Bioresource Technology 128 (2013) 259–265

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Comparative investigation on microbial community and electricity generation in aerobic and anaerobic enriched MFCs

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HIGHLIGHTS

- Power density as an important parameter to evaluate MFC performance was added.
- The uncertainties of CE and COD were amended in manuscript and figures.
- The performance of the aerobic MFC was compared with other studies.
- Languages were polished and spelling and grammar errors were corrected.

ARTICLE INFO

Article history:
Received 4 July 2012
Received in revised form 25 September 2012
Accepted 2 October 2012
Available online 23 October 2012

Keywords:
Microbial fuel cell
Microbial community
Power generation
Anode aeration

ABSTRACT

This study compared the difference in microbial community and power generation capacity of air-cathode MFCs enriched under anode aerobic and anaerobic conditions. Results showed that MFCs successfully started with continuous air inputting to anode chamber. The aerobic enriched MFC produced comparable and even more electricity with the fuels of acetate, glucose and ethanol compared to the anaerobic MFC when returning to anaerobic condition. The two MFCs showed a slightly different microbial community for anode biofilms (a similarity of 77%), but a highly similar microbial community (a similarity of 97%) for anolyte microbes. The anode biofilm of aerobic enriched MFC showed the presence of some specific bacteria closely related to *Clostridium sticklandii*, *Leucobacter komagatae* and *Microbacterium laevaniformans*. The anaerobic enriched MFC found the presence of a large number of yeast *Trichosporon* sp. This research demonstrates that it is possible to enrich oxygen-tolerant anode respiring bacteria through purposely aeration in anode chamber.

1. Introduction

Microbial fuel cell is a bio-electrochemical system with exoelectrogenic microbes as biocatalyst to produce electricity. Exoelectrogenic bacteria are capable of transferring electrons outside their cells through direct contact or using soluble electron shuttles. Based on types of respiration, known exoelectrogens can be classified into the groups of obligate anaerobic, facultative and aerobic bacteria. Different types of exoelectorgens may have different responses to the presence of oxygen. A typical electro-chemical active bacteria *Geobacteraceae* are obligate anaerobes and very sensitive to the presence of oxygen (Bond and Lovley, 2003). *Shewanella* is a well known facultative exoelectrogens, which can produce power under both anaerobic and aerobic conditions. There are some aerobic facultative exoelectrogens which can use both oxygen and anode as electron acceptors, such as *Pseudomonas* sp. and *Burkholderia* sp. (Borole et al., 2011; Kim et al., 2006). Therefore, MFCs can be expected to harvest energy with different types of microorganisms as bio-catalysts from a wide variety of carbon sources under diverse environmental conditions.

MFC anode biofilms often show the presence of diverse populations when enriched under different conditions. In most cases, MFC culture is enriched under anaerobic conditions and oxygen is tried to be removed from the anode chamber during operation. To achieve that, proton exchange membranes (PEM) are generally used as separator to prevent oxygen diffusion from the air-cathode. However, recent researches have found that some MFCs performed well with an amount of oxygen in the anode chamber. For example, a pure strain *Shewanella oneidensis* DSP 10 could even generate electricity in the presence of high oxygen ($\geqslant$8 ppm) (Ringeisen et al., 2007). Biffinger et al. (2008) compared the performance a mini MFC fed with glucose and inoculated with a pure strain *Shewanella* under aerobic and strictly anaerobic conditions, and found that more power density ($270 \pm 10\ W/m^3$) was obtained when the anode chamber was exposed oxygen compared to the

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http://dx.doi.org/10.1016/j.biortech.2012.10.001