Development of a Microbial Desalination Fuel Cell (MDFC) Based on C Type Cyt and Extracellular Polymeric Substances (EPS) From S. putrefaciens

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This study presents the design, development and mechanistic investigation of a novel self-powered electrochemical system, the Microbial Desalination Fuel Cell (MDFC), capable of simultaneous electricity generation and seawater desalination without external power input. Shewanella putrefaciens was employed as the electron-donating microorganism, utilizing its C type cytochrome (Cyt) based extracellular electron transfer (EET) pathway. Extracellular polymeric substances (EPS) secreted during metabolism were incorporated as an ion buffering layer and integrated into the internal electrochemical reactions of the MDFC. Experimental results demonstrated that the presence of EPS significantly improved the stability of both current and voltage outputs. This enhancement is attributed to the insertion of ions (Na? and Cl?) into the EPS matrix, maintaining an electrostatic nonequilibrium state within the system. Furthermore, the application of C type Cyt led to a marked increase in current generation, likely due to the multi-heme structure of Cyt facilitating direct electron transfer (DET, by extracellular electron transfer (EET)) and reducing charge transfer resistance at the cell–electrode interface. Meanwhile, the salinity of the seawater chamber gradually decreased over time. When converted to actual seawater concentration, the results confirmed that desalination to freshwater levels could be achieved within 24 hours. This study demonstrates the potential of MDFC as a sustainable and eco-friendly technology capable of simultaneously supplying water and electricity in resource-limited environments such as arid regions.

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