2025

REDSTACK

Rethinking ElectroMembrane Stacks

Project name: Electrochemical membrane water treatment for selective nitrate removal

CATEGORY: INNOVATION IN WATER AND CIRCULAR ECONOMY

COMPANY: REDSTACK BV

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1. Project Details

Project Name	Electrochemical membrane water treatment for selective nitrate removal
Category	Innovation in water and circular economy
Company	REDstack
Project Location	TWZ De Vlot, The Netherlands
Project Date	25-08-25 till 28-11-25
Application	Agricultural wastewater treatment
Feed Water	Treated horticultural effluent

2. Justification for Project Award Consideration

This project demonstrates an innovative and forward-looking approach to water management through the implementing Electrodialysis Reversal (EDR) technology tailored to local needs, specifically enhanced by **REDstack's advanced stack design**.. The compact and modular REDstack design ensures minimal footprint while achieving highly efficient and selective nitrate removal, meeting discharge regulations and reducing environmental impact. Unlike conventional biological, chemical u other filtration processes, EDR with REDstack design offers lower energy consumption, improved operational stability, and reduced fouling, resulting in a sustainable and cost-effective solution.

Beyond immediate benefits, the project serves as a scalable model for horticultural facilities and other sectors facing nutrient-rich effluents. REDstack's robust design allows the system to be adapted for varying water qualities and treatment capacities, making it suitable for broader regional deployment. It also enables long-term circularity: the concentrated nitrate stream could be recovered for greenhouse use, while treated water—currently discharged—could be polished for irrigation. This reduces reliance on groundwater and rainwater, resources increasingly stressed by climate change.

By integrating REDstack's innovative EDR design stack, the project simultaneously addresses compliance, resource recovery, and water reuse, and infrastructure resilience. It sets a benchmark for sustainable, high performance water management and provides a blueprint for replication across the horticultural sector and beyond. These qualities make the project a strong candidate for award recognition

3. Project Description

This case study at a horticultural wastewater treatment plant in the Netherlands evaluated the EDR technology for compliance with surface water discharge regulations. The existing process—coagulation, sedimentation, sand filtration, and activated carbon—discharges to the sewer, but limited sewer capacity demands alternative solutions.

Current treatment removes solids and pesticides but not nutrients such as nitrates and phosphates, which are critical due to environmental and regulatory constraints. EDR, an electrochemical membrane process, selectively removes ions, reducing Total Dissolved Solids (TDS) and specifically nitrate (NO_3^-) and phosphate (PO_4^-).

The study assessed EDR performance for salts, focusing on chloride, nitrate, and phosphate. Due to ion mobility differences, EDR preferentially removes calcium, magnesium, chloride, and nitrate. Results showed that a 75% TDS reduction achieved up to 95% nitrate removal, meeting nitrogen discharge limits. Chloride also complied, while phosphate removal needs improvement through optimized flocculation and dosing.

Overall, EDR proved effective for horticultural wastewater treatment, improving regional water management, enabling water reuse in the future, and potentially allows for nutrient recovery from the concentrate stream—supporting circular water strategies.

4. Explanation REDstack's EDR Technology and Process

The Electrodialysis Reversal (EDR) process uses specially engineered EDR stacks equipped with ion-selective membranes and is powered by the input of electrical energy to separate a feedwater containing salt into a product stream and a concentrated or reject stream. In a conventional EDR stack, multiple flow compartments are formed by alternating cation and anion exchange membranes. **REDstack's design enhances this principle by using a fully moulded, spacer-free hydrodynamic architecture**, which optimizes flow distribution, minimizes pressure losses, and reduces the risk of dead zones and fouling. . As feedwater enters the module, it is evenly distributed across both the product and reject compartments. When a voltage is applied, ions in the product compartments migrate through the membranes into the reject compartments, effectively reducing the salinity of the product stream. **The REDstack configuration further improves ion transport efficiency by eliminating electrical losses at gasket interfaces and ensuring uniform current density across all membranes**, resulting in higher energy efficiency, improved reliability, and superior long-term performance compared with traditional frame-and-plate EDR stacks.

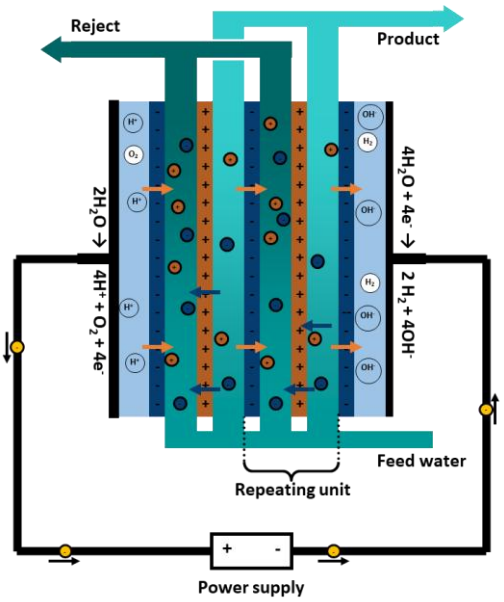


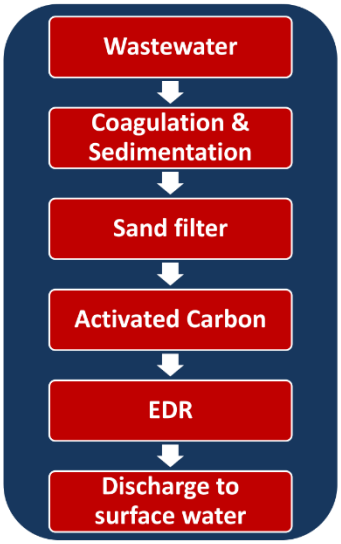
Figure 1 Schematic overview of the EDR technology.

Apendix I

Case Study: Salt Removal from Horticultural Effluent

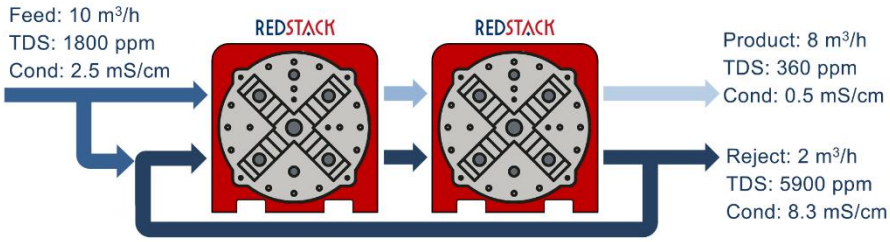
Case study at Horticultural wastewater treatment plant

- Existing treatment consist of
  - Coagulation & Sedimentation
  - Sand filter
  - Activated Carbon
  - Discharge to sewer
- Sewer capacity is limited
- Investigate use of EDR to remove TDS
  - Specifically nitrate (NO_3^-) and phosphate (PO_4^{2-})
- Discharge EDR product to surface water
- Discharge EDR reject to sewer



Apendix II

Case Study: Salt Removal from Horticultural Effluent



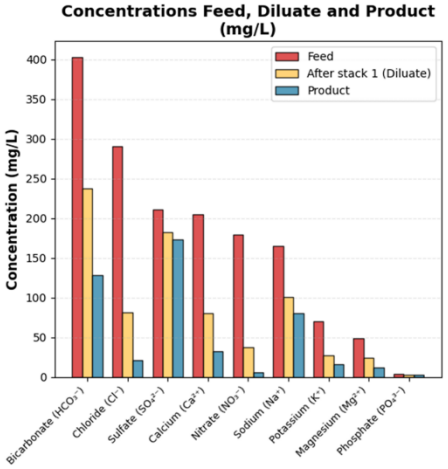
Results pilot investigation:

- Product target always achieved with fluctuating feed water composition
  - Required salt removal degree 75 – 80%
- Achieved water recovery of 80%
  - limited by feedwater total hardness
- Average energy consumption < 0.7 kWh/m³
- Excellent nitrate (NO_3^-) removal > 95%

Apendix III

Case Study: Salt Removal from Horticultural Effluent

Parameter	Unit	Feed	Product	Reduction
EC	µS/cm	2400	600	-75%
TDS (NaCl eq.)	mg/l	2202	491	-78%
NO_3	mg/l	174	6.2	-96%
N-total	mg/l N	40	1.4	-97%
P-total	mg/l P	1.4	0.8	-43%



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