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Salinity-Gradient Energy Driven Microbial Electrosynthesis of Hydrogen Peroxide from Oxygen Reduction

Xiaohu Li, Yifeng Zhang*, Irini Angelidaki*

DTU Environment

*Corresponding author email: yifz@env.dtu.dk (Y. Zhang), iria@env.dtu.dk (I. Angelidaki)

Hydrogen peroxide (H$_2$O$_2$) is widely used in various chemical industries and environmental remediation. Recently, bioelectrochemical systems (BES) have gained increasing attention for synthesizing H$_2$O$_2$ with simultaneous wastewater treatment [1]. However, in order to get high-yield H$_2$O$_2$ requires additional electrical energy to power these BES or control the cathode potential. In this study, we develop an innovative BES called microbial reverse-electrodialysis electrolysis cell (MREC) to produce H$_2$O$_2$ in cathode. In the MREC (See Fig.1), the salinity-gradient energy between seawater and river water can be used to generated renewable electrical energy to replace the external power supply [2]. Operational parameters such as air flow rate, pH, cathodic potential, flow rate of high and low concentration NaCl solution in RED were investigated as to improve the H$_2$O$_2$ yield. The optimal parameters for H$_2$O$_2$ production are air gas flow rate of 8-20 ml/min, cathode potential of -0.485 ± 0.025 V vs Ag/AgCl, the corresponding dissolved oxygen is 6.80 ± 0.30 mg/l in catholyte. Under the optimal conditions, a maximum H$_2$O$_2$ yield of 770 ± 18 mg/L could be obtained with corresponding H$_2$O$_2$ production rates of 0.44 ± 0.04 g/m$^2$/h and current density of 1.40 ± 0.13 A/m$^2$. Results indicate the air gas flow rate and cathode potential are the key parameters for H$_2$O$_2$ production in MREC. This study indicate for the first time high yield synthesis of H$_2$O$_2$ from oxygen reduction in BES without external power supply, furthermore, we also discover the cathode potential can be controlled through adjusting the air flow rate without power supply and potentiostat.

Reference
