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Effect of cathode types on long-term performance and anode bacterial communities in microbial fuel cells

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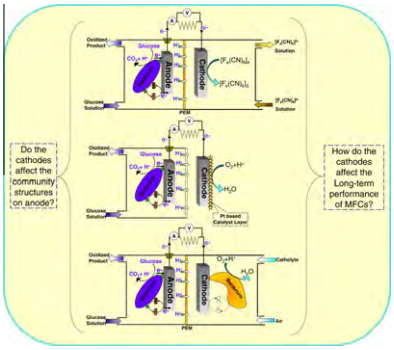
HIGHLIGHTS

- Cathode effect on MFC long-term stability and anode community is substantial.
- MFCs R1–3 with $K_3Fe(CN)_6$ catholyte, air cathode and biocathode were evaluated.
- Over time the P_{max} and CE of R1 and R2 were all impaired, except for R3.
- The anode bacterial density in R3 biofilm was higher than in R1 and R2.
- Community structures of R1–3 were markedly different.

GRAPHICAL ABSTRACT



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ABSTRACT

Effects of cathode types on the long-term stability of microbial fuel cell (MFC) and the anodic microbial communities were studied using $K_3Fe(CN)_6$ catholyte (R1), air cathode (R2) and biocathode (R3) over a testing time of 400 d. Upon 400 d of testing, the maximum power densities (P_{max}) of R1 and R2 decreased by 44% and 37%, and the Coulombic efficiencies (CEs) decreased 8.4% (R1) and 2.0% (R2), respectively, using the performances on 10 d as the comparison basis. Conversely, the P_{max} and CE of R3 increased by 68.2% and 116.8%, respectively. The non-ohmic resistances (R_{no}) in all tests were the principal contributors of cell internal resistances. Phylogenetic analyses revealed that the microbial communities on anodic surface varied with cathode types and operational history.

1. Introduction

A microbial fuel cell (MFC) is a device to extract electricity from organic and/or inorganic electron donors through biocatalytic reactions (Logan et al., 2006). MFCs consist of anode and cathode, often being separated by an ion exchange membrane. The cathode is the electron sink of an MFC, the efficiency of electron transport on it affects the performance of MFC (Cheng et al., 2006a; Fan et al., 2008). The long-term stability of MFC was determined by numerous factors including characteristics of electrode materials, membranes, biofilms formed on electrode surface, and particularly the cathodic performance (Logan, 2008).

Potassium ferricyanide ($(K_3Fe(CN)_6$) (Aelterman et al., 2006), potassium permanganate (You et al., 2006) and potassium dichromate (Li et al., 2008) were added in cathodic cell as promoted

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