Turning Waste into Power: Reducing Emissions in Wastewater Treatment with Ammonia Electrolysis

Client	Jorrit Reede Docent-onderzoeker Chemische technologie
Related project	Turning Waste into Power: Reducing Emissions in Wastewater Treatment with Ammonia Electrolysis
Start date	Semester 2, 2025-2026
Suitable for training course	Chemical Engineering, Chemistry, Mechanical Engineering, Electrical Engineering, European Master in Renewable Energy (EMRE), industrial engineering and management
Learning Community	REMO-lab

Assignment description

One of the major challenges faced by wastewater treatment plants is the emission of nitrous oxide (N_2O). Nitrous oxide is approximately 300 times more potent as a greenhouse gas than carbon dioxide (CO_2), and it is estimated to account for around 60% of the total carbon footprint of wastewater treatment facilities. Conventional treatment processes rely on microbiological systems to break down ammonia. However, under certain operating conditions, these biological pathways may result in the unintended production of nitrous oxide.

This project explores an alternative approach to ammonia removal through electrolysis **(1)**. Unlike microbiological processes, electrochemical methods have shown in literature to operate under conditions that do not generate nitrous oxide emissions. The aim of this study is to investigate whether an electrolyzer system could serve as a viable replacement for biological treatment processes. If successful, this technology could be implemented at wastewater treatment plants, offering a more sustainable solution with significantly reduced greenhouse gas emissions.

$$\mathbf{2NH_3}\ (\boldsymbol{aq}) \rightarrow \boldsymbol{N_2}(\boldsymbol{g}) + \mathbf{3}\boldsymbol{H_2}\ (\boldsymbol{g})\ \mathbf{(1)}$$

Assignment

The assignment may encompass several components.

1. Laboratory experiments can be conducted to generate data on the electrolysis reaction. A set-up has already been prepared, and initial data have been collected by previous students. In these experiments different electrode materials and factors will be explored. (Chemical Engineering/chemistry students)
2. the operation of the electrolyzer can be automated. While preliminary steps toward automation have been taken, further development is required. (Electrical engineering students)
3. Third, simulations can be performed to evaluate the electrolyzer configuration for potential upscaling. (mechanical engineering)

Research questions

"How can electrolysis of ammonia contribute to minimizing nitrous oxide emissions and the overall carbon footprint in wastewater treatment systems?"

Sub-questions

1. *How do different electrode materials and operational factors influence the ammonia electro-oxidation reaction (AOR) in both model solution and wastewater?*
2. *What control strategies and sensor integrations are most effective for real-time monitoring and regulation of the electrolysis process?*
3. *How do flow dynamics, reactor geometry, and energy requirements affect the feasibility of large-scale implementation?*

General information

Final Product	Report
Location	Entrance/Zernikelaan 17
Parties involved	Lectorate sustainable gases and fuels
Contact person	Jorrit Reede
Guidance	Jorrit Reede
Details	j.reede@pl.hanze.nl

Photo and/or video

Heb je een geschikte foto of video? Stuur deze dan los mee met de vacature.
Heb je een video op YouTube staan? Dan ontvangen wij graag de link/url:

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Contact us

Are you interested in the vacancy? Do you have questions or would you like to apply directly?

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