

# The stainless steel lining of drinking water reservoirs – Initial erection and refurbishment

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## **1. Introduction**

Saving money is a basic principle not only for authorities, but also for companies. In view of tighter and tighter budget constraints, it must also be taken into account in the erection, development and refurbishment of the water distribution infrastructure. The objective is the optimal use of the available resources. Some designers hesitate to use stainless steel, which is believed to be expensive and prefer other materials. However, is this really the most economical solution?

Infrastructure buildings must have a long useful life, in the case of drinking water reservoirs typically 50 years. The components, which may be built in or embedded in the concrete, can differ substantially in terms of actual durability. Stainless steel parts can last as long as the entire structure avoiding expensive renovation at a later stage. Why not use this saving potential? Otherwise, there is a risk of designing repairs into the initial layout.

In water basins of the nuclear industry, where quality requirements are particularly high, stainless steel liners have been used in for about 20 years. The experience made in this application is now used for lining drinking water reservoirs.

## **2. Limitations of conventional systems**

The durability of reinforced concrete reservoirs is not unlimited, even if the technical standards are fulfilled in the erection process. Ageing processes typical of the material, for instance erosion and chemical reactions, can reduce the useful life further. Other factors are static and thermodynamic loads, which can be causes of premature damage and leaks. Whilst damage in the facades can be repaired with specialised techniques, the removal of leaks in the reservoir itself and in the base are much more difficult, because the cracks are difficult to localise.

Water penetrating into the concrete makes the steel reinforcement corrode. The surface may spall off and create porous surfaces. Lack of homogeneity in the concrete and ageing expansion joints can lead to bacterial contamination. Conventional coating systems can only solve the problem temporarily as they do not adhere permanently to the damaged surfaces and tend to come off. Continual repairs and high costs are the consequences.

Our attempt to find a perfect refurbishment and cladding system, which also meets the highest demands in terms of cleanability and hygiene, has led us to the choice of stainless steel.

### 3. Characteristics of stainless steel solutions

Stainless steel lining is growing in importance, because it is often the technically and economically most suitable solution to permanently restore water tightness. If fabricated with the necessary expertise, is an option with a number of advantages:

1. 100% water tight, no loss of water, easy control through leakage detection systems.
2. Surface roughness of only 0.15 to 0.25  $\mu\text{m}$ , which
  - a. Reduces deposits and film formation
  - b. Drastically facilitates cleaning and minimises cleaning time
  - c. Makes chemical cleansers redundant
3. Compared to conventional coating systems like chlorinated rubber, epoxy, ceramic tiles and polymer-modified cement slurries, the stainless steel lining is considerably more resistant to mechanical and dynamic damage.
4. Outstanding corrosion resistance. Under the influence of oxygen from water on air, the chromium content in stainless steel leads to the formation of a thin and chemically stable passive layer. This natural mechanism protects the surface from corrosive attacks – permanently and, above all, free of charge. Accidental damage does not create problems, because in normal circumstances, the passive layer is self-repairing. Corrosion does not get a chance. Choosing the most appropriate stainless steel grade, for the particular application, long-lasting corrosion resistance is obtained. However, the formation of fully developed passive layer requires good practice in fabrication. This requires



- Use of appropriate tools and techniques including welding processes and post-welding surface treatment.
  - Optimal assembly.
5. Wear resistance. Another remarkable feature of stainless steel is its abrasion and erosion resistance. The material even withstands abrasive stress, for instance from sand, for many years.
6. Stainless steel is process-neutral, antibacterial and hygienic. In all areas of food processing, including water treatment, stainless steel is appreciated for its hygienic advantages, which go back to a combination of properties. Neither migration nor abrasion will release any relevant amounts of substances into the processed or conveyed medium. For the handling of drinking water, it is particularly important that stainless steel does not change the taste of the water in any way.
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- Stainless steel surfaces are smooth, hard and homogenous. They are neither rough nor do they develop cracks, making it difficult for bacteria and fungi to adhere. Therefore, deposits are minimal. However, if any deposits need to be removed, steam cleaning can easily be performed.
7. There are no obvious limits to the useful life of stainless steel.

Coating systems are applied directly to the building. This makes it difficult for them to resist movement in the building and bridge cracks. Typically, such systems require repair or replacement in intervals of 8 to 10 years.

These factors need to be taken into consideration in cost calculations. Long-term maintenance has to be accounted for along with initial investment. These include operational costs, maintenance and repair, and of course the time before a new investment becomes necessary. All in all, it is obvious that coating systems cannot ensure long-term water tightness.

#### **4. Practical aspects of the lining process**

The stainless steel lines can be applied directly to the supporting structure without any previous treatment. The sometimes difficult removal of, for instance, damaged epoxy coatings, is dispensable. The stainless steel is 1.5 mm sheet grade 1.4571, surface finish 2D. The lining process is consistent with EN 10204 / 3.1.

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The metal is applied in sheets of commercially available size, bolted and welded with an overlap. The welding process, TIG without filler material, ensures that the heat input is minimal. On the water contact side, discolorations resulting from the welding process are removed mechanically through brushing. Passivation is not necessary as the passive layer reforms automatically within a few days when exposed to ambient air.

The welded seams are checked using the liquid penetrant testing according to national standards to ensure water tightness. For all welding operation, only welders with a certificate according to EN 287 are employed.

Typically the liner ends below the reservoir ceiling. In the case of refurbishment projects, a special profile is used to create the seam. They are additionally sealed with silicon. Stainless steel tubes are inserted in both existing steel or cast iron pipes and are welded to the stainless steel lining and joined to the existing system.

The only difference in the case of initial erection is that the upper joint can be introduced right in the casting process and that the feeding pipes can be mounted with the transition joints already in place. Anchor plates for ladders and other components can be fitted right away. It is also possible to use stainless steel pipes as a permanent formwork to create supporting pillars.

Requirements on surface properties of the concrete can be reduced. The stainless steel liner bridges uneven surfaces, which can be caused by gravel accumulations and poor alignment of the formwork, avoiding sharp edges.

To check the water tightness of the system, leak detectors are installed in the reservoir or more precisely, in the deepest point of the sump, where a stainless steel pipe is installed to enable visual inspection. Other components, like ladders, stairs, supports, doors or lights can easily be integrated in the cladding.



### 5. Summary

The assets of stainless steel linings can be summarised as follows:

- Stainless steel lining provides an opportunity to ensure long-term water-tightness economically.
- Cracks, which may occur during the operation, can be neglected.

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- Good cleanability and almost unlimited durability of stainless steel are an obvious option to keep the follow-up cost of drinking water reservoirs to a minimum.