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Performance Evaluation of a Low-Cost Microbial Fuel Cell Using Municipal Wastewater

Germán Buitrón · Carlos Cervantes-Astorga

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Abstract A low-cost microbial fuel cell (MFC) with a brush-shaped anode was constructed with low-cost materials and operated in a fed-batch mode using wastewater as a substrate. The operational performance of the MFC was evaluated considering the organic matter removal, coulombic efficiencies, and current and power densities. Its relative performance to cost was evaluated considering a MFC with platinum/carbon cathode. It was observed that the organic matter removal efficiency was up to 80 % and the coulombic efficiencies varied from 3.5 to 5.7 %. Maximum average voltages and power and current densities of 207±30 mV, 9.2±2.4 mW m^{-2}, and 56.8±14.9 mA m^{-2} were obtained, respectively. It was observed that the low-cost MFC produced higher power and current densities per dollar when compared to a MFC using platinum-catalyzed electrode.

Keywords Microbial fuel cell · Wastewater · Current density · Power density · Low-cost materials

G. Buitrón (✉) · C. Cervantes-Astorga
Laboratory for Research on Advanced Processes for Water Treatment, Instituto de Ingeniería, Unidad Académica Juriquilla, Universidad Nacional Autónoma de México, Blvd. Juriquilla 3001,
Querétaro 76230, Mexico
e-mail: gbuitronm@ii.unam.mx

1 Introduction

Microbial fuel cells (MFCs) are devices that use bacteria as the catalysts to oxidize organic and inorganic matter and to produce electrical current. Electrons produced by bacteria from these substrates are transferred to the anode and flow to the cathode linked by a conductive material containing a resistor (Logan et al. 2006). Due to improvements of the reactor design, the application of new electrodes materials, and the enrichment of highly specialized microbial communities, the performance of MFCs has increased steadily over the last years (Aelterman et al. 2008; Pham et al. 2009). In particular, the volumetric power densities have been improved by increasing the total surface area of the electrodes per volume of reactor and by reducing the total reactor volume (Logan 2010). Fan et al. (2007) reported that using oxygen and a separator between the electrodes, a power density of 1.55 kW m^{-3} was produced with a cathode surface area of 280 m^{2}m^{-3}.

The potential applications of MFCs have been increasingly expanded from the production of power from the electrical current generated by bacteria to other applications as the generation of several products at the cathode such as hydrogen, methane, and hydrogen peroxide (Rozendal et al. 2006, 2009). However, the scaling up of the process for practical applications is a problem, because they use expensive materials for its