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Microbial desalination cell: a sustainable approach for brackish water desalination and wastewater treatment with bioelectricity generation

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Abstract

"The shortage of the fresh water has become a more and more serious issue because of the rapid increase in human population and resource consumption. Although water is an abundant natural resource available in the earth, only 3% of the water is potable and the other 97 % (seawater) is not potable. To meet the demand for fresh water, desalination processes are used for removing salt from seawater. The major limitation with current desalination processes (membrane or thermal) is their high energy requirement. Therefore, new technologies are required to reduce energy consumption by desalination. Among the new developments, microbial desalination cell (MDC) has a great potential as a low-energy desalination process with significant benefits such as simultaneous wastewater treatment.

MDC is a new technology in which salt water can be desalinated without using any external energy source (except that for pumping water). The exoelectrogenic-bacteria in the anode of an MDC oxidize biodegradable substrate in wastewater and transfer the electrons to the anode electrode. Those electrons flow through an external circuit to the cathode electrode where they are used to reduce external electron acceptors such as oxygen. Unlike microbial fuel cell (MFC) from which an MDC is derived, an MDC contains a middle chamber between the anodic and cathodic chambers formed by a pair of anion exchange membrane and cation exchange membranes. This middle chamber works as a desalination chamber like that in an electrodialysis (ED). The potential difference between the anode and cathode electrodes drives the migration of ions out of the desalination chamber, with cations (Na^+) migrating to the cathodic chamber and anion (Cl^-) moves to the anodic chamber. As a result, salts are removed from the saltwater. MDC technology could be attractive in Qatar and the region because of strong demand for cost effective desalination technologies for desalination of seawater through linking to conventional desalination process, or of brackish water.

This paper will introduce the fundamentals and future prospects of MDC technology."