T.51 OZONATION | ADVANCED OXIDATION

TECHNOLOGY

Ozonation is the injection of ozone gas into a water stream for the chemical removal (i.e., via oxidation) of organic and some inorganic pollutants, as well as odor and color. Ozone (O_3) is an unstable chemical which, when injected in water, forms free radicals (HO_2, •OH) that react with organic and inorganic compounds to break them down or inactivate them. Due to this strong oxidizing capacity, ozonation is effective for disinfection of pathogens, as well as for the removal of persistent organic micropollutants, that are broken down into smaller, more readily biodegradable compounds. These smaller, often insoluble compounds can then be removed in subsequent treatment steps. Advanced Oxidation Processes (AOPs) work by generating highly reactive oxygen species, mainly hydroxyl radicals (•OH), that oxidize and degrade micropollutants. These processes can be, for example, ozone-based, hydrogen peroxide-based, photocatalytic (i.e., UV/light-driven).

Ozonation and other AOPs can be used for the targeted removal of organic micropollutants (like pesticides, pharmaceuticals and PFAS) from treated water for potable reuse applications, or when stricter discharge regulations apply.

INPUT STREAMS

- GW Pre-treated Greywater
- MW Pre-treated Mixed Wastewater
- RW Rainwater

TARGET OUTPUT(S)

- Treated Water

GILETTE STADIUM & PATRIOT PLACE

Foxborough, MA, USA | 2003

Ozonation and UV for mixed wastewater treatment and reuse

A large water reuse system, designed to treat approximately 950 m³/d of mixed wastewater, provides treated water for toilet flushing, cooling, and other services for the stadium and adjacent shopping center. Excess treated water is discharged to a groundwater recharge field. Ozonation is used to remove residual color from the effluent of the MBR, and is followed by UV for disinfection.

MW — T.41 BUFFER TANK — T.46 MBR — T.51 OZONATION — T.50 UV DISINFECTION — T.41 STORAGE TANK

SPECIFICATIONS

INFRASTRUCTURE

Ozonation or AOP systems are typically placed in a technical room and usually occupy a relatively small space compared to biological or filtration treatment units.

Ozonation systems typically include (1) an oxygen/air supply system (e.g., oxygen production/storage), (2) an ozone generator, where the dry air or oxygen gas is submitted to an electrical field to generate ozone gas, (3) an ozone contact chamber, where ozone is injected into the stream, and (4) an off-gas destructor, to safely remove excess ozone. Basic monitoring sensors for ozone dosing, residual ozone and oxidation-reduction potential are also required.

AOPs rely on a combination of treatments, and therefore include more complex infrastructure. This can include infrastructure for ozonation, together with, for example, dosing systems for hydrogen-peroxide, or UV lamps and reactors for photocatalytic systems.

OPERATION & MAINTENANCE

Capital and operational costs are generally higher for ozonation and AOPs, compared to UV or chlorine disinfection T.50 alone because they are more complex technologies, and because ozone generation uses significant amounts of electrical power. Safety in operation and maintenance of ozonation systems is required as ozone is a toxic gas and explosive at high concentrations. An ambient ozone monitoring system to detect ozone leaks, and operation and maintenance by specialized personnel is advised for these systems. For ozonation, operators mainly ensure a steady oxygen/air supply, monitor ozone dosage/leaks, clean contact tanks and maintain/replace ozone generator parts. For AOPs, operators need to coordinate multiple inputs (chemicals, UV, pH), replace lamps and catalysts, manage chemical storage and perform frequent monitoring.

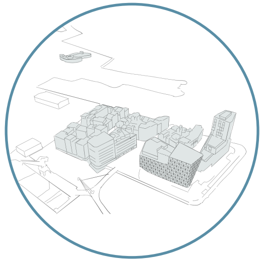
TARGET OUTPUTS

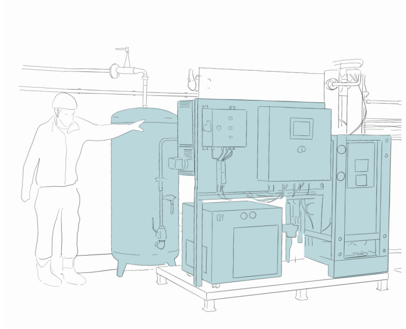
Ozonation and AOPs are used to obtain a disinfected, colorless, and odorless treated water streams for water reuse. Ozonation, like UV disinfection, is sometimes a preferred disinfection technology over chlorination because it leaves no chlorinated residuals in the stream. However, this also means that care must be taken to avoid microbial regrowth in the treated water during storage and distribution. This can be dealt with by regular booster ozonation during distribution or regularly recirculating the stored treated water through the ozonation system. Sometimes, chlorine is added to the treated water stream after ozonation as an additional precaution.

References and further information available at www.eawag.ch/en/wh/toolbox

SELECTED CASE STUDIES

OCEANHAMNEN
Helsinborg, Sweden | 2021



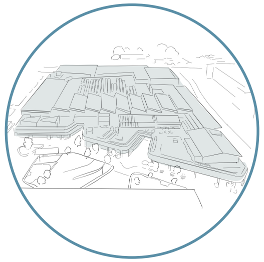


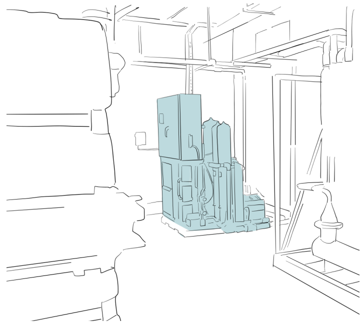
Ozonation for micropollutant removal

Greywater collected from the Oceanhamnen district (2100 p.e.) is treated with an activated sludge system coupled to nanofiltration. The reject stream from the nanofiltration is treated by ozonation, to break down persistent micropollutants, before being recycled back into the activated sludge system. In the future, it is expected that the liquid effluent from the blackwater and organic waste treatment will also be treated in this system. The recovered water will be used as bathing water in a neighboring swimming pool (under construction).

GW — COLLECTION TANK — T.46 ACTIVATED SLUDGE — T.42 DRUM FILTER — T.48 NANOFILTER — T.61 HEAT PUMP — T.41 STORAGE TANK
T.51 OZONATION
heat

BURWOOD BRICKWORKS
Melbourne, Australia | 2019



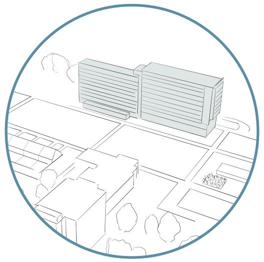


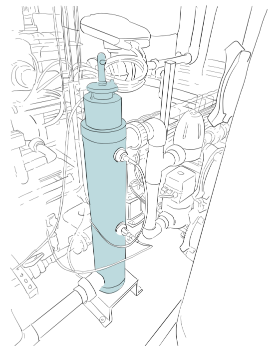
Ozonation and biological filtration for micropollutant removal

Burwood Brickworks is a large retail center certified as a Living Building that prioritizes good on-site water management. An MBR is the core of the water reuse treatment train, designed to treat 60 m³/day mixed wastewater and 30 m³/d stormwater, to be reused via the recycled water pipe network for toilet flushing, cooling towers, and irrigation. The effluent from the MBR is treated in an ozone system to break down persistent organic compounds followed by UV and BAC (biologically activated carbon). Collected rainwater, bypasses the MBR treatment and joins the input stream before ozonation.

MW — SW — T.42 SCREEN — T.41 BUFFER TANK — T.47 MBR — RW — T.51 OZONATION — T.50 UV DISINFECTION — T.49 ACTIVATED CARBON FILTER — T.41 STORAGE TANK

SUPERLOCAL
Kerkrade, the Netherlands | 2021





Advanced oxidation for potable reuse from rainwater

SuperLOCAL, or Super Circular Estate project, is a suburban, residential, new build and retrofit development of 129 apartments (250 p.e.) based on circular material and waste design principles. Next to on-site vacuum sanitation and greywater treatment, rainwater collected from roof surfaces and paved areas, is treated for potable reuse. The treatment system with a capacity of 2.5 m³/h is placed in a dedicated building over a rainwater storage cistern (250 m³). After coarse filtration and nanofiltration, the water is treated by advanced oxidation (UV combined with ozone).

RW — T.41 CISTERN — T.49 COARSE FILTER — T.48 NANOFILTER — T.51 ADVANCED OXIDATION — CALCITE FILTER