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Using a glass fiber separator in a single-chamber air-cathode microbial fuel cell shortens start-up time and improves anode performance at ambient and mesophilic temperatures

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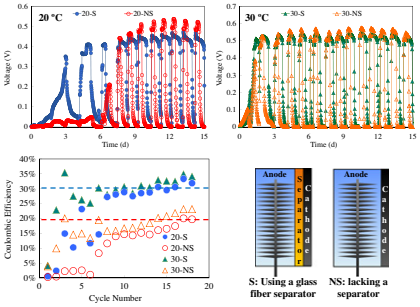
HIGHLIGHTS

- Using a separator in MFCs shortened start-up time at both 20 °C and 30 °C.
- Using a separator in MFCs enhanced anode performances at both 20 °C and 30 °C.
- MFC with a separator acclimated at 30 °C exhibited adaptability at 20 °C.

GRAPHICAL ABSTRACT



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ABSTRACT

A shorter start-up time and highly negative anode potentials are needed to improve single-chamber air-cathode microbial fuel cells (MFCs). Using a glass fiber separator reduced the start-up time from 10 d to 8 d at 20 °C, and from 4 d to 2 d at 30 °C, and enhanced coulombic efficiency (CE) from <60% to 89% (20 °C) and 87% (30 °C). Separators also reduced anode potentials by 20–190 mV, charge transfer resistances by 76% (20 °C) and 19% (30 °C), and increased CV peak currents by 24% (20 °C) and 8% (30 °C) and the potential range for redox activity (−0.55 to 0.10 mV vs. −0.49 to −0.24 mV at 20 °C). Using a glass fiber separator in an air-cathode MFC, combined with inoculation at a mesophilic temperature, are excellent strategies to shorten start-up time and to enhance anode performance and CE.

1. Introduction

Microbial fuel cells (MFCs) generate electricity from biomass using bacteria as catalysts, which can treat wastewater and simultaneously harvest electrical energy from waste (Logan, 2008; Logan and Rabaey, 2012; Lovley, 2008; Rabaey and Verstraete, 2005; Wang et al., 2012). The technical development of MFCs from small scale laboratory-based reactors, to larger-scale systems that can produce practical products faces inherent challenges to become an efficient and economical alternative to current commercialized wastewater treatment technologies (Logan, 2008). A number of factors have been found to influence MFC performances, including reactor materials and architectures (Cheng and Logan, 2007; Logan et al., 2006, 2007; Zhang et al., 2009a), substrate and solution chemistry (Fan et al., 2008; Feng et al., 2008; Huang and Logan, 2008; Liu et al., 2005), and operation mode (Ahn and Logan, 2010; Cheng et al., 2006b; Ren et al., 2011).

Temperature is an important operational parameter for MFCs (Ahn and Logan, 2010; Cheng et al., 2011; Michie et al., 2011; Patil et al., 2010). For half-cell experiments under potentiostatic control, biofilm formation required more than 40 days at 15 °C, decreased

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