Electric Ratchet Based Ion Pumps

Tech ID: 32347 / UC Case 2019-927-0

BRIEF DESCRIPTION

UCI researchers developed a new device that uses electricity to drive ion separation across a membrane. This device can increase the energy efficiency of various applications such as artificial photosynthesis, water desalination, and chemical separations.

SUGGESTED USES

·Artificial photosynthesis

·Water desalination

·Chemical separations

·Drug delivery systems

·Neuromorphic computing

FEATURES/BENEFITS

·Simple: No change of flow streams or switches like in conventional electrodialysis

·Energy Efficient: Does not waste any energy in undesired redox reactions and has substantially smaller ohmic potential losses

·Clean: Does not generate redox products that could affect water sources

·Compact: Enables very small form factor design per ionic circuit

FULL DESCRIPTION

Ion pumps are devices that use external power to introduce a net ionic flux. Photosynthesis in plants and the hydrolysis of ATP in animals are examples of ion pump driven processes. Although widely used in nature, there are very few technologies that can unleash the vast potential of ion pumps. Unlike electrons in electronic devices where contacts serve as nearly ideal sources and sinks for charge carriers, ions are sourced and removed by chemical reactions. These redox reactions are in many cases energetically expensive and require tailoring specific catalysts to the specific ions to be pumped. Said redox reactions are the means by which commercial electrodialysis is able to operate continuously, driving ion transport indefinitely in a single direction.

UCI inventors have developed a first-of-its-kind “all electric” ion pump based on an electronic ratchet mechanism. Electronic ratchets are devices that utilize modulation in a spatially varying electric field to drive steady state current. Similar to peristaltic pumps, where the pump mechanism is not in direct contact with the pumped fluid, electronic ratchets induce net current with no direct charge transport between the power source and the pumped charge carriers. Thus, electronic ratchets can be used to pump ions in steady-state with no electrochemical reactions between the power source and the pumped ions. The result is an “all-electric” ion pump that is far more simple and energy efficient than any other electrochemical deionization/desalination

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INVENTORS

» Ardo, Shane

OTHER INFORMATION

CATEGORIZED AS

» **Energy**
» Other
» **Medical**
» Delivery Systems
» **Semiconductors**
» Processing and Production
» **Sensors & Instrumentation**
» Scientific/Research

RELATED CASES

design.

2019-927-0

STATE OF DEVELOPMENT

The researchers have conducted experiments, supported by numerical models and simulations, that confirm the operational mechanisms of our technology. They are currently developing working prototypes. They then plan to develop and test prototypes that demonstrate rapid desalination/deionization of salt water.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20210187442	06/24/2021	2019-927
United States Of America	Published Application	20200402782	12/24/2020	2019-927
Patent Cooperation Treaty	Published Application	WO 2020/257708	12/24/2020	2019-927

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Optimizing Bipolar Membrane Interfaces to Catalyze Water Dissociation

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