Bioresource Technology 126 (2012) 101–106

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Decolorization of an azo dye Orange G in microbial fuel cells using Fe(II)-EDTA catalyzed persulfate

Cheng-Gang Niu *, Ying Wang, Xue-Gang Zhang, Guang-Ming Zeng, Da-Wei Huang, Min Ruan, Xiang-Wei Li

College of Environmental Science and Engineering, Hunan University, Changsha 410082, PR China
Key Laboratory of Environmental Biology and Pollution Controls Hunan University, Ministry of Education, Changsha 410082, PR China

HIGHLIGHTS

- ▶ Microbial fuel cell using Fe(II)-EDTA catalyzed persulfate as the cathode solution.
- ▶ Microbial fuel cell degraded OG and harvest electricity simultaneously.
- ▶ The decolorization kinetics of OG followed the second-order kinetics well.
- ▶ EDTA could improve the stability of voltage output.

ARTICLE INFO

Article history:
Received 7 May 2012
Received in revised form 30 August 2012
Accepted 1 September 2012
Available online 8 September 2012

Keywords:
Microbial fuel cell
Fe(II)-EDTA catalyzed persulfate
Orange G decolorization
Maximum power density

ABSTRACT

This study constructed a microbial fuel cell (MFC) using Fe(II)-EDTA catalyzed persulfate as the cathode solutions to decolorize Orange G (OG) and harvest electricity simultaneously. Chelated Fe^{2+} could activate persulfate to generate sulfate free radicals (SO_4^{-}) which with high oxidation potential ($E^0 = 2.6$ V) can degrade azo dyes. The influence of some important factors such as pH value of cathode solutions, dosages of $K_2S_2O_8$, Fe^{2+} and EDTA were investigated in a two-chamber microbial fuel cell. Under an optimal condition, the maximum power density achieved 91.1 mW m^{-2}, the OG removal rate was 97.4% and the $K_2S_2O_8$ remaining rate was 47.3% after 12 h. The OG degradation by Fe(II)-EDTA catalyzed persulfate was found to follow the second-order kinetic model.

1. Introduction

Azo dyes are characterized by the presence of one or more azo bonds (–N=N–) in association with aromatic systems and auxochromes (–OH, $–SO_3$, etc.). Azo dyes represent more than 50% of all dyes in common use because of their chemical stability and versatility, and most of them are non-biodegradable, toxic and potentially carcinogenic in nature (Figueroa et al., 2009; Bakhshian et al., 2011). The widespread utilization of azo dyes has caused an important environmental problem (Gupta and Suhas, 2009). Many wastewater treatment technologies have been applied for the removal of azo dyes from aqueous solutions including physical, chemical, and biological processes (Yuan et al., 2011; Wu and Wang, 2001; Sun et al., 2006). Nevertheless, these methods are inefficient and costly for removing dyes from wastewater (Sun et al., 2009). In recent years, advanced oxidation processes (AOPs) have been widely developed as promising and efficient methods to treat these dyes such as Fenton reaction (Fu et al., 2010), TiO_2-mediated photocatalysis (Yu et al., 2008) and other oxidative reactions using persulfate with ferrous ion (Xu and Li, 2010). AOPs are based on *in situ* generation of very powerful oxidizing agent such as hydroxyl radical, which has one unpaired electron and was highly effective for removing organic dyes from water.

Fe^{2+} activated persulfate degradation of OG (a typical azo dye in textile wastewaters) has been reported (Xu and Li, 2010), and the reactions in accordance with Eqs. (1)–(3) (Kolthoff et al., 1951):

$$2Fe^{2+} + S_2O_8^{2-} \rightarrow 2Fe^{3+} + 2SO_4^{2-} \qquad (1)$$

Through the steps:

$$Fe^{2+} + S_2O_8^{2-} \rightarrow Fe^{3+} + SO_4^{-} \cdot + SO_4^{2-} \qquad (2)$$

$$SO_4^{-} \cdot + Fe^{2+} \rightarrow Fe^{3+} + SO_4^{2-} \qquad (3)$$

---

* Corresponding author at: College of Environmental Science and Engineering, Hunan University, Changsha, Hunan 410082, PR China. Tel.: +86 731 88823820.
E-mail addresses: cgniu@hotmail.com, cgniu@hnu.edu.cn (C.-G. Niu).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.09.001