Lehrstuhl für Siedlungswasserwirtschaft
Department of Civil and Environmental Engineering
TUM School of Engineering and Design
Technische Universität München

Opportunities for Talents

1. Study Project

Starting: Mid of August 2024

Topic

Setup and development of a sulfate radical oxidation treatment system using a manganese (II) oxide-based catalyst 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 project focuses on the setup, development and preliminary testing of the catalytic filtration system (CFC) through multi-variable analysis of TOrCs' removal under different operational and experimental conditions. The goal is to obtain an operational experimental setup and removal of TOrCs. Determining the optimal column packaging, operational conditions and performance offer exploratory research opportunities for the technical aspect of the project.

Tasks

- Assist in setup and preliminary analysis of the catalytic filtration system to establish a baseline.
- Synthesize MnO_2 on the support medium through hydrothermal synthesis.
- Plan experimental design to test different operational and experimental conditions for catalytic filtration (flowrates, concentrations, column packaging, etc.).
- Use control experiments to determine performance of the experiments.
- Conduct catalytic filtration experiments (core workload of the lab tasks).
- Establish performance difference between narrower and wider columns.
- Investigate removal rates of TOrCs through the catalytic filtration column systems through TOrCs analysis.

Skillset

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

Timeline and application

The master's thesis can be initiated once the initial system has been assembled and will last for 6 months, constituting for 900 working hours (including data analysis and writing) as per TUM regulations.

If you are interested, please contact me with the following documentation by **2nd August 2024**:

1. Curriculum Vitae,
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

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Opportunities for Talents

2. Master Thesis

Starting: End of August 2024

Topic

Characterization of reaction kinetics for Trace Organic Chemicals (TOrCs) degradation through sulfate radical oxidation in a MnO_2@GAC/sand column.

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 master's thesis focuses on the determining the reaction kinetics of the sulfate radical oxidation. Compounds can be degraded by direct interaction with the precursor peroxymonsulfate and with sulfate and hydroxl radicals.Therefore, an experimental strategy is required to determine the reaction rates and orders for the targeted TOrCs.

Tasks

- Research into reaction kinetics of selected TOrC targets.
- Determination of viable approaches to analysis chemical reaction kinetics (EBR, transformation products, etc.).
- Development of the laboratory testing strategy to analyze samples.
- Conduct sampling and analysis of the samples.
- Analyze and determine rates and order of reactions.

Skillset

- Background in Environmental/Chemical Engineering or Chemistry.
- Knowledge in statistical analysis
- Programming language skills are an added bonus.
- Experience in laboratory tasks (please highlight which course or if you have work experience).
- Independent working capabilities.
- Capable of conducting in-depth research and compiling literature studies.

Timeline and application

The master's thesis can be initiated once the initial system has been assembled and will last for 6 months, constituting for 900 working hours (including data analysis and writing) as per TUM regulations.

If you are interested, please contact me with the following documentation by **17th August 2024**:

1. Curriculum Vitae,
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

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3. Master Thesis

Starting: September 2024

Topic

Removal of antimicrobial resistance genes (ARGs) in tertiary wastewater effluent through sulfate radical oxidation using MnO_2@GAC as catalytic activator.

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 master's thesis focuses on the selecting target ARGs (or representative surrogates) for antimicrobial resistance (AMR), developing and testing in-house PCR protocols to quantify gene counts. This will be used to determine the disinfection capabilities of the catalytic filtration system pending data validation.

Tasks

- Research relevant antimicrobial resistance genes (and representatives) found in wastewater effluent.
- Investigate and validate quantification protocols (Standard or long-amplicon PCR) for ARGs.
- Conduct an experimental design for measuring the system's disinfection capabilities.
- Evaluate obtained data and validate the study.
- Compare data against disinfection data in existing literature.

Skillset

- Background in Microbiology/Biosciences/Environmental Engineering.
- Experience in microbial lab tasks ((q/d/-)-PCR, primer design, etc.) and so are a plus. **Note**: please mention this in your cover letter as well.
- Knowledge in statistical analysis, and programming language skills are an added bonus.
- Independent working capabilities.
- Capable of conducting in-depth research and compiling literature studies.

Timeline and application

The master's thesis can be initiated once the initial system has been assembled and will last for 6 months, constituting for 900 working hours (including data analysis and writing) as per TUM regulations.

If you are interested, please contact me with the following documentation by **30th August 2024**:

1. Curriculum Vitae,
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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