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DISRUPTIVE AND SUSTAINABLE TECHNOLOGY FOR NITRATE REMOVAL IN SALINE WATERS, WATER RECOVERY, AND VALORIZATION OF OTHER IONIC CONTENTS

PATENTED TECHNOLOGY

CONTACT DETAILS:

Research Results Transfer Office-OTRI
University of Alicante
Tel.: +34 96 590 99 59
Email: areaempresas@ua.es
http://innoua.ua.es

ABSTRACT

The **Applied Electrochemistry and Electrocatalysis Research Group (LEQA)** at the **University of Alicante**, in collaboration with the **University of Valencia** and the company **AVSA**, has developed an innovative technology that efficiently removes nitrates (NO_3^-) from saline streams through an electrochemical denitrification process (REN). This system focuses on optimizing the treatment of reject streams generated by reverse electrodialysis (EDR) plants, effectively integrating pretreatment, denitrification, and post-treatment phases to maximize resource recovery, such as water and hydrogen.

The process is highly efficient in converting nitrates into nitrogen gas (N_2), with minimal formation of toxic by-products. Additionally, the comprehensive resource management allows for the reintegration of demineralized water into the treatment cycle, electricity generation, and the recovery of valuable salts such as calcium and magnesium. Another distinguishing feature is the absence of sludge generation, a common problem in other methods, and its compliance with stringent environmental regulations. The operational flexibility of this technology, which supports both continuous and batch modes, further expands its industrial applicability.

The technology, protected by a patent application, has been developed at a pilot scale and is ready for demonstration. Companies interested in its commercial exploitation are sought.

ADVANTAGES AND INNOVATIVE ASPECTS

ADVANTAGES OF THE TECHNOLOGY

The developed technology presents multiple advantages, standing out both technically and environmentally:

- **High efficiency in nitrate removal**: The electrochemical denitrification process is designed to maximize the conversion of nitrates into nitrogen gas (N_2), preventing the generation of contaminating residual streams. The pretreatment stage increases treatment capacity and reduces energy consumption, improving industrial feasibility.
- **Advanced by-product management**: The pretreatment and post-treatment stages ensure efficient handling of high-hardness waters and minimize undesirable by-products, such as ammonia, while facilitating the regeneration and reuse of ion exchange resins, reducing operational costs.
- **Energetic use**: The valorization of the hydrogen generated during the process enables its use as a renewable energy source in fuel cells, contributing to a reduction in global electricity consumption.
- **Compliance with environmental regulations**: The technology transforms pollutants into less harmful products, meeting regulatory requirements and eliminating the need to manage solid waste such as sludge.
- **Operational flexibility**: The system supports both continuous and batch operation modes, adapting to different industrial needs.

- **Resource recovery and diversification**: Allows for the reintegration of treated and demineralized water at the beginning of the process, minimizing new water use. Additionally, it enables the valorization of salts such as calcium and magnesium for commercial applications, adding a strategic economic component.
- **Sustainability**: This process destroys contaminants instead of transferring them to other streams, significantly reducing environmental impact. The energy generation from the obtained hydrogen maximizes the sustainability of the process.

INNOVATIVE ASPECTS

On one hand, the technology combines a highly selective electrochemical process for nitrate (NO_3^-) removal with the generation of high-purity hydrogen (≥ 97%) as a recoverable by-product. This approach not only efficiently eliminates contaminants but also transforms a waste material into a renewable energy source usable in fuel cells, representing a significant advancement in energy sustainability and operational efficiency.

On the other hand, the system incorporates an integrated design that allows the reintegration of demineralized water into the reverse electrodialysis (EDR) cycle, maximizing resource reuse. Additionally, the recovery of valuable resins and salts, such as calcium and magnesium, reinforces the circular economy approach, distinguishing it from other technologies that generate difficult-to-manage waste, such as sludge or contaminant-laden streams.

These two aspects position this technology as an advanced and disruptive solution, standing out for its focus on sustainability, energy efficiency, and the circular economy.

MARKET APPLICATIONS

This technology is particularly advantageous for **treating water** from reverse electrodialysis (EDR) desalination plant reject streams contaminated with nitrates. However, it can also be applied to any stream with a high nitrate concentration, such as those from the chemical, food, or textile industries. Additionally, its nitrate removal capability makes it particularly useful in regions where intensive fertilizer use has contaminated aquifers and water sources.

COLLABORATION SOUGHT

Companies interested in acquiring this technology for **commercial exploitation** are sought through:

- Patent licensing agreements.
- R&D collaboration agreements to develop the technology according to company needs.
- Scientific-technical advisory services.
- Etc.

Types of companies sought:

- Manufacturers of water treatment equipment and systems.
- Companies integrating turnkey solutions for treatment plants.
- Desalination and EDR plants.
- Industrial wastewater management companies.
