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making-drinking-water-from-saltwater-with-shock-electrodialysis

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Infinity Turbine LLC

Making Drinking Water from Saltwater with Shock Electrodialysis Desalination by Infinity Turbine

This webpage QR code

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Company Name: Infinity Turbine LLC
Product: SDR Spinning Disc Reactor Desalination
Applications: Removing salt from saltwater to make drinking water
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Uses: Making drinking water from saltwater and brackish water using spinning disc reactor and shockwave dynamics cavitation

PDF Version of the webpage (first pages)

https://infinityturbine.com/making-drinking-water-from-saltwater-with-shock-electrodialysis-desalination-by-infinity-turbine.html

Desalination

Infinity Turbine is currently working on the development of incorporating Teflon with SDR (Spinning Disc Reactor) technology to implement a commercial scale shock electrodialysis process (a recently developed electrokinetic process, which can be used to continuously desalinate artificial seawater).

Problem: Conventional desalination technologies such as distillation and reverse osmosis are well suited for the supply of fresh water at large scale. The expensive infrastructure and high capital, operating, and maintenance costs associated with these technologies, however, limit their application in remote or underdeveloped areas.

Concept: Infinity is working within its developed technologies to utilize the amazing qualities of Teflon, static electricity, and cavitation (sonochemistry) to further promote simple low cost solutions for removing salt from water.

5/9/2024

SHOCK-ELECTRODIALYSIS

Electrodialysis (ED), which has been commercially exploited for 70 years now, is another water treatment method, using selective transport of ionic species in an electric field across ion-exchange membranes [5]. This process offers high energy efficiency for desalination in the range of concentrations between ca. 500 and 5000 ppm and is, therefore, more suitable for low-salinity brackish waters. Thanks to being able to selectively separate charged species from non-ionic ones, ED finds use in the treatment of industrial wastewaters, including removal and recycling of heavy metals (nickel) from rinse waters, inorganic acid regeneration in the chemical industry, reacidification of fruit juices, desalination of whey in the food industry, and more. On the other hand, the effectiveness of ED falls significantly as the feed stream becomes more diluted (<100 ppm). The high ohmic resistivity drives the energy consumption up. Therefore, ED cannot be used for complete water purification purposes. In electrodeionization (EDI), a related method, this is solved by filling the dilute chambers with ion-exchange beads. Ion-exchangers are characterized by relatively high conductivity and provide a large active ion-exchange area. As a result, it is possible to obtain a concentration of ionic and ionizable species far below ppb levels. Therefore, EDI is a method that is used in the electronic, pharmaceutical, and chemical industries, where ultra-pure water with conductivity lower than 0.1 μs/cm is needed. Conventional desalination technologies such as distillation and reverse osmosis are well suited for the supply of fresh water at large scale. The expensive infrastructure and high capital, operating, and maintenance costs associated with these technologies, however, limit their application in remote or underdeveloped areas. Here, we show that shock electrodialysis, a recently developed electrokinetic process, can be used to continuously de- salinate artificial seawater (3.5 wt. percent) for small-scale (less than 25 m3 day−1 as a long-term goal), decentralized applications. In two steps, 99.8 percent of the salt fed was rejected, with selectivity for magnesium ions of which > 99.99 percent were removed (based on measurements of concentration by mass spectrometry). We also demonstrated for the first time the viability of using and continuously recycling solutions of sodium citrate buffer to simultaneously reduce waste and inhibit precipitation reactions in the electrode streams. As with conventional electrodialysis, the energy consumed by our technology can be significantly reduced by desalinating sources that are less saline than seawater, such as brackish water and various industrial or municipal process streams. Since the design of the system and choice of materials have yet to be optimized, there remain ample opportunities to further reduce the cost of desalination by shock electrodialysis. Scalable and Continuous Water Deionization by Shock Electrodialysis

Theory of shock electrodialysis I: Water dissociation and electrosmotic vortices Shock electrodialysis (shock ED), an emerging electrokinetic process for water purification, leverages the new physics of deionization shock waves in porous media. In previous work, a simple leaky membrane model with surface conduction can explain the propagation of deionization shocks in a shock ED system, but it cannot quantitatively predict the deionization and conductance (which determines the energy consumption), and it cannot explain the selective removal of ions in experiments. This two-part series of work establishes a more comprehensive model for shock ED, which applies to multicomponent electrolytes and any electrical double layer thickness, captures the phenomena of electroosmosis, diffusioosmosis, and water dissociation, and incorporates more realistic boundary conditions. In this paper, we will present the model details and show that hydronium transport and electroosmotic vortices (at the inlet and outlet) play important roles in determining the deionization and conductance in shock ED. We also find that the results are quantitatively consistent with experimental data in the literature. Finally, the model is used to investigate design strategies for scale up and optimization.
Water Purification by Shock Electrodialysis: Deionization, Filtration, Separation, and Disinfection [We show that shock ED can thoroughly filter micron-scale particles and aggregates of nanoparticles present in the feedwater. We also demonstrate that shock ED can enable disinfection of feedwaters, as approximately 99% of vi- able bacteria (here Escherichia coli) in the inflow were killed or removed by our prototype. Shock ED also sepa- rates positive from negative particles, contrary to claims that ICP acts as a virtual barrier for all charged particles. By combining these functionalities (filtration, separation and disinfection) with deionization, shock ED has the potential to enable highly compact and efficient water purification systems.] The development of energy and infrastructure

Electrodialysis

Electrodialysis (ED), which has been commercially exploited for 70 years now, is another water treatment method, using selective transport of ionic species in an electric field across ion-exchange membranes [5]. This process offers high energy efficiency for desalination in the range of concentrations between ca. 500 and 5000 ppm and is, therefore, more suitable for low-salinity brackish waters. Thanks to being able to selectively separate charged species from non-ionic ones, ED finds use in the treatment of industrial wastewaters, including removal and recycling of heavy metals (nickel) from rinse waters, inorganic acid regeneration in the chemical industry, reacidification of fruit juices, desalination of whey in the food industry, and more. On the other hand, the effectivity of ED falls significantly as the feed stream becomes more diluted (<100 ppm). The high ohmic resistivity drives the energy consumption up. Therefore, ED cannot be used for complete water purification purposes. In electrodeionization (EDI), a related method, this is solved by filling the dilute chambers with ion-exchange beads. Ion-exchangers are characterized by relatively high conductivity and provide a large active ion-exchange area. As a result, it is possible to obtain a concentration of ionic and ionizable species far below ppb levels. Therefore, EDI is a method that is used in the electronic, pharmaceutical, and chemical industries, where ultra-pure water with conductivity lower than 0.1 μs/cm is needed. Conventional desalination technologies such as distillation and reverse osmosis are well suited for the supply of fresh water at large scale. The expensive infrastructure and high capital, operating, and maintenance costs associated with these technologies, however, limit their application in remote or underdeveloped areas. We also demonstrated for the first time the viability of using and continuously recycling solutions of sodium citrate buffer to simultaneously reduce waste and inhibit precipitation reactions in the electrode streams. As with conventional electrodialysis, the energy consumed by our technology can be significantly reduced by desalinating sources that are less saline than seawater, such as brackish water and various industrial or municipal process streams. Since the design of the system and choice of materials have yet to be optimized, there remain ample opportunities to further reduce the cost of desalination by shock electrodialysis.