



Electricity generation from a floating microbial fuel cell

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ABSTRACT

A floating microbial fuel cell (FMFC) has been designed and its performance has been evaluated for 153 days. The power output gradually increased to a maximum value of 390 mW/m³ at 125 days. The polarization resistance of the anode (R_p^a) changed with operating time reaching a minimum value at 125 days, while the polarization resistance of the cathode (R_p^c) was relatively constant and much smaller than R_p^a . It has been demonstrated that the observed changes of the internal resistance (R_{int}) and the maximum power (P_{max}) with exposure time were mainly due to the changes of R_p^a . Compared with sediment MFCs for which the anode is embedded in marine or river sediments, the application of the FMFC, which could be installed in a buoy, is not limited by the depth of the ocean. The FMFC has the potential to supply electricity to low-power consuming electronic devices at remote locations.

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1. Introduction

Electrical energy can be harvested using sediment microbial fuel cells (SMFCs) that consist of an anode embedded in marine or river sediment and a cathode suspended in the aerobic water column above the anode (Dumas et al., 2007; Girguis et al., 2010; Nielsen et al., 2008; Schampelaire et al., 2008). Bacteria inhabiting the sediment oxidize organic compounds and supply electrons to the anode, while at the cathode oxygen is reduced (Dumas et al., 2007; Girguis et al., 2010; Nielsen et al., 2008; Schampelaire et al., 2008). Holmes et al. (2004) have shown that among the different electrochemically active bacteria, *Desulfuromonas* spp. are rich in marine sediments, while *Geobacter* spp. become predominant in freshwater sediments.

Current technologies provide electric power to remote sensors or other electronic devices via batteries, which require periodic replacement at a high cost, in addition to the cost of the batteries themselves. SMFCs have been studied and developed to operate low-power consuming electronic devices installed in marine or river environments (Dumas et al., 2007; Logan et al., 2006; Lowy et al., 2006; Schampelaire et al., 2008; Tender et al., 2008). Tender et al. (2008) demonstrated that a benthic microbial fuel cell (BMFC) can be used as an alternative to batteries for a meteorological buoy. SMFCs are potentially advantageous over current technologies (e.g. batteries) for powering remote sensors or other

electronic devices because of low cost and less frequent maintenance (e.g. periodic replacement).

SMFCs are commonly installed in marine or river sediment (Dumas et al., 2007; Girguis et al., 2010; Logan et al., 2006; Lowy and Tender, 2008; Lowy et al., 2006; Nielsen et al., 2008; Schampelaire et al., 2008; Tender et al., 2008). The cathode should be deployed close to the water surface to ensure sufficient oxygen supply. The distance between the anode and the cathode cannot be too large due to increased installation difficulties and Ohmic drop. Hence, it is questionable whether the traditional SMFCs could be applied in deep waters at remote areas. To overcome the limitation due to water depth, the floating MFC (FMFC) was designed for potential applications at remote locations. A single-chamber tubular FMFC has been evaluated during exposure at Long Beach Harbor, CA for 153 days. Previous studies have investigated floating-type MFCs that were significantly different from the present FMFC in reactor configuration and operation (An et al., 2009; Song et al., 2010). The obtained results in the present study have demonstrated that electricity was constantly produced from the FMFC which in the future may be installed with a buoy floating in ocean water.

2. Experimental approach

2.1. FMFC configuration and operation

A schematic of the FMFC developed in this project is shown in Fig. 1. The FMFC was constructed using a tube made of cation exchange membrane (Ultrax CMI7000, Membranes International,

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