Performance comparison of different types of constructed wetlands for the removal of pharmaceuticals and their transformation products

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Abstract

This work presents a comprehensive and critical comparison of four types of constructed wetlands (CWs): free water surface CW (FWSCW), vertical flow CW (VFCW), horizontal flow CW (HFCW) and hybrid CW (HCW) for the removal of 29 pharmaceuticals (PhCs) and 19 transformation products (TPs) using a global data compiled for 247 CWs reported in 63 peer reviewed journal papers. Biodegradation (aerobic being more efficient than anaerobic) is the major removal mechanism for 16 out of 29 PhCs besides the influence of other processes (e.g., adsorption/sorption, plant uptake and photodegradation). The HCW performed better followed by VFCW, HFCW and FWSCW. The comparatively better removal in HCW might be due to the co-existence of aerobic and anaerobic conditions and longer hydraulic retention time considering more than one compartment enhances the removal of PhCs (e.g., diclofenac, acetaminophen, sulfamethoxazole, sulfapyridine, trimethoprim and atenolol), which are removed under both conditions and adsorption/sorption processes. The augmentation in dissolved oxygen by the application of artificial aeration improved the removal of PhCs, which are degraded under aerobic conditions. Furthermore, the high performance of aerated CWs could be due to the establishment of various micro-environments with different physicochemical conditions (aerobic and anaerobic),

which facilitated the contribution of both aerobic and anaerobic metabolic pathways in the removal of PhCs. The removal of some of the PhCs takes place by the formation of their transformation products (TPs) and the nature of these TPs (persistent or non-biodegradable/biodegradable) plays a major role in their removal.

Keywords: Artificial aeration; Constructed wetlands; **Geo and cosmochemistry; Microbiology;** Pharmaceuticals; Removal efficiency; Removal mechanisms; Transformation products; Wastewater.