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Technical manual on water reuse: Study of technological solutions for water reuse production

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Highlights:

- A comparative study of water reuse technologies was performed at a WWTP.
- Microbial quality and nitrogen content were the quality decisive factors for reclaimed water applications.
- Membrane technologies, particularly ultrafiltration, yielded high-quality water for urban uses.

Keywords: Water Reuse; ultrafiltration; reverse osmosis.

INTRODUCTION

Considering the current trend of water scarcity, it is urgent to promote a more rational use of this resource and explore alternative water sources for non-potable purposes. The reuse of treated water from wastewater treatment plants (WWTPs) emerges as an alternative water source, representing a more sustainable use of this resource by reducing the need for extraction and promoting greater water circularity (DL 119/2019).

To promote the wastewater reuse, it is necessary for wastewater treatment plants (WWTP) to be equipped with treatment levels that allow for the production of reclaimed water (RW) compatible with the quality levels required for different purposes. Operational flexibility is also required to accommodate different usage needs while ensuring the constant quality of RW - only possible if robust and reliable treatment technologies are available. There is a wide range of technological solutions available in the market for RW production tailored to different requirements, which can meet the most demanding quality criteria.

The present technological study was integrated in a comprehensive Water Reuse Manual, produced to under ApR-TEC project that researched technological solutions for maintaining the microbiological quality of water for reuse. This study investigated and compared the application of different tertiary treatment technologies for RW production, evaluating the quality of the obtained water and its potential

uses in urban contexts. A cost evaluation of RW production based on the tested technologies was also conducted.

METHODOLOGY

The study was conducted on-site at a Portuguese urban WWTP, with pilot and industrial-scale treatment units, all tested under real conditions with the same secondary effluent. Tertiary technologies with different mechanisms of action were selected for this study, including filtration processes (sand filters - SF), membrane separation (ultrafiltration - UF, nanofiltration - NF, and reverse osmosis RO), disinfection (UV and NaOCl), and advanced oxidation (ozone - OZ and non-thermal plasma - NTP), which were applied individually or in a series of treatment schemes. The different treatment schemes explored in this study are presented in Figure 1.

Grab samples were collected from WWTP secondary effluent at the inlet of the tested technology and from its respective outlet. Physicochemical analysis of the inlet and treated effluent samples were performed by a certified laboratory using the Standard Methods' methodologies. The quality of the RW was evaluated through the Portuguese water reuse regulations for non-potable applications (DL 119/2019).

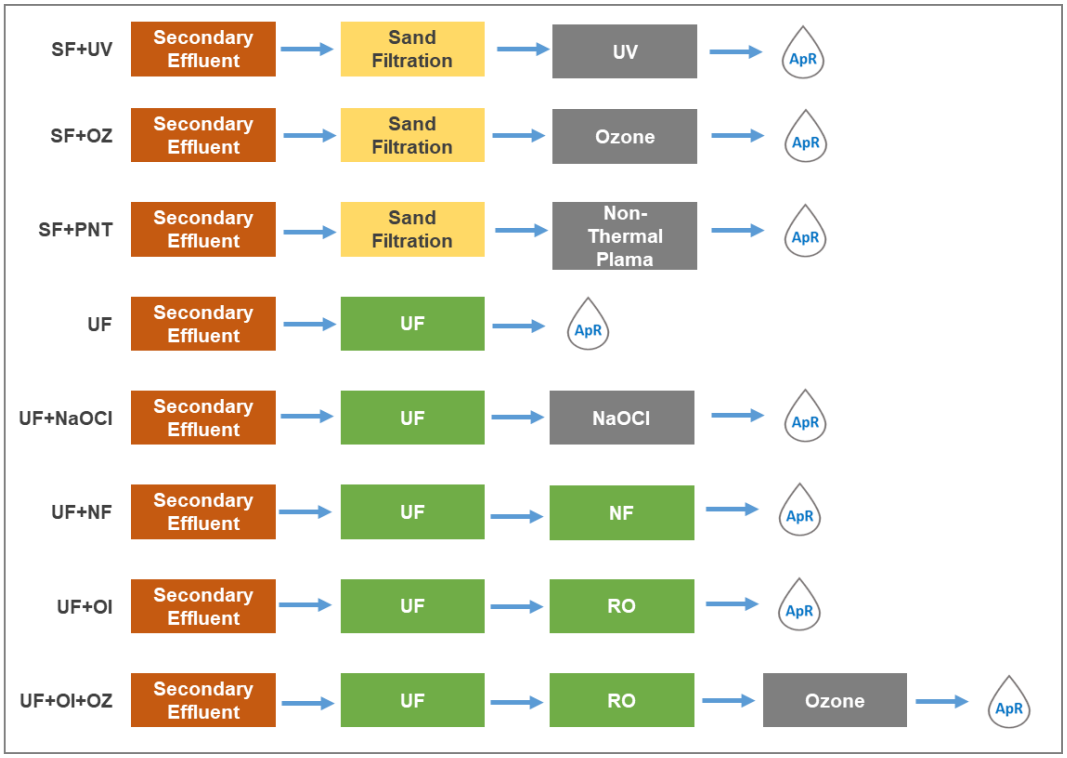

Figure 1 – Treatment schemes tested and compared for water reuse production.

RESULTS AND CONCLUSIONS

An extensive technological study was performed to produce RW from the secondary effluent of a WWTP. The application of different tertiary technologies, at pilot and industrial scale, allowed the production of RW with differentiated quality, suitable for various intended uses.

Microbial quality and nitrogen content of the various RW produced were decisive factors for WR classification and definition of possible uses. Membrane technologies, including ultrafiltration and its combinations, produced WR with the best quality for irrigation and other urban context uses. UV disinfection, applied at an industrial scale, was not effective in reducing the microbial load of the effluent.

The operational cost analysis developed in this study allowed for the identification and comparison of different treatment costs in the tested treatment schemes. In this comparison of treatment schemes, ultrafiltration stands out as a solution with a balanced cost-benefit ratio, producing high-quality RW at reduced operational costs compared to other alternatives to achieve equivalent quality.

The selection of the treatment configuration for RW production should be based on the quality required for the intended use, in a fit-for-purpose approach, also considering the associated operational costs.

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