Docket #: S10-123

Mixing Entropy Battery

With energy costs rising and environmental problems worsening, there's a growing need for efficient, scalable, alternative energy. A team of researchers at Stanford University led by Prof. Yi Cui has developed a low-cost, easily fabricated rechargeable battery (the “mixing entropy battery”) that takes advantage of the difference in salinity between seawater and freshwater to produce electricity. The battery consists of two electrodes – a positive electrode made from nanorods of sodium manganese oxide, and a negative electrode made from silver chloride. Energy extraction occurs by a simple process of the battery being filled with freshwater in its discharged state, then charged with a small electric current, drained, and filled with seawater. Because seawater is salty, containing 60 to 100 times more ions than freshwater, it increases the voltage between the two electrodes, thus making it possible to reap more electricity than the amount used to charge the battery. Prof. Cui's team has achieved 75% efficiency in converting energy to electrical current, and expects to reach 85% efficiency in the future. A power plant using this type of battery could be situated anywhere freshwater runs into the sea, such as an estuary. The researchers calculate that a power plant operating with 50 cubic meters of freshwater per second could produce up to 100 megawatts of power. The water does not have to be extremely clean; storm runoff and gray water could potentially be used.

This system could be modified to operate on a smaller scale using solar energy to distill water, with complete recycling of the electrolyte to achieve conversion of solar energy into electrical energy. Also, if the process is reversed, it can potentially be used as a method for water desalination.

Applications

- Utility scale battery
- Solar energy
- Desalination

Advantages

- Completely renewable source of energy
- Minimal environmental footprint
- Simple to fabricate
- Reduced cost
- Doesn't rely on membranes
- Overcomes the challenges of supercapacitor electrodes based on activated carbon

Publications

- Fabio La Mantia, Mauro Pasta, Heather D. Deshazer, Bruce E. Logan, and Yi Cui, " Batteries for Efficient Energy Extraction from a Water Salinity Difference," Nano Letters, published online March 17, 2011.
- "Stanford researchers use river water and salty ocean water to generate electricity," Stanford Report, published online March 28, 2011.
- Mauro Pasta, Colin Wessells, Yi Cui, and Fabio La Mantia, "A Desalination Battery," Nano Letters (2012), 12 (2), pp 839–843, published online January 23, 2012, DOI: 10.1021/nl203889e
- "Stanford Woods Institute for the Environment announces 2012 Environmental Venture Project awards," Stanford Report, June 21, 2012.

Patents

- Published Application: 20120135282
- Published Application: WO2012061429

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