



Removal of micropollutants and nutrients in household wastewater using organic and inorganic sorbents

W. Zhang^{a,*}, K. Blum^b, M. Gros^c, L. Ahrens^c, H. Jernstedt^c, K. Wiberg^c, P.L. Andersson^b, B. Björleinius^d, G. Renman^a

^aDepartment of Sustainable Development, Environmental Science and Engineering, KTH Royal Institute of Technology, Teknikringen 10B, SE-10044 Stockholm, Sweden, email: zhangw@kth.se (W. Zhang), gunno@kth.se (G. Renman)

^bDepartment of Chemistry, Umeå University, Linnaeus väg 6, SE-90187 Umeå, Sweden, email: kristinblum89@gmail.com (K. Blum), patrik.andersson@umu.se (P.L. Andersson)

^cDepartment of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, Box 7050, SE-75007 Uppsala, Sweden, email: mgros@icra.cat (M. Gros), lutz.ahrens@slu.se (L. Ahrens), henrik.jernstedt@slu.se (H. Jernstedt), karin.wiberg@slu.se (K. Wiberg)

^dDepartment of Biotechnology, KTH Royal Institute of Technology, AlbaNova University Centre, SE-10691 Stockholm, Sweden, email: berndtb@kth.se (B. Björleinius)

Received 28 April 2018; Accepted 22 July 2018

ABSTRACT

The efficiency of five organic and five inorganic sorbents in removing 19 organic micropollutants (MPs), phosphorus, nitrogen, and dissolved organic carbon (DOC) was tested in a two-week column experiment using household wastewater spiked with pharmaceuticals ($n = 6$), biocides/pesticides ($n = 4$), organophosphates ($n = 3$), a fragrance, a UV-stabilizer, a food additive, a rubber additive, a plasticizer and a surfactant. Two types of granular activated carbon (GAC), two types of lignite, a pine bark product, and five mineral-based sorbents were tested. All the organic sorbents except pine bark achieved better removal efficiencies of DOC (on average, $70 \pm 27\%$) and MPs ($93 \pm 11\%$) than the inorganic materials (DOC: $44 \pm 7\%$ and MPs: $66 \pm 38\%$). However, the organic sorbents (i.e. GAC and xyloid lignite) removed less phosphorus ($46 \pm 18\%$), while sorbents with a high calcium or iron content (i.e. Polonite[®] and lignite) generally removed phosphorus more efficiently ($93 \pm 3\%$). Ammonium-nitrogen was well removed by sorbents with a pH between 7 and 9, with an average removal of 87%, whereas lignite (pH 4) showed the lowest removal efficiency (50%). Some MPs were well removed by all sorbents ($\geq 97\%$) including biocides (hexachlorobenzene, triclosan and terbutryn), organophosphates (tributylphosphate, tris-(1,3-dichloro-2-propyl)phosphate and triphenylphosphate) and one fragrance (galaxolide). The pesticide 2,6-dichlorobenzamide and the pharmaceutical diclofenac were poorly removed by the pine bark and inorganic sorbents (on average, 4%), while organic sorbents achieved high removal of these chemicals (87%).

Keywords: Micropollutants (MPs); Synthetic substances; Sorbents; On-site sewage facilities (OSSFs)

*Corresponding author.