DESTINATION DESALINATION

Fujifilm's Natalie Tiggelman discusses novel electrodialysis applications for the worldwide provision of safe drinking water

The demand for safe drinking water is outgrowing the planet's natural resources at an alarming rate. Climate change, drought, urbanisation and pollution are just some examples of factors that are accelerating the crisis. Approximately two billion people live in areas of water scarcity and another 1.6 billion people face water shortage because their countries lack the necessary infrastructure to take water from rivers and aquifers to the populations that need it.[1] If the efforts to combat climate change are not intensified, by 2025 two thirds of the world's population could be under water stress conditions.[2]

The desalination industry has responded well to the increasing demand and is constantly evolving by reducing the costs and improving the reliability of producing high-quality water. Despite remarkable progress so far, the high costs and energy requirements are still critical factors preventing the wider adoption of desalination. Continuous innovation is necessary to make the desalination technology more affordable.

REvivED water, a European Commission-funded pilot project led by Fujifilm Manufacturing Europe BV, is focusing on the potential of electrodialysis for desalination applications, both as standalone systems and in combination with established desalination technologies.

The project builds on the success of Fujifilm in developing advanced ion exchange membranes with performance and cost that make electrodialysis suitable for desalination applications. This allows the industry to benefit from the inherent advantage of electrodialysis, whereby only the ions (salt) flow through the membranes, rather than the water. This delivers huge benefits:

- Decreased energy consumption – lowering carbon dioxide emissions and reducing money spent on energy;
- Flexibility to work with variable energy input – making it suitable for combination with solar and wind energy; and
- The membranes stay cleaner for longer – reducing the amount of chemicals and energy used to keep the membranes clean and efficient.

Improved seawater desalination

The application of these innovative ion exchange membranes will allow for the use of electrodialysis to desalinate seawater. The REvivED water project will go one step further, applying a reverse electrodialysis (RED) unit as a pre-desalination step. This approach can be used when a low salinity water stream, such as treated wastewater, is available. In such cases, ions move naturally from the seawater to the wastewater during the RED process, reducing the desalination load on the main electrodialysis process, without the need for any energy input.

Compatibility with established technologies

The RED pre-desalination step described above is an exciting new technology. It is a versatile technology which can also be used in combination with the well-established reverse osmosis technology. As such, RED can be added to most existing desalination plants provided a suitable low salinity stream is available. If there is no treated water available, a simple electrodialysis system can be added to reverse osmosis plants to pre-desalinate the sea water. The hybrid system with electrodialysis as a pre-desalination can increase the water recovery of reverse osmosis systems, producing more drinking water from the same amount of seawater at low energy consumption and at affordable costs.

Brackish water applications

Electrodialysis was always considered as an interesting option for brackish water desalination. The REvivED water project has brought together past experience and new technological developments in an innovative design. This progress allows for the creation of safe drinking water from most brackish water sources, particularly for remote areas in developing countries that are threatened by water stress. The low energy requirements and the flexibility of the electrodialysis system to operate with variable energy input allows for a simple integration with solar energy supply. This makes the system independent from any other external power supply, ready to be deployed where safe drinking water is needed, and brackish water is available.

The team

The REvivED water project brings together leading companies, research groups and experts from across Europe. Everyone contributes skills and innovative technologies, all of them necessary for delivering the electrodialysis components that can help in making desalination more affordable and more environmentally friendly. For example, the partners explore advanced designs of electrodialysis and reverse electrodialysis stacks and innovative electrodes. There are new types of spacers, which regulate the flow of water between the membranes, ensuring efficient operation. For other applications, ion exchange membranes with a structured surface – called profiled membranes – are developed, leaving an open path for the water to flow between the membranes and avoiding the need to use a spacer.

The ongoing advanced modelling work enables the partners to fully understand the intricacies and interlinkages of the process at all levels. This modelling tool is validated with experimental data and can be used for design and optimisation, allowing the definition of the optimal system design and operational parameters for each case, and selecting from the various innovative components and approaches developed.

Next steps

Several pilot projects will be built around the world to demonstrate the role of electrodialysis in the provision of drinking water for the world's growing population. All system configurations described above will be tested in real conditions, demonstrating the operation of electrodialysis in different settings and for various applications.

The seawater desalination solutions will be tested in Europe. The brackish water systems powered by solar energy will be tested in remote locations of developing countries, mostly in Africa. Some sites with water shortages in Asia and South America are also being considered. All installations will be carried out by specialised companies from the REvivED water consortium.

Follow the progress of the REvivED water project on its website (www.revivedwater.eu) and on the LinkedIn group 'Electrodialysis Applications' (www.linkedin.com/groups/8596116).

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The REvivED water project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement no. 685579.

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