1. Study Project

Starting: Mid-June 2025

Topic

Preliminary experimentation to determine variable influences on a manganese (II) oxide-based catalytic filtration as an Advanced Oxidation Process technology to remove Trace Organic Chemicals (TOrCs).

Background

With ever-increasing concern over the presence and spread of Trace Organic Chemicals (TOrCS) and anti-microbial resistance genes (ARGs) in the wastewater matrix, investigations into quartenary treatment stage in wastewater treatment plant has become a necessity. The spread of TOrCs and ARGs constitute an impact for agriculture and also pose health hazards for humans and animals alike. Conventional treatment steps such as Ozonation, UV/H_2O_2, and biodegradation steps are researched and employed as a treatment step. Further advanced oxidation processes involve the use of radicals to target TOrCs and remove them, however, there are drawbacks or insufficient selectivity between radicals, and alternative and economic technologies are required to remove these targets. Bein, Yecheskel et al. (2023) developed a sulfate radical oxidation system through a packed column, which presented promising results in selective removal of TOrCs. This was used as a proof of concept for a follow-up project and requires further development, analysis and optimization, before it can be scaled up and benchmarked against existing quaternary-stage treatment systems. (Bein, Seiwert, et al., 2023; Bein, Yecheskel, et al., 2023)

The goal

This study focuses on the further analysis of TOrCs removal with a constructed lab-scale column filtration system by testing different combinations of process variables. Experimental planning is required prior to executing any experiments. The goal is to determine which variables are strongly influencing the removal of TOrCs and ensuring a step towards optimization is then possible. This can also be done through a factorial design experiment.

Tasks

- Assist in the setup and preliminary analysis of the catalytic filtration system to establish a baseline.
- Plan experimental design to test different operational and experimental conditions for catalytic filtration (flowrates, concentrations, column packaging, etc.).
- Use control experiments to determine the performance of the experiments.
- Conduct catalytic filtration experiments (core workload of the lab tasks).
- Investigate removal rates of TOrCs through the catalytic filtration column systems through TOrCs analysis.
- Determine variables with highest influence on TOrC removal rates.
- Measure PMS, Sulfate ions, and Manganese levels in effluent treatment.
- Determine (statistically) the extent of influence for each parameter.

Skillset

- Background in Environmental, Chemistry, or Chemical Engineering.
- Knowledge in statistical analysis
- Programming language skills are an added bonus.
- Experience in laboratory task **(please highlight which course you have completed or are taking, or if you have work experience)**

Timeline and application

The study project can be initiated after the initial introduction and will last for 6 months, as per TUM regulations. As it is 12 ECTS, a total workload of 360 hours is expected.

If you are interested, please contact me with the following documentation by **30th May 2025**:

1. Curriculum Vitae Or Resume,
2. Cover letter detailing your motivation and how you fit into this role (ideas are a plus) and,
3. Grade Report.

Contact

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References

Bein, E., Seiwert, B., Reemtsma, T., Drewes, J. E., & Hübner, U. (2023). Advanced oxidation processes for removal of monocyclic aromatic hydrocarbon from water: Effects of O3/H2O2 and UV/H2O2 treatment on product formation and biological post-treatment. *Journal of Hazardous Materials*, *450*, 131066. https://doi.org/https://doi.org/10.1016/j.jhazmat.2023.131066

Bein, E., Yecheskel, Y., Zucker, I., Drewes, J. E., & Hübner, U. (2023). A novel catalytic filtration process using MnO2@sand and peroxymonosulfate for unselective removal of organic contaminants from water. *Chemical Engineering Journal*, *476*, 146636. https://doi.org/https://doi.org/10.1016/j.cej.2023.146636

2. Bachelor Thesis

Starting: June/July 2025

Topic

Current Advances in Sulfate Radical-Based Oxidation to Remove Trace Organic Chemicals (TOrCs): A Literature Study.

Background

With ever-increasing concern over the presence and spread of Trace Organic Chemicals (TOrCS) and antimicrobial resistance genes (ARGs) in the wastewater matrix, investigations into the quaternary treatment stage in wastewater treatment plants have become a necessity. The spread of TOrCs and ARGs constitutes an impact on agriculture and also poses health hazards for humans and animals alike. Conventional treatment steps, such as Ozonation, UV/H2O2, and biodegradation steps, are researched and employed as a treatment step. Further advanced oxidation processes involve the use of radicals to target TOrCs and remove them; however, there are drawbacks to the insufficient selectivity between radicals, and alternative and economic technologies are required to remove these targets. Bein, Yecheskel et al. (2023) developed a sulfate radical oxidation system through a packed column, which presented promising results in the selective removal of TOrCs. This was used as a proof of concept for a follow-up project and requires further development, analysis, and optimization before it can be scaled up and benchmarked against existing quaternary-stage treatment systems. (Bein, Seiwert, et al., 2023; Bein, Yecheskel, et al., 2023)

The goal

This bachelor's thesis will play a role in the preliminary understanding of the technology used in the NEWR Project at TUM. The goal is to obtain a wide understanding of the progress and insights in existing literature to incorporate into our current experiments. This thesis will not focus not only on the methods and results, but also on the recommendations and kinetic data.

Tasks

- Research into the reaction kinetics of selected TOrC targets.
- Consolidating data on methodology and results.
- Recording viable approaches to analyzing chemical reactions and kinetics (EBR, transformation products, etc.).
- Sorting and classifying information into discernible categories.
- Provide insights and recommendations based on existing publications.

Skillset

- Bachelor student in Environmental/Chemical Engineering or Chemistry.
- Independent working capabilities.
- Capable of conducting in-depth research and compiling literature studies.

Timeline and application

The bachelor's thesis can be initiated once the initial system has been assembled and will last for 6 months, constituting for 300 working hours (including and writing) as per TUM regulations.

If you are interested, please contact me with the following documentation by **30th May 2025**:

4. Curriculum Vitae,
5. Cover letter detailing your motivation and how you fit into this role (ideas are a plus), and,
6. Grade Report.

Contact

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References

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Bein, E., Yecheskel, Y., Zucker, I., Drewes, J. E., & Hübner, U. (2023). A novel catalytic filtration process using MnO2@sand and peroxymonosulfate for unselective removal of organic contaminants from water. *Chemical Engineering Journal*, *476*, 146636. https://doi.org/https://doi.org/10.1016/j.cej.2023.146636