Bioresource Technology 119 (2012) 22–27

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Efficient decolorization of real dye wastewater and bioelectricity generation using a novel single chamber biocathode-microbial fuel cell

Shafeer Kalathil, Jintae Lee, Moo Hwan Cho *

School of Chemical Engineering, Yeungnam University, Gyeongsan, Gyeongsangbukdo 712-749, Republic of Korea

HIGHLIGHTS

- ▶ A highly scaled-up MFC for decolorization of real dye wastewater and electricity generation.
- ▶ We have addressed most of the obstacles that hinder large scale applications of MFC.
- ▶ The proposed MFC produced a high power density with high removals of color, toxicity and COD.
- ▶ GAC-biocathode can be an excellent alternative to Pt and other chemical catalysts.

ARTICLE INFO

Article history:
Received 22 February 2012
Received in revised form 9 May 2012
Accepted 11 May 2012
Available online 26 May 2012

Keywords:
Microbial fuel cell
Scale-up
Granular activated carbon-biocathode
Decolorization
Toxicity

ABSTRACT

Large scale applications of microbial fuel cells (MFCs) have been severely hindered by several problems such as high internal resistance, low power output, expensive materials, and complicated configuration. To address these issues, a granular activated carbon based single chamber microbial fuel cell (GACB-SCMFC) has been designed using GAC-biocathodes without using any expensive materials for the simultaneous decolorization of real dye wastewater and electricity generation. The GACB-SCMFC produced a power density of 8 W/m^3 which indicates the GAC-biocathode can be a good alternative to platinum and other chemical catalysts. The dye wastewater was primarily treated at the anode and further polishing steps were occurred at the aerobic cathode. Toxicity measurement shows that the effluent after GACB-SCMFC operation was much less toxic compared to the original dye wastewater. Additional advantage of the GACB-SCMFC is that pH was automatically adjusted from 12.2 to 8 during 48 h of hydraulic retention time (HRT).

1. Introduction

Dye wastewater from textile industry is one of the most difficult industrial wastewaters to treat since dyes are recalcitrant organic molecules (Husain, 2010). It adversely affects environment due to its immense color and toxicities (Pant et al., 2008). Moreover, dyes are highly visible material and thus even minor release into the environment may cause the appearance of color which makes them aesthetically unacceptable. There are more than 100,000 commercially available dyes existing and more than 7×10^5 tones per year are produced annually (Pearce et al., 2003). The efficient removal of dyes from the textile effluents is one of the daunting tasks which still remain a major environmental challenge. There are numerous methods available for the decolorization of dye wastewater namely chemical, physical and biological methods. These methods inevitably add to the cost of the overall process and some of them present the complication associated with the possible toxicity degradation products (Robinson et al., 2001). In the chemical methods, there is also the possibility that a secondary pollution will arise because of excessive chemical use. It has been reported that many microorganisms such as fungi (Shin and Kim, 1998), algae (Dilek et al., 1999), yeasts (Martins et al., 1999) and bacteria (Wong and Yuen, 1998) can be used for the decolorization of dye wastewater. However, their large scale application is severely hindered by high cost and they cannot cope up with large amount of colored substances. Also, the usage of pure microbial cultures is of little help in the development of practical processes for the treatment of colored effluents because the dye degradation would be carried out under conditions unlikely to occur in an industrial situation (Chen et al., 2003). Enzymatic decolorization is now widely used for the decolorization of dye wastewater. However, this method is also facing several problems such as cost of enzymes, enzyme stability and product inhibition (Husain, 2010).

MFCs are new bio-electrochemical devices that use microorganisms as catalysts to produce electricity from the anaerobic degradation of biodegradable organic and inorganic substrates present

* Corresponding author. Tel.: +82 53 810 2517; fax: +82 53 810 4631.
E-mail address: mhcho@ynu.ac.kr (M.H. Cho).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.05.059