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Enhanced removal of trace organic chemicals from wastewater treatment plant effluents using advanced oxidation processes (AOP)

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☒ **ongoing** ☐ **finished:**

Introduction

In recent years, trace organic chemicals (TOrC) have been detected in the aquatic environment. Besides urban and agricultural run-offs, wastewater treatment plant effluents are the most significant TOrC emitters. For the removal of these compounds advanced oxidation processes (AOPs) including UV/H_2O_2, UV/O_3, photo catalysis and electrochemical AOP (eAOP) are viable treatment options with various degrees of efficiency depending upon water matrix and process configuration. Comparison of different AOPs is usually made by the electrical energy per order of magnitude (E_{EO}) concept. However, consideration of water matrix, reactor design, specific reaction rates or compound specificity is not included in this concept (Bolton et al., 1996) limiting the comparability of AOPs tested with different indicator substances and process capacities.

Research objectives

For ozonation, Hübner et al. (2014) demonstrated a linear correlation between radical exposure and ozone consumption. Rosenfeldt et al. (2006) have shown similar results for the correlation between UV-fluence and radical exposure with varying H_2O_2-doses. While the radical exposure ($\int(^{\circ}OH)dt$) is established for quantification of radical formation, it is not yet used to compare different AOPs.

$$\int(^{\circ}OH)dt = \frac{\ln[S/S_0]}{-k_{^{\circ}OH,S}}$$

Major objective is the development of a new concept to compare different AOPs based on OH-radical exposure.

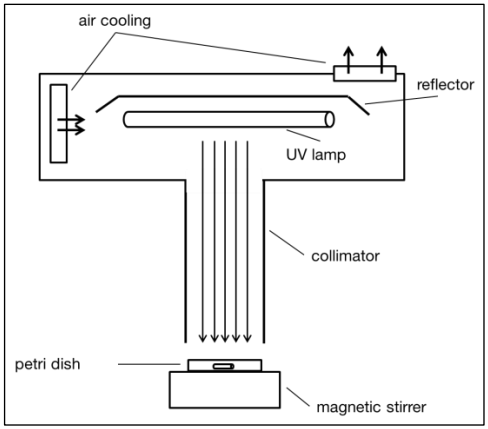

Fig. 1: Schematic figure of the collimated beam device used for UV/H_2O_2 experiments

For this concept, OH-radical exposures are determined as a function of relevant operational parameters, e.g. UV-fluence and H_2O_2-dose for UV/H_2O_2.

Optimized conditions for removal of target substances can be derived from resulting correlations based on the second order rate constant k_{OH}. Energy efficiencies of different AOPs are compared from resulting energy requirements for standardized applications. In this work, the OH-radical exposure concept is used to compare removal efficiency of TOrCs from municipal wastewater using UV/H_2O_2, O_3 and boron-doped diamond electrodes as an eAOP.

References

Bolton et al., (1996):
Bolton, J. R., Bircher, K. G., Tumas, W., & Tolman, C. A. (1996). Figures-of merit for the technical development and application of advanced oxidation processes. Journal of Advanced Oxidation Technologies, 1, 13-17.

Hübner et al. (2014):
Hübner, U., Zucker, I., & Jekel, M. (2015). Options and limitations of hydrogen peroxide addition to enhance radical formation during ozonation of secondary effluents. Journal of Water Reuse and Desalination, 5(1), 8-16.

Rosenfeldt et al. (2006):
Rosenfeldt, E. J., Linden, K. G., Canonica, S., & Von Gunten, U. (2006). Comparison of the efficiency of OH radical formation during ozonation and the advanced oxidation processes O3/H2O2 and UV/H2O2. Water Research, 40(20), 3695-3704.