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EFFECT OF HYDRAULIC RETENTION TIME IN A TWO-CHAMBER MICROBIAL ELECTROLYSIS CELL (MEC) FOR NITRATE REMOVAL FROM GROUNDWATER

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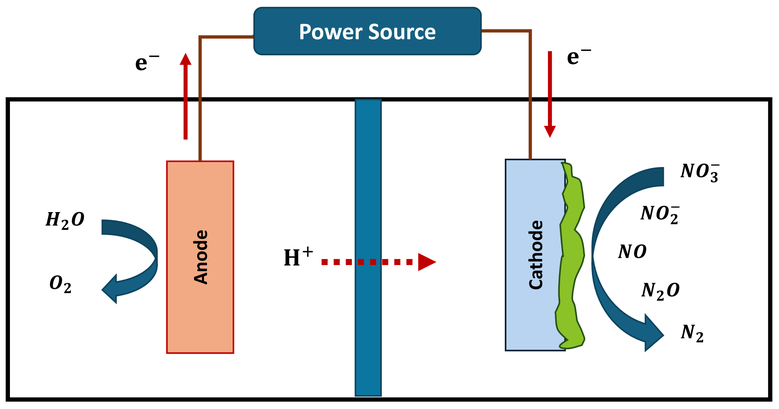
INTRODUCTION

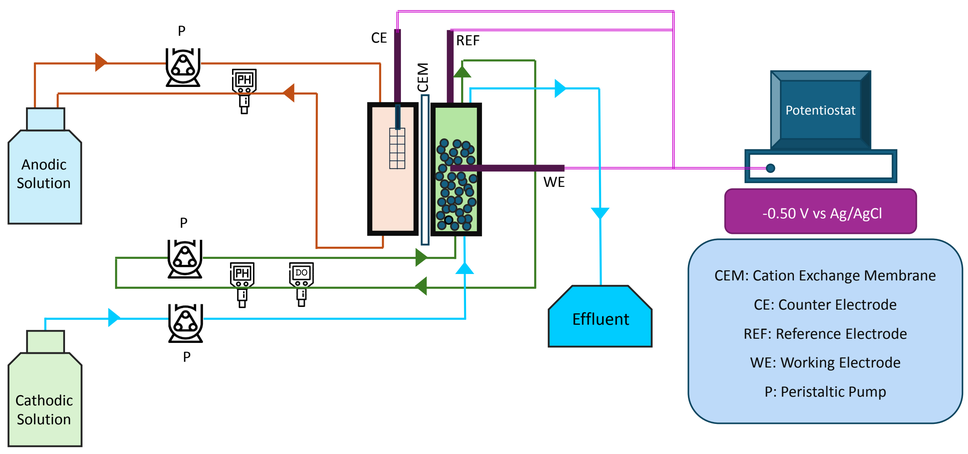


Schematic diagram of BES used in this study

- **Groundwater nitrate contamination** is a **global concern** due to increased industrial and agricultural activities.
- **High nitrate concentrations** in drinking water can cause serious **health problems**.
- **Bioelectrochemical systems (BES)** have emerged as an **efficient** and **environmentally friendly** method for nitrate-polluted groundwater remediation with low energy demand, chemical dosing, and waste generation.
- In this study, application of **a laboratory-scale BES reactor** was investigated to remove nitrate-polluted groundwater.

MATERIALS AND METHODS

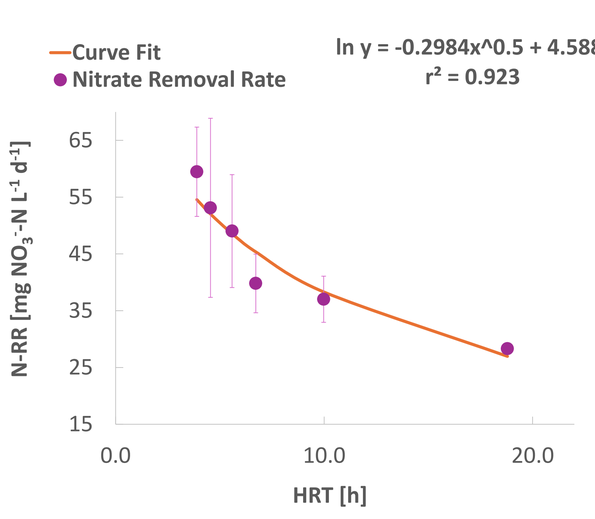
- Reactor configuration: **Two-chamber** BES (128 mL per chamber), separated by a cation exchange membrane (CEM);
- Electrodes: **Anode:** a titanium mesh coated with mixed metal oxide
  Cathode: a graphite rod and granular graphite
- Biocathode poised at -0.50 V vs Ag/AgCl
- Influent: **Synthetic groundwater** (29.6±6.0 mg NO_3^--N L^{-1}) at the cathode; **tap water** at the anode;
- Inoculum: **Activated sludge** from WWTW (100 mg L^{-1});
- Operation: **Continuous mode** in biocathodic chamber with intense recirculation;
  Batch mode in anodic chamber with intense recirculation.



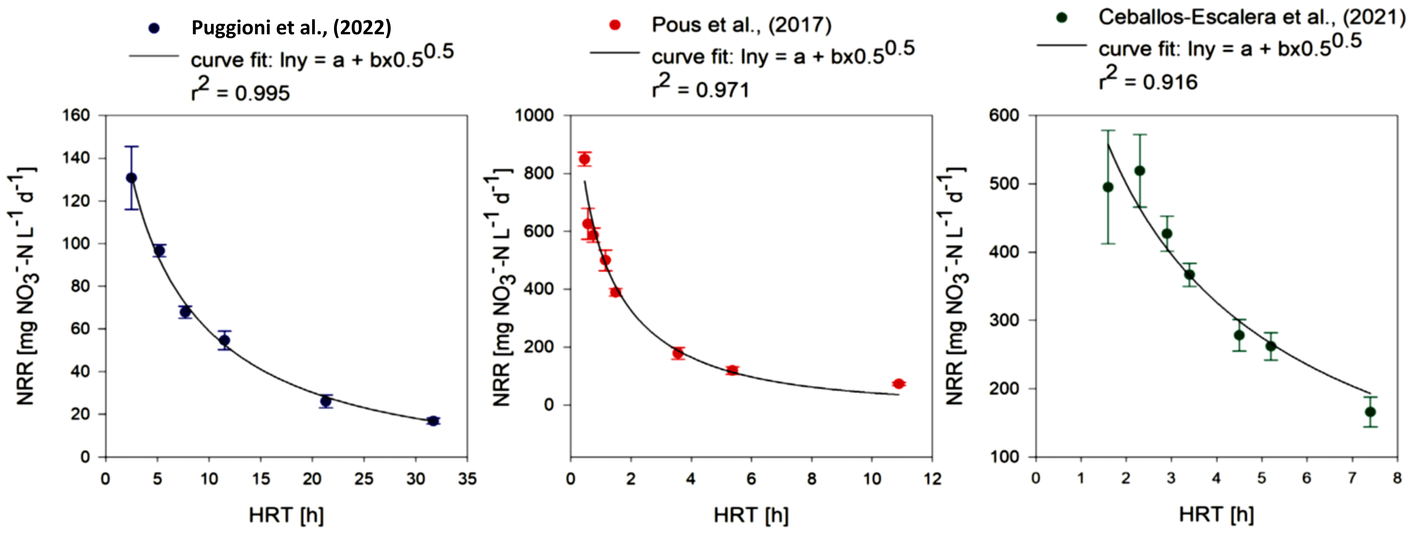
Schematic process flow diagram

RESULTS

- **Hydraulic retention times (HRT)** of 18.8, 10.0, 6.7, 5.6, 4.6, and 3.9 h were investigated at a cathodic potential of -0.50 V vs Ag/AgCl.
- **Reducing** the **HRT** from 18.8 to 3.9 hours resulted in an **increase** in the **nitrate removal rate (N-RR)** from 28.3±0.7 to 59.5±7.9 mg NO_3^--N $L^{-1}d^{-1}$, respectively.
- The **trend** of **N-RR** versus **HRT** corresponded to the observations previously reported by Puggioni et al. (2022) in a rectangular three-chamber BES, and by Ceballos-Escalera et al. (2021) and Pous et al. (2017) in tubular systems with different electrode materials and operating conditions.
- The analysis results showed that **denitrification** occurred **without the accumulation of intermediate** nitrogen species.
- A **decrease** in **HRT** was associated with a **decrease** in **specific energy consumption (SEC)**, from 0.027±0.003 kWh m^{-3} at a HRT of 18.8 h to 0.010±0.001 kWh m^{-3} at a HRT of 3.9 h.



Nitrate Removal Rate (N-RR) vs different HRT levels



CONCLUSION

- Decreasing HRT increased nitrate removal rates (N-RR) up to 59.5 mg NO_3^--N L^{-1} d^{-1} at an HRT of 3.9 h while reducing specific energy consumption, highlighting improved energy efficiency at shorter retention times.
- The trend of N-RR versus HRT was consistent with previous findings in both rectangular three-chamber and tubular systems, indicating similar patterns for groundwater nitrate removal under different configurations and operating conditions.

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