Chemical Engineering Journal 218 (2013) 19–23

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

High-quality effluent and electricity production from non-CEM based flow-through type microbial fuel cell

Kyoung-Yeol Kim[a], Kyu-Jung Chae[b], Mi-Jin Choi[a], Eun-Tae Yang[a], Moon Hyun Hwang[a], In S. Kim[a,*]

[a] School of Environmental Science and Engineering, Gwangju Institute of Science and Technology (GIST), 261 Cheomdan-gwagiro, Buk-gu, Gwangju 500-712, South Korea
[b] R&BD Center, Kolon Global Corporation, 199-5 Jeondae-ri, Pogok-eup, Cheoin-gu, Yongin-si, Gyeonggi 449-815, South Korea

HIGHLIGHTS

- ▶ A new flow-through type MFC equipped with a UF membrane instead of CEM is proposed.
- ▶ High-quality effluent and electricity can be simultaneously achieved in UF-MFC.
- ▶ Maximum power density of UF-MFC was 53.5 mW/m^2.
- ▶ High removal rate was observed for COD and total coliform (90% and 97% each).
- ▶ The pH in both of chambers of the UF-MFC was kept around neutral.

ARTICLE INFO

Article history:
Received 6 June 2012
Received in revised form 3 December 2012
Accepted 5 December 2012
Available online 12 December 2012

Keywords:
High-quality effluent
Ultrafiltration microbial fuel cell (UF-MFC)
Flow-through type
Non-CEM based
Membrane bioreactor (MBR)

ABSTRACT

A new flow-through type microbial fuel cell (MFC) system was developed for practical application as a wastewater treatment process. The ultrafiltration MFC (UF-MFC), which has a UF membrane instead of an expensive cation exchange membrane (CEM) as a separator, was designed to continuously filter the anode chamber solution to cathode chamber via UF membrane. Through the UF-MFC system, high-quality effluent and electricity generation can be simultaneously achieved by the two different wastewater treatment processes applied, e.g., a biological organic pollutant removal in the anode chamber by electrochemically active bacteria and a physical filtration by UF membrane. The maximum power density of the UF-MFC was 53.5 mW/m^2, lower than the power density shown by comparison with a Nafion based two-chambered MFC (55.7 mW/m^2). However, the UF-MFC continuously produced high-quality effluent that did not need further post-treatment processes, showing a high and stable COD removal efficiency (>90%), and high rejection rate for total coliform (>97%) and suspended solids during 20 d operation. This study confirmed that UF-MFC s could be a promising technology for both of efficient wastewater treatment and energy recovery from wastewater in future wastewater treatment plants.

1. Introduction

Microbial fuel cell (MFC) technology has been developed in attempts to acquire renewable energy during wastewater treatment [1–3]. However, current MFC technologies are not attractive as a replacement for existing wastewater treatment processes since MFCs cannot effectively remove water pollutants from wastewater, except for biodegradable organic compounds. As a wastewater treatment process, MFC is one of biological wastewater treatment process such as conventional activated sludge (CAS) or anaerobic digestion (AD). And although most organic matter can be removed by these biological systems, the remaining effluent still contains high concentrations of suspended solids (SS); lingering pathogens and/or viruses also have the potential to cause serious disease outbreaks [4]. In addition, all wastewater treatment processes should now consider the removal of micropollutants such as pharmaceuticals and personal care products (PPCPs) and endocrine disrupting compounds (EDCs), which now exist in the effluent even after completion of the wastewater treatment process [5]. For these reasons, in order to apply an MFC system to a practical wastewater treatment plant, the quality of water treated by the MFC process has become an important operational factor, in addition to the electricity generation efficiency of the plant.

Another drawback for the practical application of MFCs is the utilization of an expensive cation exchange membrane (CEM). CEMs have been widely used in MFCs as a separator between the anode and cathode chambers and for sustaining the charge balance by proton or cation transport between the two chambers during electricity generation. However, CEMs are still expensive, despite

* Corresponding author. Tel.: +82 62 715 3381; fax: +82 62 715 2434.
E-mail address: iskim@gist.ac.kr (I.S. Kim).

1385-8947/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.cej.2012.12.018