AquaNES

Demonstrating Synergies in Combined Natural and Engineered Processes for Water Treatment Systems

Ozonation combined with natural filtration processes: Water quality gains

1. Introduction

Background

- Advanced wastewater treatment due to high surface water quality demands downstream WWTP
  - Indirect potable reuse → organic micropollutants
  - Bathing water → microbial contamination
- Demonstration site will be upgraded with full-scale ozonation in 2021/2022

Demonstration aims

- Implementation of closed-loop control of ozone dose based on online UVA_{254} reduction
- Organic (micro)pollutant removal by combined oxidation and biodegradation
- Enhanced pathogen removal by combined disinfection mechanisms (chemical by ozone / physical by filtration)

2. Pilot plant

Operational parameters

- Applied ozone dose: 0.7 mg O_3/mg DOC
- Vertical flow CW → filtration rate: 200 / 400 / 1000 mm/d
- Deep-bed filters → filtrations rate: 10 / 5 m/h

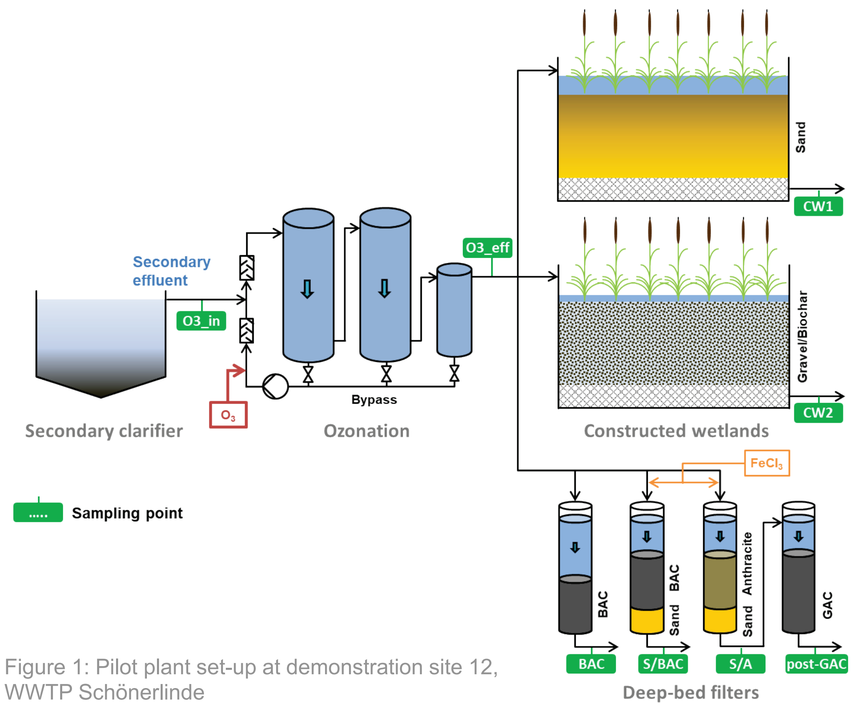

Figure 1: Pilot plant set-up at demonstration site 12, WWTP Schönerlinde

3. Results

Organic (micro)pollutants

- Oxidation of organic matter with ozone hardly reduces DOC → no mineralization (Figure 2)
- DOC removal in post-treatment ~15 % in deep-bed filters and ~20 % in CW (Figure 2)
- Decreased DOC removal in CW without ozone pre-treatment → synergy of process combination for reduction of organics (Figure 3)

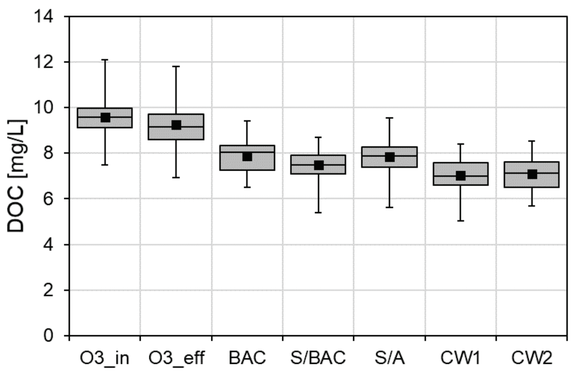

Figure 2: Box plots of DOC concentrations at different sampling points (n=22-34)

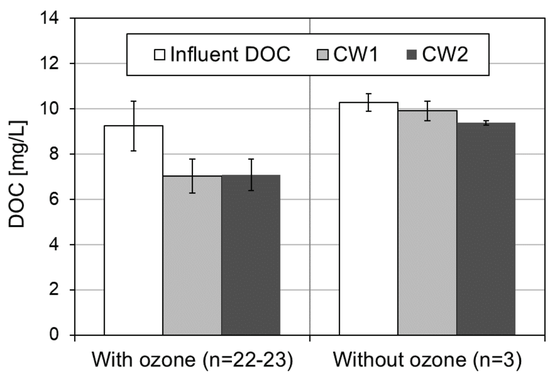

Figure 3: Mean concentrations with standard deviations of DOC in the influent and effluent of CW with and without ozone pre-treatment

- Approx. 2/3 overall removal of monitored organic micropollutants during ozonation (highly compound specific) (Figure 4)
- No relevant additional removal of micropollutants in CW and sand/anthracite filter (Figure 4)
- BAC filters reduce overall OMP concentration by ~50 % → sorption and/or biotransformation? (Figure 4)

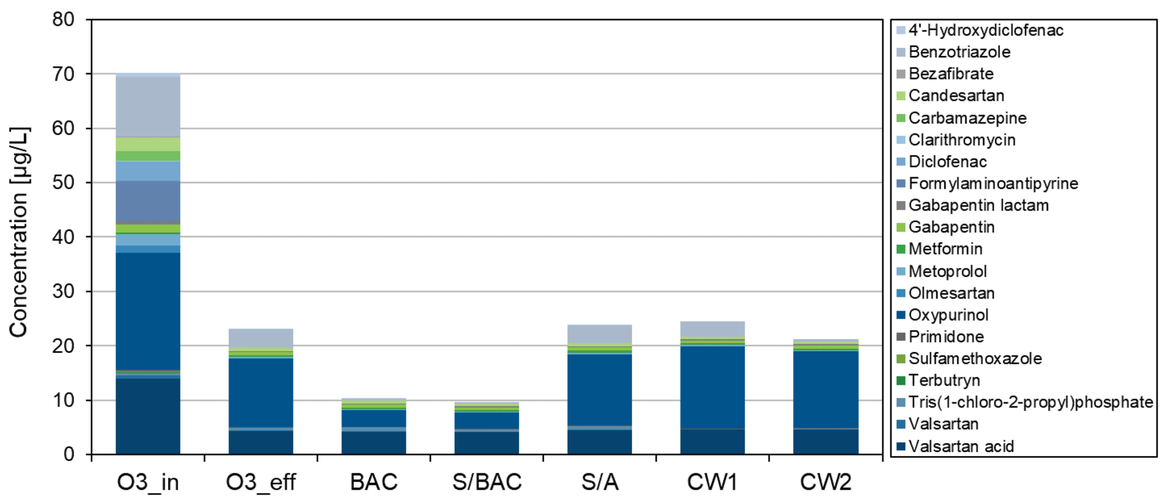

Figure 4: Stacked median concentrations of organic micropollutants at different sampling points (n=12-30). Data from the first months (specific throughput BAC filters < 20000 BV) were excluded. If c < LOQ, c = 0.

Disinfection

- Compliance with excellent quality according to EU Bathing Water Directive (Figure 5 (a) and (b))
- Low efficiency of chemical disinfection with ozone for spore-forming *C. perfringens* and somatic coliphages is compensated by physical barrier in post-treatment (Figure 5 (c) and (d))

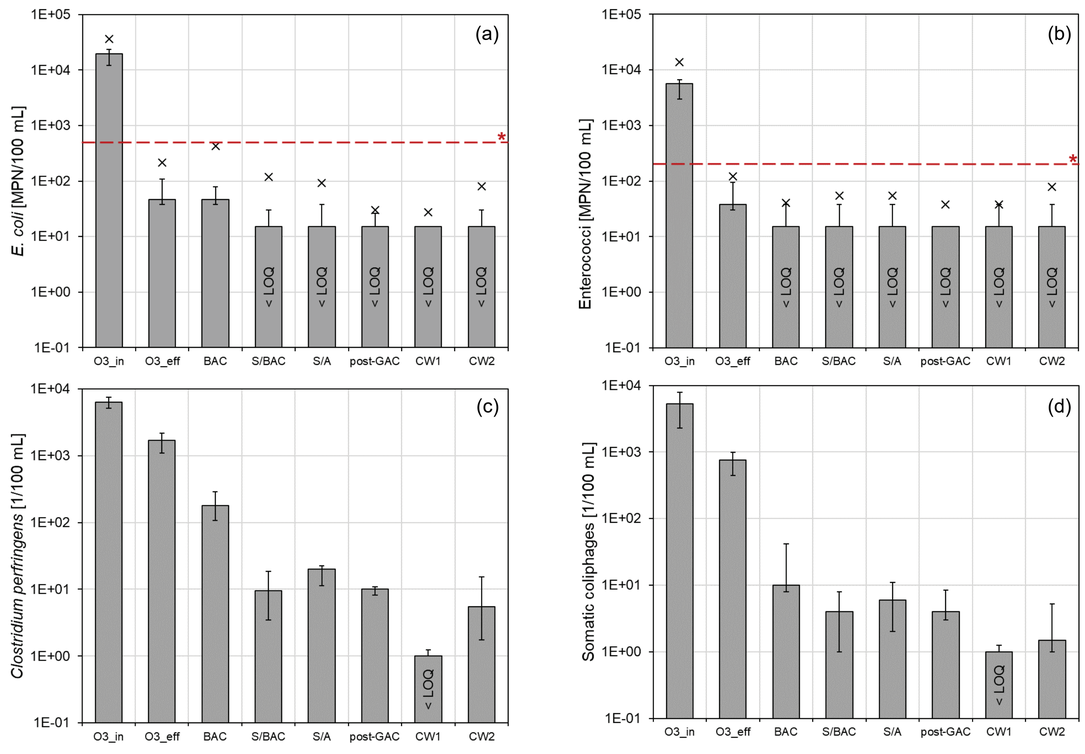

Figure 5: Median concentrations of (a) E. coli, (b) Enterococci, (c) Clostridium perfringens and (d) Somatic coliphages. Error bars: 25th / 75th percentile, crosses: 95th percentile, * red line: criteria for excellent quality according to EU Bathing Water Directive.

Oxidation by-products

- Formation of aldehydes and ketones by ozone oxidation of bulk organic matter
- Efficient reduction of by-products in all post-treatment steps (best in CW)

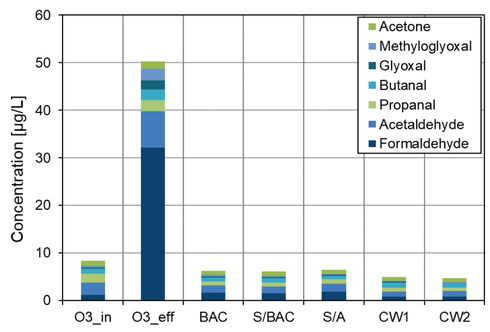

Figure 6: Stacked mean concentrations of aldehydes and acetone at different sampling points (n=2-3). Analysis by Faculty of Chemistry, Adam Mickiewicz University, Poznan.

Contact Daniel Sauter | Berliner Wasserbetriebe
daniel.sauter@bwb.de

www.aquanes.eu

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 689450