STAND-ALONE SYSTEM FOR THE PURIFICATION OF BRACKISH WATER DIRECTLY POWERED BY PHOTOVOLTAIC SOLAR ENERGY

TECNOLOGÍA PATENTADA

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RESUMEN

The Applied Electrochemical and Electrocatalysis Group (LEQA) at the University of Alicante has developed an Stand-alone system for the desalination and disinfection of water by Electrodialysis (ED) and the necessary water pre- and post-conditioning steps. The developed system is sustainable and environmentally-friendly being directly powered by a photovoltaic solar plant without using battery racks.

This new system substantially decreases both the investment and maintenance costs by eliminating the batteries. Also, it can be adjusted to be used in water from very different sources like seawater, brackish water wells, wastewater treatment plants, industrial processes water, etc. being of particular interest for remote areas isolated from the electric grid.

The Research Group has a demonstration Pilot Plant with the capacity to produce up to $1m^3$ of drinking water per day. The Group is looking for companies interested in the commercial exploitation of this technology through licensing agreements and/or technical cooperation.



INTRODUCCIÓN

The problem of water scarcity is undoubtedly one of the greatest challenges that the world's population faces in the coming

years. This problem is particularly severe in regions where the access to water and electricity is expensive or even non-existent. In these areas, it is essential to use water from aquifers, most of them overexploited and contaminated with dissolved salts.

Among the known technologies of desalination, Electrodialysis (ED) is a technology that has been proven and widely used in desalination processes of waters coming from various sources (brackish wells, seawater, industrial effluents or others). Moreover, the combination of the ED with other techniques such as disinfection (electrochemical or not) and/or filtration (micro, ultra or others) can be used to produce treated water suitable for various uses (drinking water, irrigation, flushing or others).

On the other hand, photovoltaic solar energy is a widespread renewable energy source with extensive environmental and economic benefits. In general, solar installations are based on photovoltaic solar panels and they store energy in battery racks. The energy can be consumed on demand regardless of the availability of solar irradiation. These facilities are of great interest for use in remote locations as power supply systems in an autonomous and reliable way.

Photovoltaic solar panels have already been used in ED desalination processes. However, most of these systems use battery racks for energy storage or use inverters to transform it into alternating current (AC) with the consequent increase in investment and maintenance costs as well as the decrease in the efficiency of the process (DC to AC conversion). Although electricity can be supplied directly, up to now there is no precedent where the entire electrical power supply of the system is carried out using a photovoltaic solar plant or other discontinuous power source without a battery rack.

DESCRIPCIÓN TÉCNICA

The Applied Electrochemistry and Electrocatalysis Research Group (LEQA) at the University of Alicante has developed an Stand-alone system for the desalination and disinfection of water by Electrodialysis (ED) and the necessary water pre- and post-conditioning steps, directly powered by a photovoltaic solar plant (or other discontinuous electrical power source) without using battery racks.

In general, the system consists of a unit of desalination by electrodialysis and a water disinfection unit composed by:

i) Water collection system by pumping, conditioning of water (pre-treatment) and storage in a tank.
ii) Water desalination system by electrodialysis comprising pumping equipment and electrodialyzer.
iii) Water disinfection system (post-treatment) comprising pumping equipment.
iv) Photovoltaic solar field that supplies electric power to the system.
v) Power processing system for the power supplied by the photovoltaic solar panels.
vi) Automation and control system.

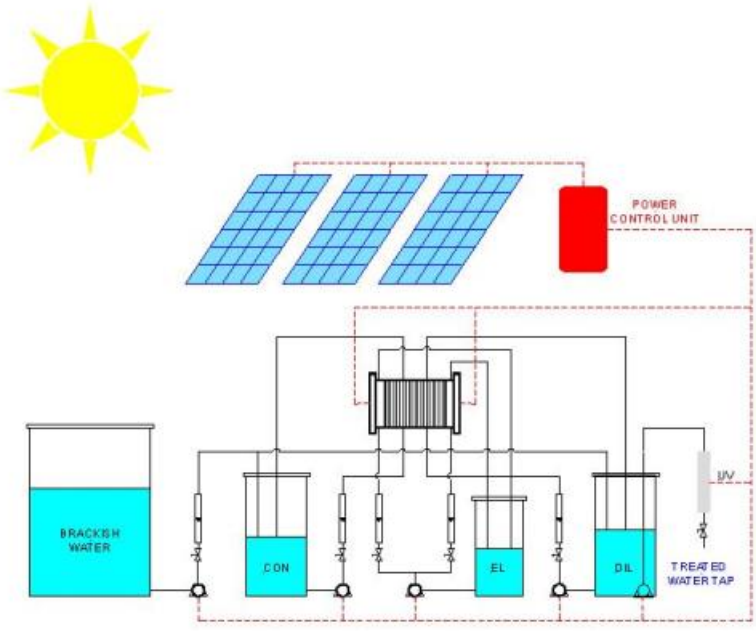


Figure 1. General scheme of the system

The characteristics of the stages of pre- and post-conditioning of the water depend on: i) the origin and physicochemical characteristics of these waters (brackish water wells, seawater, sewage or industrial wastewater treatment plants or others). Therefore, these stages may incorporate filtration (micro, ultrafiltration, etc.) and disinfection techniques (electrochemical, reagents addition, UV, etc.).

The system performs the desalting treatment by electrodialysis. Desalination can be carried out for any type of electrodialysis: batch with recirculation or continuous modes of operation, cascade, electrodialysis reversal or others. Also, the size of the electrodializer can be adapted according with the required needs.

The power supply subsystem comprises a field of photovoltaic solar panels as discontinuous energy source connected to a DC/DC converter. The latter applies the appropriate strategies of control of the maximum power point tracking (MPPT), so that it distributes the power among the loads of the output lines defined for the system as needed.

The developed system has several subsystems that require electric power with different voltage/current characteristics.

However, during the treatment process not all the subsystems that require energy operate simultaneously nor have to do it at full power.

Therefore, the system allows the implementation of operating strategies to reduce the overall requirements of electric power and adapt them to the amount of energy available at all times.

The system is particularly useful if it is isolated from the power grid. However, the system is compatible with a mixed power, so that it may combine the use of solar power with a conventional power grid when the discontinuous power source is insufficient (eg : cloudy days and nights) or to supply only certain subsystems.

From the point of view of its application, the system allows the desalination of water coming from different sources such as seawater, brackish well water, sewage or industrial wastewater treatment plants or others.

The system is highly flexible, so that its final configuration strongly depends on the final application of the treated water and the associated costs; which will determine both, the equipment selected and the most suitable configuration.

VENTAJAS Y ASPECTOS INNOVADORES

The new system:

- Allows the autonomous desalination, disinfection and purification of water in remote locations isolated from the mains.
- Is sustainable and environmentally friendly. The process is free of CO2 emissions and does not contribute to climate change.
- Substantially reduces the investment cost and the amortization of these systems by eliminating the high cost of batteries, regulators and inverters.
- Reduces maintenance time and costs by avoiding the use of batteries. Also avoids economic and environmental costs associated with the disposal of spent batteries.
- Can be applied to the desalination of water coming from different sources such as seawater, brackish well water, sewage or industrial wastewater treatment plants or others.
- Has a high availability allowing the accumulation of treated water for periods of failure of the renewable energy sources
- Improves the efficiency of use of the electric power generated by not using batteries or change to AC power, thus avoiding the energy losses associated.
- Allows implementation of operating strategies of the various subsystems, adapting them to the amount of energy available at all times and improving the energy efficiency of the system.
- Allows a mixed feed of different renewable energy sources, being possible the combination with conventional electricity grid when the first are insufficient.
- Is very flexible and can adapt its dimensions and characteristics depending on the requirements, application and specific characteristics of the water to be treated.

ESTADO ACTUAL

The system is fully developed and has been successfully tested both at laboratory and pre-industrial scale. Currently the research group has a pilot demonstration plant capable of generating 1 m3/day of drinking water for human consumption.

- Production: 1 m3/day of drinking water from brackish water (4-6 g/L dissolved solids).
- Pre-treatment: microfiltration at 50 and 10 microns.
- Electrodializer EURODIA EUR 6 80 with 80 cells, 4.4m2 of total membrane area and 500 cm2 of cell area.
- Post-treatment: disinfection subsystems by electrochemical generation of chlorine and UV treatment.
- Directly powered by Photovoltaic Solar Panels (maximum power of the solar plant 75 kW).

The Applied Electrochemical and Electrocatalysis Group (LEQA) has many years of experience in the field of Electrochemistry, having successfully carried out several Spanish and European projects. All technical and management staff has extensive experience to ensure the success of any project.



Figure 2. Demonstration Pilot Plant

APLICACIONES DE LA OFERTA

The system can be used to obtain water suitable for various uses (human consumption, irrigation, wash-down or others) from the treatment of waters coming from diverse origins: seawater, brackish wells, wastewater treatment plants, industrial processes or others.

Potential customers can include:

- Industrial developers of water treatment systems.
- Consulting and engineering companies in the environmental sector interested in incorporating this new desalination system among its wastewater treatment activities.
- Food and Industrial companies in general wishing to incorporate this brackish water desalination system.
- Irrigation communities, golf courses, housing developments, etc.

COLABORACIÓN BUSCADA

Companies interested in acquiring this technology for use and/or commercial exploitation through:

- Patent and/or know-how license agreements to transfer use, manufacture or commercialization rights.
- Design and construction of industrial equipment, including automation, according to the technical specifications and customer needs.
- R&D project agreement (technical cooperation) for use of technology or application in other sectors.
- Subcontracting agreement (technical assessment, turnkey plant, training, etc.)

DERECHOS DE PROPIEDAD INTELECTUAL

This technology is protected by patent:

- Title: “Sistema autónomo de tratamiento de aguas”.
- Application number: P201690069
- Application date: 08/05/2015

PERFIL DEL GRUPO DE INVESTIGACIÓN

In the following link you will find a description of the nature and activities of the Research Group:
https://cvnet.cpd.ua.es/curriculum-breve/grp/en/electroquimica-aplicada-y-electrocatalisis/356

SECTORES DE APLICACIÓN (11)

Agri-food and Fisheries
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Footwear and Textile
Construction and Architecture
Pollution and Environmental Impact
Marine Studies
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Stone and Marble
Water Resources
Chemical Technology
Tourism