



POWER GENERATION // TOC REDUCTION



APPLICATION: TOC reduction // MARKET: Power Generation // LOCATION: Forsmark Power Plant, Sweden

POWER PLANT TOC REDUCTION

Our ultraviolet (UV) TOC reduction systems are used in a wide range of applications. The most common application is in the Microelectronics industry treating ultrapure water (UPW). However, there is an increasing need for TOC reduction in power plants to inhibit corrosion from the steam used to drive the generating turbines.

We use low-pressure lamp technology (185 nm wavelength) in our systems to promote the formation of free -OH radicals leading to the oxidation of organics present in the water.



High water volume applications such as ultrapure, reclaim, or high-pressure boiler feed water for nuclear power plants require efficient TOC reduction. This is most effectively accomplished using low-pressure (LP) UV lamp systems which emit energy at 185 nm. LP lamp systems generate powerful -OH hydroxyl radicals which break organics into ionized materials that are easily removed through downstream polishing deionization systems.

We have 40 years of experience successfully employing our TOC reduction systems in the Microelectronics industry and other industries that require the same high level of treatment. Single unit or modular skid designs (up to 10 reactors on a skid) are available. Our systems can be installed indoors or outdoors, have low operating and maintenance costs and utilize the most efficient lamps for destroying TOC. For advanced design, technology and cost efficiency, the most recognized names in the industry today rely on Aquafine.

Forsmark Power Plant

The Forsmark nuclear power plant is located about 120 km outside of Stockholm, Sweden. The facility generates 20 – 25 billion kilowatt hours of electricity per annum from three, on-site, boiling water reactors. The facility employs the following water treatment process to feed reactor reservoirs (see Figure 1 for a similar configuration): Surface water → cation exchange → degas → anion exchange → UV TOC reduction → polishing mixed bed resins. They are required to maintain the reservoir water at < 100 ppb TOC in order to prevent the formation of acids which can lead to corrosion issues in the steam turbines.

TOC Reduction Concerns

Treated water entering the plant had TOC loads in the 200 – 300 ppb range. The original UV equipment used medium-pressure (MP) lamp technology and had difficulty reducing TOC to the required <100 ppb level. Forsmark struggled for a number of months to resolve this performance issue with the only solution being installation of more equipment. We offered an alternative UV system design that employs LP 185 nm lamp technology and a hydraulically efficient UV chamber with baffles. Forsmark began an intensive pilot study in which operators compared our LP lamp system with the original MP lamp system. This side by side test monitored TOC reduction performance over time at a range of flows and influent TOC levels. Table 1 defines results achieved from the on-line system and highlights the pilot outcomes.

// CASE STUDY

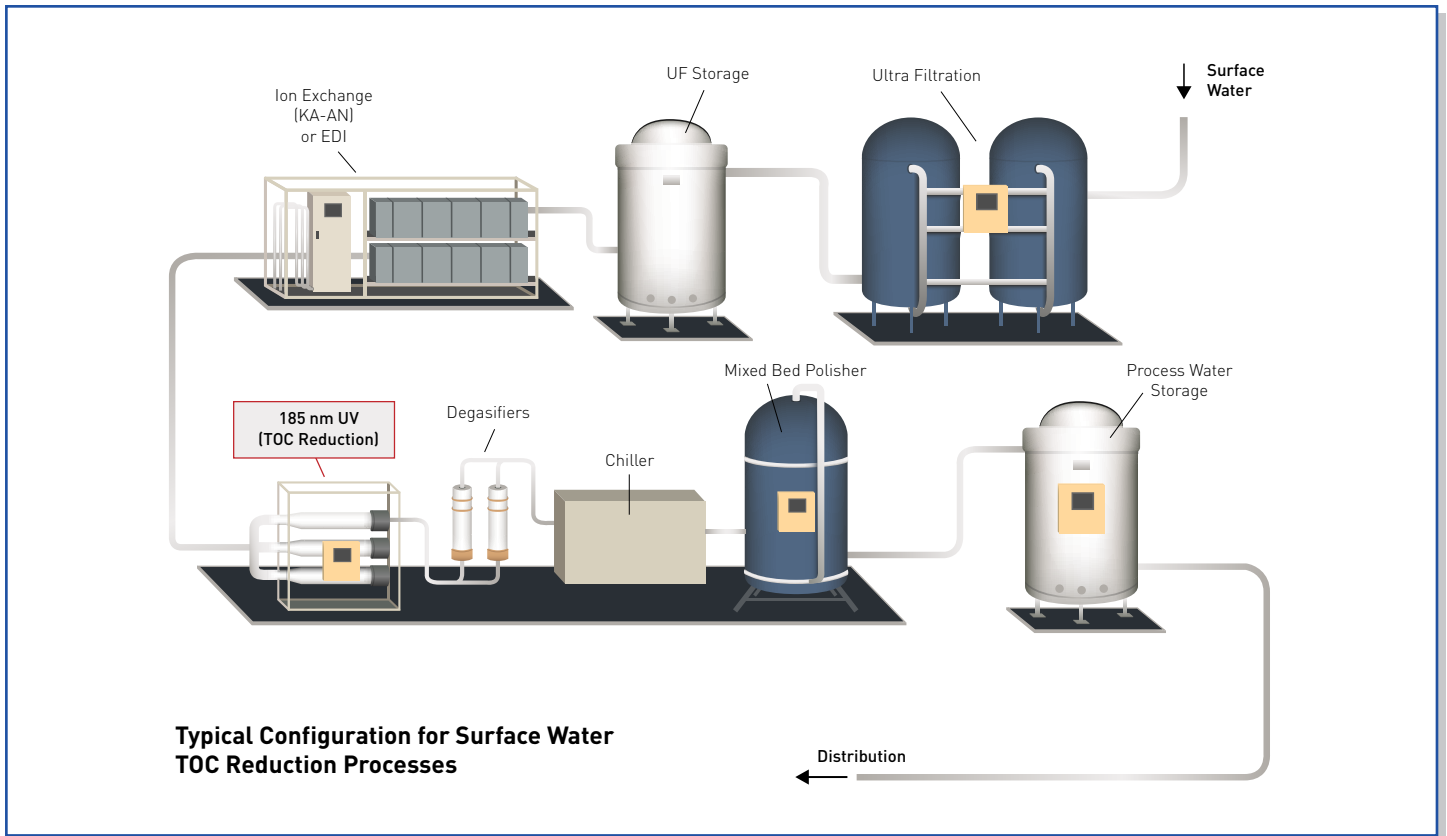


Figure 1 // A general flow scheme for surface water treatment using UV for TOC reduction.

| FORSMARK TOC STUDY - REPORT DATA | | | | | |
|----------------------------------|--------------|-----------------|--------------------|---------------------|--------------------------|
| System | Flow (l/min) | UV System Power | UV Inlet TOC (ppb) | UV Outlet TOC (ppb) | Post Mixed Bed TOC (ppb) |
| MP Lamp | 480 | 2.2 kW | 223 | 222 | 163 |
| Full Scale | 480 | 2.2 kW | 248 | 245 | 190 |
| | 960 | 1.5 kW | 233 | 230 | 187 |
| | 960 | 1.5 kW | 271 | 269 | 219 |
| | Aquafine | 10 | 0.6 kW | 204 | 187 |
| Pilot | 15 | 0.6 kW | 204 | 192 | 48 |
| | 20 | 0.6 kW | 204 | 180 | 55 |
| | 25 | 0.6 kW | 204 | 183 | 50 |

Table 1 // Piloting results for our system demonstrated consistent TOC reduction, well below Forsmark's required <100 ppb. As a result, we installed our full scale solution using a single SCD-600H UV system. Total power consumption for the system is 2.7 kW to treat full flow. The system was started up in 2009 and has been successfully operating since then.



Figure 2 // Our SCD H series provides TOC and chlorine destruction solutions, maximizing reduction efficiency in high volume, ultrapure, waste or reclaim applications.