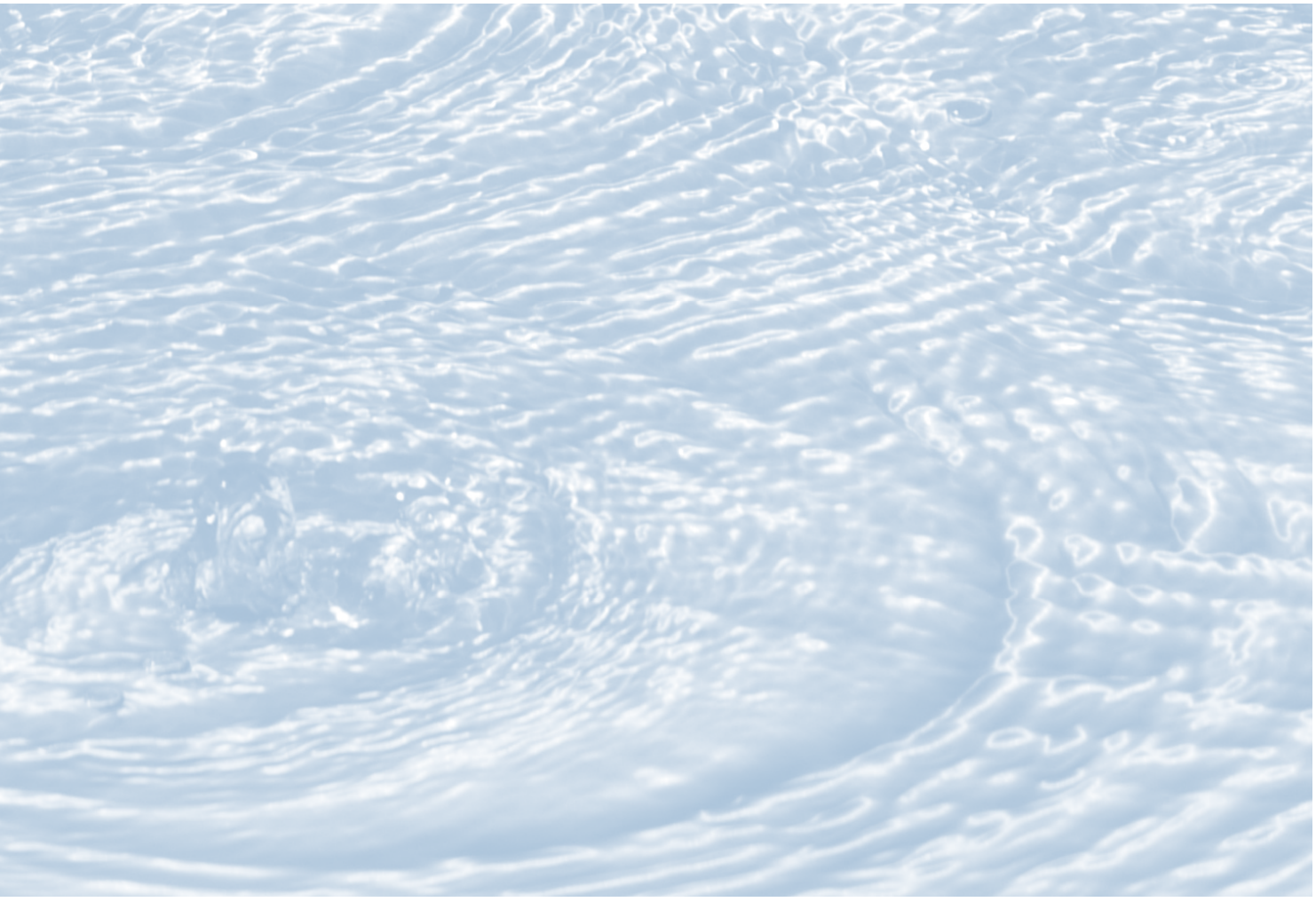


Stainless steel pipework and flexible stainless steel connectors for seismic design.
Source: Nickel Institute (Canada), www.nickelinstitute.org



Summary

Experience shows the long-term corrosion resistance of stainless steel in feed water intakes, waterworks, reservoirs and urban distribution grids. A range of austenitic and duplex grades is available to suit virtually any feed water composition. Stainless steel applications encompass both initial installation and refurbishment. The ductility of the material enables complex forming operations: beads add to the stiffness of wall components and bellows provide pipework with unparalleled seismic properties. The work-hardening of austenitic grades make stainless steel doors and manholes a safety feature. The high strength of duplex stainless steels allows wall thicknesses of pipes and tanks to be reduced. Hard martensitic grades are used in mechanical components of valves. As a food-safe material, stainless steel does not negatively affect drinking water quality and its surface characteristics ensure excellent long-term hygiene properties.



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