Enhanced Area of Current Collector Increase Power Generation of Microbial Fuel Cell

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Abstract

Microbial fuel cell (MFC) is an innovative environmental and energy system that converts organic wastewater into electrical energy. For the practical implementation of MFC as a wastewater treatment process, a number of limitations need to be overcome. Improving cathodic performance is one of the major challenges, and introduction of a current collector can be an easy and practical solution. In this study, three types of current collectors made of stainless steel (SS) were tested in a single-chamber cubic MFC. The three current collectors had different contact areas to the cathode (P 1.0 cm², PC 4.3 cm², PM 6.5 cm²) and increasing the contacting area enhanced the power and current generations and coulombic and energy recoveries by mainly decreasing cathodic charge transfer impedance. Application of the SS mesh to the cathode (PM) improved maximum power density, optimum current density, and maximum current density by 8.8%, 3.6%, and 6.7%, respectively, compared with P of no SS mesh. The SS mesh decreased cathodic polarization resistance by up to 16%, and cathodic charge transfer impedance by up to 39%, possibly because the SS mesh enhanced electron transport and oxygen reduction reaction.

Material & Methods

1. Anode & Cathode
A brush electrode was made with a carbon fiber brush (25-mm diameter and 50-mm length) as an anode. Platinum-coated carbon-cloth cathode was made of carbon cloth, with a PTFE diffusion layer on the air facing side and Pt catalyst layer on the solution side.

2. Current collector
Three different current collectors were made of non-corrosive stainless steel plate (SUS 304) and stainless steel mesh (# 30, type SUS 304). A broad stainless steel plate (1 cm² of contact area) (P), rounded rim (4.3 cm² of contact area) (PC), a broad stainless steel mesh (6.5 cm² of contact area) (PM) were applied to a cathode.

Conclusions

• Increasing contacting area of a carbon cloth cathode to a metal current collector increased the power, current densities, and coulombic and energy recovery of the MFC by decreasing cathodic resistance.
• Application of a SS mesh to the cathode (PM) improved maximum power density, optimum current density and maximum current density of the MFC by 8.8%, 3.6% and 6.7%, respectively, compared with P having no SS mesh.
• In overall, by applying a SSM, cathodic polarization resistance decreased by up to 16%, and cathodic charge transfer impedance decreased by up to 39%.

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