Bioresource Technology 120 (2012) 26–33

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Long-term effect of set potential on biocathodes in microbial fuel cells: Electrochemical and phylogenetic characterization

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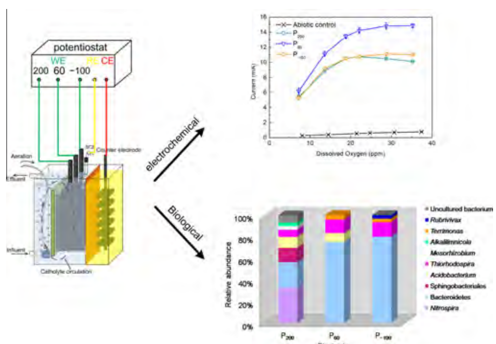
HIGHLIGHTS

- ▶ The long-term effect of set potential on oxygen reducing biocathode was studied.
- ▶ 60 mV *vs.* SCE is the optimum potential to get a high electrochemical performance.
- ▶ A period of 40–60 days is needed for biocathode regulation to get a mature biofilm.
- ▶ Potential impacts the specific electrochemical activity rather than biomass amount.
- ▶ Potential has a strong selection for cathode bacteria.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 27 April 2012
Received in revised form 9 June 2012
Accepted 9 June 2012
Available online 16 June 2012

Keywords:
Microbial fuel cell
Biocathode
Set potential
Long-term effect

ABSTRACT

The long-term effect of set potential on oxygen reducing biocathodes was investigated in terms of electrochemical and biological characteristics. Three biocathodes were poised at 200, 60 and −100 mV *vs.* saturated calomel electrode (SCE) for 110 days, including the first 17 days for startup. Electrochemical analyses showed that 60 mV was the optimum potential during long-term operation. The performance of all the biocathodes kept increasing after startup, suggesting a period longer than startup time needed to make potential regulation more effective. The inherent characteristics without oxygen transfer limitation were studied. Different from short-term regulation, the amounts of biomass were similar while the specific electrochemical activity was significantly influenced by potential. Moreover, potential showed a strong selection for cathode bacteria. Clones 98% similar with an uncultured Bacteroidetes bacterium clone CG84 accounted for 75% to 80% of the sequences on the biocathodes that showed higher electrochemical activity (60 and −100 mV).

1. Introduction

Microbial fuel cells (MFCs) are a promising technology for simultaneous wastewater treatment and electricity production (Logan et al., 2006). Currently, the relatively high cost and low performance of cathodes have become big obstacles for the practical application of MFCs (Rozendal et al., 2008; Wei et al., 2011a). To make MFCs more cost-effective, cathodes with catalysts other than the noble metal Pt have been developed for oxygen reduction (Clauwaert et al., 2007; Zhao et al., 2005), among which biocathodes using microorganisms as catalysts are an attractive alternative (Liang et al., 2009; Xie et al., 2011). Compared with chemical cathode MFCs, the cost of biocathode MFCs can be lower without the involvement of precious metals. Moreover, the microorganisms on cathode are self-sustainable (He and Angenent, 2006), contributing to a long-term stability of biocathode MFCs. Nevertheless, the enrichment of cathode bacteria is difficult since most of them are autotrophs (Huang et al., 2011b). This leads to a long startup time and a relatively low power generation of biocathode MFCs.

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http://dx.doi.org/10.1016/j.biortech.2012.06.017