Alexandria Engineering Journal (2015) **xxx**, xxx–xxx

HOSTED BY
ELSEVIER

Alexandria University

Alexandria Engineering Journal

www.elsevier.com/locate/aej
www.sciencedirect.com

REVIEW

Microbial fuel cell as new technology for bioelectricity generation: A review

Mostafa Rahimnejad [a,b,*], Arash Adhami [a,b], Soheil Darvari [a,b], Alireza Zirepour [a,b], Sang-Eun Oh [c]

[a] *Biofuel & Renewable Energy Research Center, Faculty of Chemical Engineering, BabolNoshirvani University of Technology, Babol, Iran*
[b] *Advanced Membrane & Biotechnology Research Center, Faculty of Chemical Engineering, BabolNoshirvani University of Technology, Babol, Iran*
[c] *Department of Biological Environment, Kangwon National University, Chuncheon, Kangwon-do, Republic of Korea*

Received 5 September 2014; revised 18 March 2015; accepted 22 March 2015

KEYWORDS

Microbial fuel cell;
Biosensor;
Biocatalyst;
Anaerobic anode;
Bioelectricity

Abstract Recently, great attentions have been paid to microbial fuel cells (MFCs) due to their mild operating conditions and using variety of biodegradable substrates as fuel. The traditional MFC consisted of anode and cathode compartments but there are single chamber MFCs. Microorganisms actively catabolize substrate, and bioelectricities are generated. MFCs could be utilized as power generator in small devices such as biosensor. Besides the advantages of this technology, it still faces practical barriers such as low power and current density. In the present article different parts of MFC such as anode, cathode and membrane have been reviewed and to overcome the practical challenges in this field some practical options have been suggested. Also, this research review demonstrates the improvement of MFCs with summarization of their advantageous and possible applications in future application. Also, Different key factors affecting bioelectricity generation on MFCs were investigated and these key parameters are fully discussed.

© 2015 Faculty of Engineering, Alexandria University. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Contents

* Corresponding author at: Biofuel & Renewable Energy Research Center, Faculty of Chemical Engineering, BabolNoshirvani University of Technology, Babol, Iran. Tel./fax: +98 111 323 4204.
E-mail addresses: Rahimnejad@nit.ac.ir, Rahimnejad_mostafa@yahoo.com (M. Rahimnejad).

Peer review under responsibility of Faculty of Engineering, Alexandria University.

http://dx.doi.org/10.1016/j.aej.2015.03.031
1110-0168 © 2015 Faculty of Engineering, Alexandria University. Production and hosting by Elsevier B.V.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

In the recent decades, consumption of energy within the world has had a prosperous trend [1]. Energy sources are classified into three batches: fossil fuels, renewable sources and nuclear sources [2], in which non-renewable sources of energy, which include an enormous portion of energy consumption, could be categorized into two major classifications: nuclear and fossil energy [3]. Fossil fuels negatively influence the nature owing to the emission of carbon dioxide. It follows logically from what has been said that the consumption of fossil fuels has severely imperiled human life through its drastic aftermaths, such as global warming and atmospheric pollution [4].

However, miscellaneous countries around the world have made remarkable efforts to find a piece of cogent solution for energy crisis by turning the eyes into renewable energy sources such as solar energy, energy produced from wind and water. As an upshot of these efforts, one of the latterly proposed alternative energy sources is fuel cell (FC) which generates energy using high value metal catalysts (in the traditional version). In actual fact, FC is of plethora advantages over other kinds of energy generators, e.g. no emissions of environmental polluting gases (such as SOx, NOx, CO_2 and CO), higher efficiency, no existence of mobile parts, as a result, lack of sonic pollution, and so forth [5]. In contrast, high cost and high mass generation are the only disadvantages of these new energy sources [5,4].

One type of FCs is microbial fuel cell (MFC) that uses an active microorganism as a biocatalyst in an anaerobic anode compartment for production of bioelectricity [6,7]. Although electrical current produced by bacteria was observed by Potter in 1911 [8], limited feasible results were acquired in this area by the next 50 years [9]. However, in the early 1990s, FCs became far more appealing devices; consequently, MFCs were considered as promising technology [10]. Furthermore, research domain of MFCs turned much vaster in 1999 once it was discovered that mediator was not a compulsory component within MFCs [11–13].

Approximately all MFCs, as it is shown in Fig. 1, consist of anode and cathode chambers, physically separated by a proton exchange membrane (PEM) [14]. Active biocatalyst in the anode oxidizes the organic substrates and produces electrons and protons [15]. The protons are conducted to the cathode chamber through the PEM, and the electrons are conveyed through the external circuit [16]. Protons and electrons are

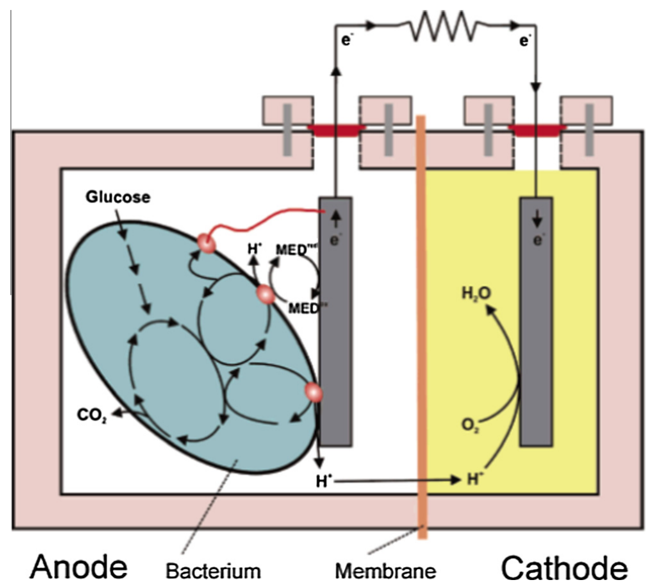

Figure 1 The MFC system is consisted of anode and cathode compartments [22].

reacted in the cathode chamber along with parallel reduction of oxygen to water [17]. It is worth mentioning that active biocatalyst in the anode compartment oxidizes the carbon sources or substrates, and generates electrons and protons. As a further illuminating illustration, anodic reaction of acetic acid is presented in Eq. (1). Oxygen in the anode chamber will inhibit the production of electricity; thus, a pragmatic system must be designed to keep the bacteria separated from oxygen (anaerobic chamber for anodic reaction) [18].

Biocatalyst is able to be divided from oxygen by posing a membrane between two separate chambers that allow charge to be transferred between the electrodes, the anode chamber, where the bacteria grow, and the cathode chamber, where the electrons react the oxygen [19].

$$C_2H_4O_2 + 2H_2O \rightarrow 2CO_2 + 8e^- + 8H^+ \quad (1)$$

$$2O_2 + 8H^+ + 8e^- \rightarrow 4H_2O \quad (2)$$

Based on transfer of produced electron by active microorganisms from media to anode electrode, MFCs could be of two different categories: MFCs with mediator and mediator-less MFCs [20].

Please cite this article in press as: M. Rahimnejad et al., Microbial fuel cell as new technology for bioelectricity generation: A review, Alexandria Eng. J. (2015), http://dx.doi.org/10.1016/j.aej.2015.03.031

Download English Version:

https://daneshyari.com/en/article/816328

Download Persian Version:

https://daneshyari.com/article/816328

Daneshyari.com