Bioresource Technology 117 (2012) 55–62

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

# Performance of a continuous flow microbial electrolysis cell (MEC) fed with domestic wastewater

A. Escapa [a], L. Gil-Carrera [a], V. García [b], A. Morán [a,*]

[a] Chemical and Environmental Bioprocess Engineering Group, Natural Resources Institute (IRENA), University of Leon, Avda. de Portugal 41, Leon 24009, Spain
[b] Isolux-Corsan S.A., C/Caballero Andante 8, 28021 Madrid, Spain

## HIGHLIGHTS

- ▶ A continuous MEC was able to reduce up to 76% of the DQO of a domestic wastewater.
- ▶ Hydrogen production rate peaked at 0.3 L $L_r^{-1}$ $d^{-1}$ (hydraulic retention time: 3–6 h).
- ▶ Hydrogen production rate saturated at OLRs above 2000 mg $L_r^{-1}$ $d^{-1}$.
- ▶ Energy consumption was comparable to that typically associated to aerobic treatments.
- ▶ Low strength domestic wastewater failed to produce hydrogen regardless of the OLR.

## ARTICLE INFO

*Article history:*
Received 12 December 2011
Received in revised form 17 April 2012
Accepted 18 April 2012
Available online 26 April 2012

*Keywords:*
Microbial electrolysis cell
Domestic wastewater
Continuous flow
Hydrogen

## ABSTRACT

In this study, MEC performance was investigated in terms of chemical oxygen demand (COD) removal, hydrogen production rate and energy consumption during continuous domestic wastewater (dWW) treatment at different organic loading rates (OLR) and applied voltages ($V_{app}$). While the COD removal efficiency was improved at low OLRs, the electrical energy required to remove 1 g of COD was significantly increased with decreasing the OLR. Hydrogen production exhibited a Monod-type trend as function of the OLR reaching a maximum production rate of 0.30 L/(Lr d). Optimal $V_{app}$ was found to be highly dependent on the strength of the dWW. The results also confirmed the fact that MEC performance can be optimized by setting $V_{app}$ at the onset potential of the diffusion control region.

Although low columbic efficiencies and the occurrence of hydrogen recycling limited significantly the reactor performance, these results demonstrate that MEC can be successfully used for dWW treatment.


## 1. Introduction

Global energy needs and increasing concern about fossil fuel emissions have prompted scientists to research alternative fuels and energy production technologies. Hydrogen ($H_2$) has been suggested as the energy carrier of the future because it is a clean fuel, producing only water when combusted, and has a high-energy yield (142.35 kJ $g^{-1}$). Among the technologies currently available for hydrogen production, biological methods are generally preferred over chemical and thermal methods because organic wastes can be used as substrates (Gómez et al., 2011). As a result, wastes such as wastewater (WW) are now being regarded as potential commodities for bioenergy and biochemical production rather than as useless materials (Angenent et al., 2004). In contrast, activated sludge systems, a conventional WW treatment in developed nations, use large blowers to favor oxygen transfer from air into the mixed liquor that are energy intensive and increase treatment costs (Rosenbaum et al., 2010). Therefore, there is great interest in seeking new methods and technologies to reduce treatment costs or produce other products from WW.

A microbial electrolysis cell (MEC) is a device capable of converting the chemical energy contained in wastewater into hydrogen while reducing its organic load with an input of electricity. Since the production of hydrogen through MECs was first demonstrated (Liu et al., 2005), MEC performance has been evaluated using individual organic compounds such as acetate (Rozendal et al., 2006), glucose (Tartakovsky et al., 2008) and glycerol (Escapa et al., 2009). Few tests have been conducted with actual wastewaters, such as those from potato chip (Kiely et al., 2011) or swine facilities (Wagner et al., 2009) and wineries (Cusick et al., 2010; Cusick et al., 2011). Despite the great potential of microbial electrolysis in domestic wastewater (dWW) treatment, only two studies (Ditzig et al., 2007; Cusick et al., 2010) have explored the performance of MECs fed dWW to our knowledge. Ditzig et al. (2007)evaluated MEC performance in terms of hydrogen recovery,

* Corresponding author. Tel.: +34 987 29 1841; fax: +34 987 29 1839.
*E-mail address:* amorp@unileon.es (A. Morán).

0960-8524/$ - see front matter 
http://dx.doi.org/10.1016/j.biortech.2012.04.060