European Commission

Science for Environment Policy

New treatment system able to remove at least 95% of pharmaceuticals from waste water

The release of pharmaceutically active compounds (PhACs) in waste water from treatment plants (WWTPs) is currently not regulated anywhere in the world, with the exception of a few plants in Switzerland. Yet thousands of PhACs or their by-products — excreted by humans — can be found in waste water and some of these may harm biodiversity when released into waterways. For example diclofenac and oxazepam may have negative effects on aquatic species.

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Source: Kårelid, V., Larsson, G. and Björlenius, B. (2017). Effects of recirculation in a three-tank pilot-scale system for pharmaceutical removal with powdered activated carbon. *Journal of Environmental Management*, 193: 163-171. DOI: 10.1016/j.jenvman.2017.01.078

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The unregulated release of some pharmaceuticals poses a risk to the environment, especially to aquatic species. In addition, the release of antibiotics into the environment in waste water may be contributing to the development of antibiotic resistance in potentially pathogenic bacteria. In the context of the EU Water Framework Directive (WFD)[1] a number of PhACs are listed in the first surface-water watch list established in 2015[2] under the Environmental Quality Standards Directive (EQSD)[3]. Diclofenac was included to facilitate the establishment of appropriate measures to address the risk it poses, and three antibiotics also included to assess the risk they pose[4], but there are currently no EU-level environmental quality standards.

A design solution is lacking for cost-effectively removing all PhACs in large-scale WWTPs without generating unwanted breakdown products. This study presents a pilot design that seeks to deliver an alternative to less effective technologies, in particular by optimising the use of activated carbon. The Swedish study was undertaken at two WWTPs in the Stockholm region in 2015. The scientists chose 21 of the more common PhACs in waste water for further analysis, including carbamazepine, clarithromycin and diclofenac, which were used as study indicators.

The design consisted of a mixing tank for mixing waste water with powdered activated carbon (PAC) at a dose of 10–15 milligrams per litre (mg/L), followed by three sequential but optional contact tanks (for increasing the exploitation of the PAC's adsorption capacity), a sedimentation tank (from which the PAC could be recirculated to the contact tanks), and a sand filter. The researchers tested three contact times of 30, 60 and 120 minutes. The aim was to reduce the concentrations of all 21 PhACs by 95% — beyond the 80% level currently required by Swiss regulators. The PAC product, dose and contact time were investigated in a laboratory before the full-scale pilot tests were conducted.

The results showed that recirculation of PAC significantly improved the removal of PhACs — in particular when recirculation was applied to the first or second tank. The lowest contact time of 30 minutes was already sufficient to remove 95% of the PhACs, but the removal was more effective with a contact time of 60 min. A contact time of 120 minutes, or a higher dose of PAC, was required for a few substances. A higher first dose of PAC, at 68 mg/L, resulted in a 99% overall reduction in PhACs, including for some drugs – such as fluconazole – that didn't meet the target of 95% reduction at the lower dose except at longer contact times. Of the indicator PhACs, diclofenac and clarithromycin were removed to at least 95% in all set-ups in the pilot system, whereas carbamazepine required recirculation or a longer contact time without recirculation to achieve the same goal. Clarithromycin was removed to a greater extent than the average of all the PhACs, whilst carbamazepine and diclofenac were removed less than the average (i.e. the extent or percentage removed in relation to all substances included in the study).

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1.See: http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1519640965167&uri=CELEX:32000L0060

2. EC Decision (EU) 2015/495: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32015D0495

3.See: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0105

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The recirculation design was a success for overall high-level removal of PhACs from the WWTP waste water. The piloted set-up can be installed before or after an existing tertiary treatment stage at WWTPs, with recirculation in the first or second tank, and the use of a sand filter to ensure complete retention of the PAC before effluent water is released. A single high dose of PAC can be used during peak loads of PhACs to rapidly reduce such loads, while increased contact time can be used during low-load periods. Some substances require longer contact times for removal. The piloted recirculation system could remove some of the pollutants monitored under the WFD, and could be a solution for European WWTPs should future waste-water regulation[5] include PhACs.

4. If the treated waste water discharges negatively affect the quality of a water body, and the corresponding river basin management plan (under the WFD) state that a more stringent treatment is necessary than that required by the UWWTD (e.g., addressed to totally or partially remove these substances), the corresponding measures at treatment plant level would have to be taken by the responsible authorities.

5. Recently, the EC has launched the Evaluation of the Urban Waste Water Treatment Directive, 91/271/EEC). This is aimed to assess how far the Directive has worked in the past and whether there is a need for its revision. Any revision of the Directive will depend on the results of the ongoing Evaluation. As part of this, the EC will gather feedback from citizens and other stakeholders. Removal of pharmaceuticals might be one of the issues that would need to be addressed in the future.