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# ABSTRACT BOOK

# ORAL PRESENTATIONS

*The abstracts on the following pages are listed by session number. The presenter's name has been underlined.*

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# Pilot-scale studies of advanced wastewater treatment for direct potable water reuse for beer production

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Session 6A: Potable water reuse (indirect and direct), Auditorium 1, March 18, 2025, 15:00 - 16:00

The Lisbon Water Smart Living Lab was established in the scope of the B-WaterSmart project (2020-2024) with a strong focus on water reuse (on the short-term, for unrestricted irrigation and other urban non-potable uses in Lisbon) and will continue beyond 2024 as a water-oriented living lab (WOLL) of the Water4All “Atlas of EU WOLLs”. To build the society’s trust and acceptance of water reuse and anticipating solutions for mitigating future scenarios of more severe water scarcity, the Lisbon WOLL innovation actions included a pilot demonstration of water reclamation for artisanal beer production to provide scientific evidence on the safety of direct potable reuse in industry.
The demonstration took place at the Portuguese Beirolas Water Resource Recovery Facility (WRRF), one of the biggest in Portugal, designed for 213,510 population equivalent, comprising anaerobic/anoxic/oxic activated sludge treatment and sand filtration, and receiving urban and industrial wastewater (predominantly domestic) from a combined sewer system draining ca. 2,970 ha in Loures and Lisbon municipalities.
Four advanced treatment technologies were pilot tested – ultrafiltration (UF), ozonation (O3), biologically active granular activated carbon (BAC) filtration, and reverse osmosis (RO):
- Ozonation: 1-2 mgO3/mgTOC, 45 min contact time;
- BAC filtration: ca. 5 min EBCT (empty bed contact time), operated for 31 kBV (bed volumes);
- Reverse osmosis (3-stage RO (2:1:1)): 8-12 bar net driving pressure, 15-25 L/(m2.h) permeate flux, 60% and 70% water recovery rate, concentrate recirculation and 3 mg/L antiscalant dosing.

The pilot was set in a containerized unit with external cork coating and photovoltaic energy production.
Aiming at comparing different RO-based reclamation schemes towards water quality and operational performance, four different treatment schemes were continuously piloted (24/7): (1) UF+RO, (2) UF+O3+RO, (3) UF+O3+BAC+RO, (4) O3+BAC+RO.
The system integrity monitoring included online UF and RO flowrate, pressure, and turbidity, and RO pH, and electrical conductivity. The water quality was analysed regularly (once a week) for E. coli, organic matter parameters (TOC/DOC, A254, A436, SUVA), NH4, NO3, KN, TN, P, hardness, and alkalinity. Once per treatment scheme, it was analysed for trace compounds [54 pharmaceutical compounds (PhCs); 2 hormones; oxidation by-products, N-nitrosodimethylamine (NDMA), bromate, chlorate, 4 trihalomethanes (THMs), 9 haloacetic acids (HAAs); 20 per- and polyfluoroalkyl substances (PFAS); 10 alkylphenol; toxicity (Daphnia magna, Vibrio fischeri); the EU Drinking Water Directive 2020 parameters; pathogen indicators of enteric bacteria (Clostridium perfringens), enteric viruses (somatic coliphages/F-specific RNA bacteriophages), and protozoa (Clostridium perfringens spores).
All treatment schemes produced water with an adequate quality to be reused in the beverage industry, complying with the EU and the Portuguese drinking water quality standards – no pathogen indicators; PFAS, disinfection by-products, NDMA, and pharmaceutical compounds below the quantification limits (PFAS <0.3 ng/L, total THMs <2 µg/L, HAAs <2 µg/L, bromate <3 ng/L, NDMA <3 ng/L, PhCs <100 ng/L). The operational monitoring results showed higher normalized permeate flowrates for the treatment scheme comprising only UF and RO.

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