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Published in:
18th DWF Water Research Conference

Publication date:
2024

Document Version
Publisher's PDF, also known as Version of record

Treatment of water from two generational pollution sites utilizing the treatment train concept

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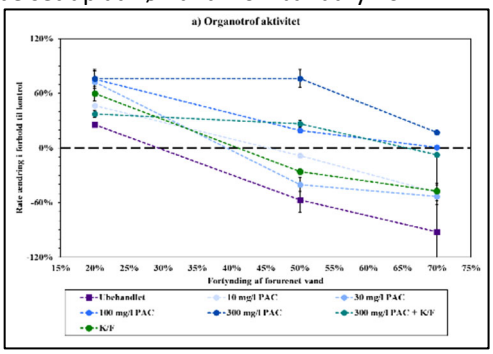
This project is partly funded by the Environmental Technology Development and Demonstration Program (MUDP).

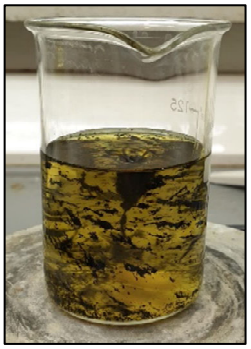
Introduction: In Denmark, numerous sites and sources of water pollution have been identified. Among the most conspicuous are 10 old industry sites identified as 'generational pollutions'. The complex and extensive pollution at these sites will remain a problem for generations as the pollutions are complex or extraordinarily persistent and recalcitrant. However, this is no easy task, as these specific pollutions are also characterized by a substantial monetary cost to examine and remediate (min. estimates amounts to 6.7 Mio. €). This study aimed to evaluate treatment options for polluted groundwater from two industrial sites located in Denmark. Site 1 was used for pesticide production since the 1950s and Rønland is the adjacent active modern plant, resulting in soil pollution that require the groundwater to be pumped up to prevent spreading the pollution to the environment. The main pollutants are the reactant for parathion production, 4-nitrophenol, and the solvent isopropanol. Specifically, for Rønland, the polluted groundwater also constitutes almost 50% of the WWTP load which can potentially impact production of new more modern pesticides.

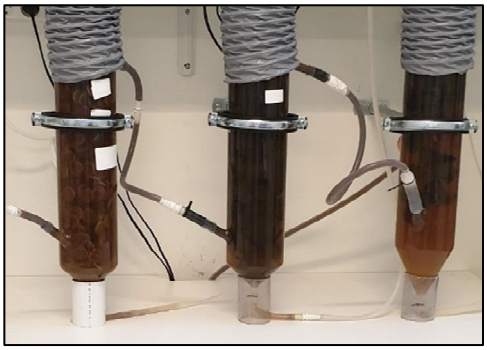
Methods and data: Polluted water from two sites, Site 1 and Rønland, were collected, and the extent of microbial inhibition was determined with oxygen uptake rate experiments. These were supplemented by measurements of chemical oxygen demand, ammonium, nitrite, and nitrate, to quantify the microbial nitrification- and organotrophic-activity. Experiments were completed to examine the effect of activated carbon and coagulation/flocculation as a pre-treatment step prior to biological treatment. The potential for microbial treatment was examined in moving bed biofilm reactors (MBBRs), where the microbes were subjected to both untreated water from the two sites and water pre-treated by activated carbon and coagulation/flocculation.

Results: Chemical- and oxygen uptake measurements revealed differing degrees of microbial inhibition in the water from the two sites. No inhibition was detected in water from Site 1, while complete inhibition was measured in water from Rønland at 70% concentration. Pre-treatment experiments revealed a huge potential to treat the water from Rønland with activated carbon, as it significantly lowered inhibition caused by the water, thereby enabling biological treatment as subsequent treatment.
Measurements of chemical oxygen demand in the MBBRs revealed active and stable reduction of organic material (potentially pollutants), while both ammonium reduction and accumulation of nitrite and nitrate revealed active and stable nitrification.

Discussion and take-home message: Microbial treatment of wastewater is often cheaper than other physical or chemical solutions, but as it has been shown in this project, microbial communities are susceptible to inhibition. However, combinations of pretreatments can enable efficient microbial degradation of problematic wastewater as documented in the present project. The next step is pilotscale experiments to test the treatment combinations, which will be set up at Rønland from January 2024.







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