Microbial Removal of Pesticides in Rapid Sand Filters for Treatment of Drinking Water

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In Denmark approximately 100% of the population is supplied by groundwater. However, the water supply is threatened by pesticides, since these were detected in 24% of the Danish groundwater in 2012 (GEUS, 2013). The Danish water treatment is simple and consists of aeration of anaerobic groundwater, followed by filtration in primary and secondary rapid sand filters. Since none of these treatment steps are known to remove pesticides from the water, the general strategy is to close pesticide contaminated wells, or dilute contaminated water, which is expensive and unsustainable. Pesticides can be removed from water by advanced technologies such as activated carbon filtration (Heijman et al., 2002). However, the environmental sustainability and cost-effectiveness of these processes remain uncertain. Recent investigations have shown that the herbicide MCPP was removed in the secondary rapid sand filters at Kerteminde waterworks (Hedegaard et al., 2014). If pesticides can be removed in the filter sand, it is of large commercial interest due to the environmental and economic sustainability of this treatment method. This study aimed at investigating the microbial pesticide removal kinetics, potential and processes in rapid sand filters for drinking water treatment. Microcosms were set-up with filter sand and water from Sjælsø Waterworks Plant II, Denmark, and ^{14}C-bentazone (0.1–2.4 µg/L). At all the tested concentrations it took less than 30 minutes to remove bentazone to 50% of the initial concentration by a microbial process (Hedegaard and Albrechtsen, 2014). This removal rate was relevant for the system since the contact time of water in the full-scale filter was 56 minutes. Increased oxygen availability enhanced the removal of bentazone. It was investigated whether the bentazone removal was a cometabolic process of methane or ammonia oxidizing bacteria. In this case removal could possibly be regulated by controlling methane and ammonium concentrations in the filters. Varying concentrations of methane and ammonium was added to the microcosms. When methane was applied in concentrations of 7.4 mg/L, 75% of the bentazone was left in the water phase after two hours, while only 49% was left when methane was not added. The same tendency appeared for ammonium. Hence, addition of methane and ammonium decreased the removal of bentazone. This study showed very promising perspectives for removing pesticides from contaminated groundwater by using rapid sand filters. Utilising rapid sand filters to treat contaminated groundwater is a very economic and environmentally sustainable technical solution to secure a safe drinking water supply.

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