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Enhanced conventional treatment and advanced processes using powdered activated carbon for controlling pharmaceutical compounds in reclaimed water

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Abstract

There is a significant potential for an increased use of reclaimed wastewater in Europe and a major challenge is to protect the environment and human health without blocking the development of water reuse programs. No legal requirements have been set for pharmaceutical compounds (PhCs) discharge into surface water bodies; however, changes in legislation may arise as a result of their monitoring in the water bodies (e.g. through the watch list of the environmental quality standards directive) and sound cause-effect (e.g. risk cancer increase or reproductive abnormalities) studies. The largest input source of PhCs into the aquatic environment is through wastewater treatment plants (WWTPs) and, since many of such compounds are resistant to conventional treatment, it is important to anticipate solutions for improving the performance of those infrastructures as crucial barriers for controlling PhCs, and ultimately for the preservation of drinking water sources and the development of safe water reuse projects.

The development of technology safety credits towards PhCs control is essential for assisting risk assessment studies, key tools for effective safe water reuse programs. In this perspective, our team has been developing two approaches for controlling PhCs in reclaimed water, on one hand the enhancement of conventional treatment and, on the other hand, the use of advanced wastewater treatment, presenting in this communication one case study for each. Case study I (LIFE Impetus project) focuses the chemical enhancement of conventional activated sludge (CAS) treatment through the addition of commercial and local vegetal waste-based tailored powdered activated carbons (PACs). Case study II (LIFE aWARE project) focuses a PAC/loose nanofiltration (PAC/NF) process for advanced treatment of a membrane bioreactor (MBR) effluent from a Spanish WWTP plant.

In case study I, lab adsorption studies and modeling allowed calibrating predictive models of the PAC adsorption capacity and rate. Results anticipate that the addition of 6 mg/L PAC to a well-mixed bioreactor with 12 h of contact time is able to remove 80% of target PhCs. A long-term pilot-scale demonstration with PAC addition to activated sludge systems is on-going in two Portuguese WWTPs.

In case study II, two PAC/NF lab configurations were selected and tested at lab scale: i) one with a single PAC dose at the beginning of the filtration cycle (pulse dosing) and ii) another with continuous PAC dosing. No pressure increase was observed during the filtration cycles and high removals of the target PhCs were observed, with 58-89% for the continuous dosing of 50 mg/L PAC. The results were successfully used in the design and operation of the PAC/NF pilot for the technology demonstration in El Prat WWTP (Spain).