AnoPerm-R

with protective current regulation

Corrosive attacks on the cement mortar lining and in some cases even on the structural concrete occur in many drinking water reservoirs. Images of the corrosion range from the occurrence of solitary spots with surface discoloration to local softening in the area of the spots and to more or less full-field softenings, especially on the walls. The affected places are often concentrated in the permanently submersed and badly ventilated areas (extinguishing water reserve), while in the intermittently immersed areas (service water reserve) and in rear-ventilated zones there are usually considerably fewer local softenings present.

Cause of damage due to the exposure to direct currents

The source of these currents can either refer to macroelements (galvanic cells also known as batteries) or stray currents of direct current facilities. Electrochemical processes caused by the current flow occur in those macroelements, where reservoir reinforcement or components of stainless steel serve as a cathode (+ pole) and there is an anode (- pole) placed outside of the reservoir (e.g. cast conduits) or in the concrete wall (e. g. corroding reinforcing bars). In the electric field, migration takes place in such a way that anions – e.g. chlorides, sulfates, hydrogen carbonates etc.- migrate towards the anode and cations – e.g. Calcium-, Magnesium-, Sodium ions migrate towards the cathode.

The most common cations present in concrete refer to ions of Calcium, the most common anions present in the water are ions of bicarbonate (HCO3-).

During the passage of current from concrete/mortar to water, the bicarbonates migrate into the concrete/mortar and ions of Calcium come out from the pores.

Both processes lead to dissolution of calcium hydroxide deposits in the cement coatings and creation of limestone according to the following equation:

$Ca^{2+} + 2\ HCO_3^- = CaCO_3\ (s) + H_2O + CO_2$

During the passage of current from water into the concrete (passage of current to the reinforcing bars) the Ca^{2+} -ions migrate from the water into the concrete and create hardly soluble $Ca(OH)_2$ and gradually also $CaCO_3$.

It is safe to say, that a passage of current from concrete into the water can lead to change and loosening of the mortar- and/or concrete structure, while a passage of current into the concrete leads rather to its condensation

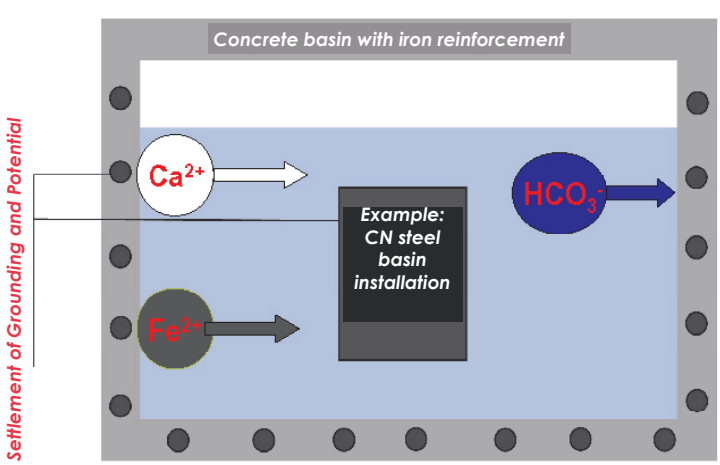
At this point it has to be mentioned, that, when it comes to grounding issues, Switzerland represents a special case. Until recent times, the underground water pipes were used as a grounding and accordingly they were built to be longitudinal conductive. These water pipes create a widely ramified, low-impedance net of anodes linked together and that leads to powerful macroelement currents.

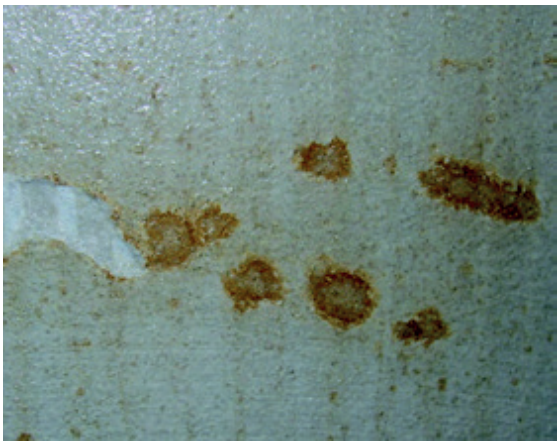
Prevention options in the case of exposure to direct currents

Avoidance of passages of current into the thermal siphon by compensation with external current (cathodic protection).

Natural reservoir corrosion

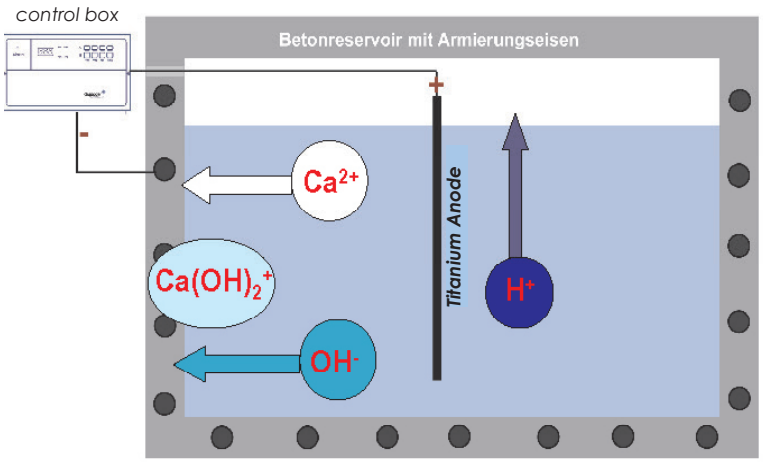
Different Potential between the iron reinforcement and the basin installations results in ion migration through concrete and lining





Concrete corrosion with cathodic corrosion prevention

Prevention against current leakage in the water tank through compensation provided by external current (cathodic protection).



The role of the cathodic corrosion prevention

All ionic currents, pouring out from the concrete surface can be, regardless of their origin, compensated with the installation of a cathodic protection system inside the reservoir..

Mixed-oxide coated titanium anodes with a life span of at least 15 years have to be installed into the reservoir tank at a certain distance between them and also to the wall of the reservoir, so they can enable an even distribution of the current between the protective reservoir walls and the ground. The positive pole of the DC power source has to be connected to the current penetrations of the titanium electrodes, which thereby become anodes.

The negative pole has to be connected to the reinforcing bars. The reinforcing net thereby turns into a cathode. The applied rectified voltage usually varies between 2 and 12 Volt and the current densities, depending on the water composition and service conditions, vary between 100 mA/m^2 and 500 mA/m^2 of the cathode surface. At the same time there is a flow of direct current from the inert anodes to the reinforcing bars (cathode) in the water.

This setting ensures the occurrence of passages of current into the mortar only. Given time of the consumption of protective current declines due to the re-passivation of previously corroded steel surfaces, reducing the exposure of the cement stone to the passages of current.