Effect of organic loading rate on anaerobic digestion of pig manure: Methane production, mass flow, reactor scale and heating scenarios

The effect of organic loading rate (OLR) with total solid (TS) control (3%–8%) on the performance of anaerobic digestion of pig manure (PM) using completely stirred anaerobic reactor was investigated. Based on the lab data, how OLR affects mass flow, construction scale and heating requirement in a farm-scale biogas plant was calculated. And three scenarios of typical reactor-heating technology were comparatively analyzed. The optimal OLR was 1.89g volatile solid (VS)/(L.d) with methane yield of 438.38 mL/gVS in the lab condition. The lower OLR, the larger amount of water and energy consumption, lower methane production and larger amount of liquid digestate was observed. Thus, the reactor with low OLR was suitable in tropical regions with the main target of disposing PM and fertilizer production. High OLR has advantage in the investment, but owns risk of instable process for a long-term run. In our study, among the three heating supply scenarios, biogas boiler was the best option for the designed biogas plant with the given breeding scale under moderate OLR. Combined heat and power (CHP) has potential advantage for the biogas plant under high OLR.
Improved methane production and energy recovery of post-hydrothermal liquefaction waste water via integration of zeolite adsorption and anaerobic digestion

Hydrothermal liquefaction (HTL) is a promising technology for converting organic wastes into bio-crude oil, with organic-rich post-hydrothermal liquefaction wastewater (PHWW) as by-product. In this study, zeolite adsorption and anaerobic digestion (AD) were integrated to improve the methane production and energy recovery of PHWW from Chlorella 1067. A statistical design for maximum toxicants removal by zeolite was applied before AD process. Zeolite could mitigate the inhibition associated to compounds such as ammonia, N-heterocyclic compounds, etc. in PHWW and thereby shortening the lag phase and increasing methane production by 32–117% compared with that without zeolite adsorption. Zeolite adsorption also increased energy recovery efficiency (up to 70.5%) for this integrated system. Integration of HTL and AD brought higher energetic return from feedstock via oil and biomethane production, which may offer insight into industrial application of microalgae biomass in the circular economy. In addition, carbon and nitrogen flow for the integrated process was determined.

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BFI (2009): BFI-level 1
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Microbial electrolytic disinfection process for highly efficient Escherichia coli inactivation

Water quality deterioration caused by a wide variety of recalcitrant organics and pathogenic microorganisms has become a serious concern worldwide. Bio-electro-Fenton systems have been considered as cost-effective and highly efficient water treatment platform technology. While it has been extensively studied for recalcitrant organics removal, its application potential towards water disinfection (e.g., inactivation of pathogens) is still unknown. This study investigated the inactivation of Escherichia coli in a microbial electrolysis cell based bio-electro-Fenton system (renamed as microbial electrolytic-Fenton cell) with the aim to broaden the application of microbial electrolyrochemistry. Results showed that a 4-log reduction of Escherichia coli (10⁷ to hundreds CFU/mL) was achieved with an external applied voltage of 0.2 V, 0.3 mM Fe²⁺ and cathodic pH of 3.0. However, non-notable inactivation was observed in the control experiments without external voltage or Fe²⁺ dose. The disinfection effect was enhanced when cathode air flow rate increased from 7 to 41 mL/min and was also in proportion to the increase of Fe²⁺ concentration from 0.15 to 0.45 mmol/mL. Fatal cell membrane destruction by [rad]OH was identified as one potential mechanism for disinfection. This study successfully demonstrated the feasibility of bio-electro-Fenton process for pathogens inactivation, which offers insight for the future development of sustainable, efficient, and cost-effective biological water treatment technology.

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Bioelectrochemical systems serve anaerobic digestion process for process monitoring and biogas upgrading

Bioelectrochemical systems (BESS), which employ microbes as catalysts to convert chemical energy stored in organic matter into sustainable electricity and high-value chemicals, is an emerging and promising technology. BESSs have broad applications including wastewater treatment, chemical production, resource recovery and waste remediation. Recently, new concepts of integrating BESS with anaerobic digestion (AD) for process optimization have been proposed. The purpose of this work was to optimize the AD process using BESS in two aspects: developing a new volatile fatty acid (VFA) monitoring system which can be used as the AD process indicator, and for improving biogas quality by removing CO2.

Firstly, a microbial desalination cell (MDC) was developed for measuring VFAs concentrations during AD process. The response time was approx. 5 h and the detection range was 1 to 200 mM. Secondly, in order to reduce the construction cost and response time, microbial electrolysis cell (MEC) was employed as VFA biosensor. The response of the biosensor
was only 1 h due to the faster transfer of VFAs supported by the external voltage. The produced H2 could potentially contribute to the energy needs for operating the biosensor and thereby to a self-sustaining system. Thirdly, to improve biogas quality, a microbial electrolytic capture, separation and regeneration cell (MESC) was developed. In MESC, acid and alkaline generation, CO2 capture, biogas upgrading and wastewater treatment were simultaneously achieved.

**Bio-Electro-Fenton processes for wastewater treatment: advances and prospects**

Water quality deterioration caused by a wide variety of persistent organic pollutants (POPs) has become a serious concern worldwide. Traditional advanced oxidation process (e.g., Fenton reaction) is often inadequate, unsafe, and require post-treatment to remove residual H2O2. In this context, the bioelectrochemical technology assisted advanced oxidation reactions (namely bio-electro-Fenton system) have found a niche where they can become dominant in the near future, especially for POPs removal. Compared to traditional Electro-Fenton technologies, the bio-Electro-Fenton system greatly reduced the expenses on wastewater treatment in terms of electric energy consumption and operation costs. The bio-electro-Fenton system is becoming a versatile platform technology and offers a new solution for emerging environmental issues related to wastewater treatment. This paper critically reviews the existing literature about the degradation of POPs in bio-electro-Fenton system, especially with respect to the treatment performance associated with reactor design and main operating parameters. The review aims to assist researchers and engineers to gain fundamental understandings and critical view of bio-electro-Fenton system, and hopefully with the knowledge it could bring new opportunities for the future development of this promising wastewater treatment technology.
Bio-Electro-Fenton process for the degradation of Non-Steroidal Anti-Inflammatory Drugs in wastewater

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) are ubiquitous municipal wastewater pollutants of which several are resistant to degradation in conventional wastewater treatment, and represent a major environmental health concern worldwide. An alternative treatment, the bio-electro-Fenton process, has received increasing attention in past years. In this process the strong oxidant •HO is formed using the electrons derived from bacterial oxidation of organic substrate. In this work, a laboratory scale microbial electrolysis cell based bio-electro-Fenton process was developed for the treatment of four different NSAIDs. The system was demonstrated to remove low concentration NSAIDs from water and wastewater and all tested parameters (cathode pH, cathode air-flow, cathode Fe2+ concentration, applied voltage, NSAIDs concentration and reaction time) were found to affect the apparent first order rate constant and removal efficiency for NSAIDs. Optimum parameter values were found to be pH = 2, Fe+2 = 7.5 mM, air-flow = 8 mL min-1, applied voltage = 0.3 V; the apparent rate constant was higher for higher NSAIDs initial concentration. For reaction times of 5 hours removal efficiencies were 59%-61% for Ketoprofen, 87%-97% for Diclofenac, 80%-86% for Ibuprofen and 75%-81% for Naproxen. Prolonged reaction times lead to substantial increase in removal efficiencies for Ketoprofen and Naproxen. Finally results obtained with real wastewater show lower removal rate constants than with distilled water matrices suggesting interference from wastewater components in the NSAIDs oxidation process. The results offer insight into future developments of an efficient platform for wastewater treatment technology targeting micropollutants.

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Contributors: Nadais , H., Li, X., Alves , N., Couras , C., Andersen, H. R., Angelidaki, I., Zhang, Y.
Current as an indicator of ammonia concentration during wastewater treatment in an integrated microbial electrolysis cell - Nitrification system

A key challenge for ammonia monitoring during nitrogen removal process is the extra cost and toxic reagent consuming. Herein the feasibility of current generated by an integrated microbial electrolysis cell (MEC) - nitrification reactor as an indicator of initial ammonia levels (NH₃/NH₄⁺) in wastewater was explored. In this loop system, ammonia was first oxidized to nitrate in the nitrification reactor, and then the effluent was introduced into the cathode of MEC where nitrate was reduced as electron acceptor. The correlation between current and ammonia concentration was first investigated with synthetic ammonia-rich wastewater. A good linear relationship (R²=0.9419) was observed between current (0.5130–3.906mΑ) and ammonia levels (0–62.1mg NH₄+-N/L). Such linear relationship was always obtained regardless of the tested external power supply or wastewater pH. The external electrochemical cell was proved to be an effective pre-conditioning method to remove the disturbance from other possible electron acceptors. Finally, the integrated system was further tested with real waste streams and the results showed no significant difference (p>0.05) with measurements by conventional methods. This study, for the first time, demonstrated the potential application of the integrated MEC - nitrification system for ammonia monitoring in addition to water treatment.
Electricity generation and microbial communities in microbial fuel cell powered by macroalgal biomass

The potential of macroalgae Laminaria digitata as substrate for bioelectricity production was examined in a microbial fuel cell (MFC). A maximum voltage of 0.5V was achieved without any lag time due to the high concentration of glucose and mannitol in the hydrolysate. Total chemical oxygen demand removal efficiency reached over 95% at the end of batch run. Glucose and mannitol were degraded through isobutyrate as intermediate. The 16S rRNA gene high throughout sequencing analysis of anodic biofilm revealed complex microbial composition dominated by Bacteroidetes (39.4%), Firmicutes (20.1%), Proteobacteria (11.5%), Euryarchaeota (3.1%), Deferribacteres (1.3%), Spirochaetes (1.0%), Chloroflexi (0.7%), Actinobacteria (0.5%), and others (22.4%). The predominance of Bacteroidetes, Firmicutes and Proteobacteria demonstrated their importance for substrate degradation and simultaneous power generation. These results demonstrate that macroalgae hydrolysate can be used as a renewable carbon source of microbial electrochemical systems for various environmental applications.

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Energy-harvesting bio-electro-dehalogenation for sustainable wastewater treatment

The concept of an “energy-harvesting bio-electro-dehalogenation” process is demonstrated, where exoelectrogenic bacteria in an anodic chamber of a microbial fuel cell (MFC) are used to capture and exploit the electrical energy stored in the biodegradable substrate (acetate). The acetate was derived from full electrocatalytic dehalogenation of non-biodegradable halogenated organic compounds (haloacetic acids) in the cathodic chamber. Cobalt(II) meso-tetraphenylporphyrin serves the role as electrocatalyst in the MFC. Cyclic voltammetric analysis shows that full dehalogenation requires a cathodic potential of $-1.1\text{V vs. Ag/AgCl}$ which can be augmented by stacked MFCs powered by the dehalogenated products. Cyclic voltammetric analysis and ion chromatography measurement confirm that electrogenerated cobalt(I) meso-tetraphenylporphyrin is catalyzing the reduction of tri-, di-, and monochloroacetic acids in a sequential dehalogenation processes. The energy harvesting concept is also applicable to other bio-electrochemical processes for treatment of bio-refractory pollutants.

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BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.44 SJR 1.427 SNIP 1.587
Microbial Community Evolution and Fate of Antibiotic Resistance Genes along Six Different Full-Scale Municipal Wastewater Treatment Processes

The evolution of microbial community and the fate of ARGs along different full-scale wastewater treatment processes (i.e., Anaerobic-Anoxic-Oxic, Oxidation Ditch, and Cyclic Activated Sludge System) were investigated in this study. We found that the sludges of bioreactors treating similar influent showed the similar microbial communities, independent of the treatment technologies. The horizontal gene transfer (HGT) mainly occurred in aeration tank rather than anaerobic/anoxic tank. More co-occurrence of potential pathogens and ARGs was found in wastewater than in sludge. Microbial biomass was the key driver for the fate of ARGs in wastewater, while mobile genetic elements (MGEs) was the key factor for the fate of ARGs in sludge. Combination of wastewater characteristics, microbial diversity, microbial biomass, and MGEs contributed to the variation of ARGs. Finally, it was found that enhanced nutrients removal process and tertiary treatment would benefit ARGs removal.
Microbial electrochemical separation of CO$_2$ for biogas upgrading

Biogas upgrading to natural gas quality has been under focus the recent years for increasing the utilization potential of biogas. Conventional methods for CO2 removal are expensive and have environmental challenges, such as increased emissions of methane in the atmosphere with serious greenhouse impact. In this study, an innovative microbial electrochemical separation cell (MESC) was developed to in-situ separate and regenerate CO2 via alkali and acid regeneration. The MESC was tested under different applied voltages, inlet biogas rates and electrolyte concentrations. Pure biomethane was obtained at 1.2 V, inlet biogas rate of 0.088 mL/h/mL reactor and NaCl concentration of 100 mM at a 5-day operation. Meanwhile, the organic matter of the domestic wastewater in the anode was almost completely removed at the end. The study demonstrated a new sustainable way to simultaneously upgrade biogas and treat wastewater which can be used as proof of concept for further investigation.
Microbial fuel cell-based biosensor for toxic carbon monoxide monitoring

This study presents an innovative microbial fuel cell-based biosensor for carbon monoxide (CO) monitoring. The hypothesis for the function of the biosensor is that CO inhibits bacterial activity in the anode and thereby reduces electricity production. A mature electrochemically active biofilm on the anode was exposed to CO gas at varied concentrations. A proportional linear relationship ($R^2 = 0.987$) between CO concentration and voltage drop (0.8 to 24 mV) in the range of 10% and 70% of CO concentration was observed. Notably, no further decrease of voltage output was observed by with further increasing CO concentration over 70%. Besides, the response time of the biosensor was 1 h. The compact design and simple operation of the biosensor makes it easy to be integrated in existing CO-based industrial facilities either as a forewarning sensor for CO toxicity or even as an individual on-line monitoring device.

General information

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Web of Science (2014): Impact factor 3.545
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BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.74 SJR 1.2 SNIP 1.385
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ISI indexed (2013): ISI indexed yes
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Scopus rating (2012): CiteScore 3.74 SJR 1.417 SNIP 1.451
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BFI (2011): BFI-level 1
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Web of Science (2011): Impact factor 3.794
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Scopus rating (2010): SJR 1.466 SNIP 1.368
Salinity-gradient energy driven microbial electrosynthesis of value-added chemicals from CO₂ reduction

Biological conversion of CO₂ to value-added chemicals and biofuels has emerged as an attractive strategy to address the energy and environmental concerns caused by the over-reliance on fossil fuels. In this study, an innovative microbial reverse-electrodialysis electrolysis cell (MREC), which combines the strengths of reverse electrodialysis (RED) and microbial electrosynthesis technology platforms, was developed to achieve efficient CO₂-to-value chemicals bioconversion by using the salinity gradient energy as driven energy sources. In the MREC, maximum acetate and ethanol concentrations of 477.5±33.2 and 46.2±8.2mgL⁻¹ were obtained at the cathode, catalyzed by Sporomusa ovata with production rates of 165.79±11.52 and 25.11±4.46mmolm⁻² d⁻¹, respectively. Electron balance analysis indicates that 94.4±3.9% of the electrons derived from wastewater and salinity gradient were recovered in acetate and ethanol. This work for the first time proved the potential of innovative MREC configuration has the potential as an efficient technology platform for simultaneous CO₂ capture and electrosynthesis of valuable chemicals.

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Web of Science (2017): Impact factor 7.051
Simultaneous biogas upgrading and biochemicals production using anaerobic bacterial mixed cultures

A novel biological process to upgrade biogas was developed and optimised during the current study. In this process, CO2 in the biogas and externally provided H2 were fermented under mesophilic conditions to volatile fatty acids (VFAs), which are building blocks of higher-value biofuels. Meanwhile, the biogas was upgraded to biomethane (CH4 >95%), which can be used as a vehicle fuel or injected into the natural gas grid. To establish an efficient fermentative microbial platform, a thermal (at two different temperatures of 70°C and 90°C) and a chemical pretreatment method using 2-bromoethanesulfonate were investigated initially to inhibit methanogenesis and enrich the acetogenic bacterial inoculum. Subsequently, the effect of different H2:CO2 ratios on the efficiency of biogas upgrading and production of VFAs were further explored. The composition of the microbial community under different treatment methods and gas ratios has also been unravelled using 16S rRNA analysis. The chemical treatment of the inoculum(2,7),(992,995) had successfully blocked the activity of methanogens and enhanced the VFAs production, especially acetate. The chemical treatment led to a significantly better acetate production (291mg HAc/L) compared to the thermal treatment. Based upon 16S rRNA gene sequencing, it was found that H2-utilizing methanogens were the dominant species in the thermally treated inoculum, while a significantly lower abundance of methanogens was observed in the chemically treated inoculum. The highest biogas content (96% (v/v)) and acetate production were achieved for 2H2:1CO2 ratio (v/v), with Acetoanaerobium noterae, as the dominant homoacetogenic hydrogen scavenger. Results from the present study can pave the way towards more development with respect to microorganisms and conditions for high efficient VFAs production and biogas upgrading.

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BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.13 SJR 2.946 SNIP 2.702
Web of Science (2014): Impact factor 5.528
An overview of electron acceptors in microbial fuel cells

Microbial fuel cells (MFC) have recently received increasing attention due to their promising potential in sustainable wastewater treatment and contaminant removal. In general, contaminants can be removed either as an electron donor via microbial catalyzed oxidation at the anode or removed at the cathode as electron acceptors through reduction. Some contaminants can also function as electron mediators at the anode or cathode. While previous studies have done a thorough assessment of electron donors, cathodic electron acceptors and mediators have not been as well described. Oxygen is widely used as an electron acceptor due to its high oxidation potential and ready availability. Recent studies,
however, have begun to assess the use of different electron acceptors because of the (1) diversity of redox potential, (2) needs of alternative and more efficient cathode reaction, and (3) expanding of MFC based technologies in different areas. The aim of this review was to evaluate the performance and applicability of various electron acceptors and mediators used in MFCs. This review also evaluated the corresponding performance, advantages and disadvantages, and future potential applications of select electron acceptors (e.g., nitrate, iron, copper, perchlorate) and mediators.

**General information**

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Bioelectricity production and microbial communities in microbial fuel cell powered by macroalgal biomass

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Bio-electrolytic sensor for rapid monitoring of volatile fatty acids in anaerobic digestion process
This study presents an innovative biosensor that was developed on the basis of a microbial electrolysis cell for fast and reliable measurement of volatile fatty acids (VFA) during anaerobic digestion (AD) process. The bio-electrolytic sensor was first tested with synthetic wastewater containing varying concentrations of VFA. A linear correlation (R² = 0.99) between current densities (0.03 ± 0.01 to 2.43 ± 0.12 A/m²) and VFA concentrations (5–100 mM) was found. The sensor performance was then investigated under different affecting parameters such as the external voltage, VFA composition ratio, and ionic strength. Linear relationship between the current density and VFA concentrations was always observed. Furthermore, the bio-electrolytic sensor proved ability to handle interruptions such as the presence of complex organic matter, anode exposure to oxygen and low pH. Finally, the sensor was applied to monitor VFA concentrations in a lab-scale AD reactor for a month. The VFA measurements from the sensor correlated well with those from GC analysis which proved the accuracy of the system. Since hydrogen was produced in the cathode as byproduct during monitoring, the system could be energy self-sufficient. Considering the high accuracy, short response time, long-term stability and additional benefit of H₂ production, this bio-electrolytic sensor could be a simple and cost-effective method for VFA monitoring during AD and other anaerobic processes.

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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.13 SJR 2.946 SNIP 2.702
Web of Science (2014): Impact factor 5.528
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 6.02 SJR 2.956 SNIP 2.676
Web of Science (2013): Impact factor 5.323
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.15 SJR 2.914 SNIP 2.442
Web of Science (2012): Impact factor 4.655
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.43 SJR 2.862 SNIP 2.355
Web of Science (2011): Impact factor 4.865
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.592 SNIP 2.192
Web of Science (2010): Impact factor 4.546
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.319 SNIP 2.224
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.073 SNIP 2.178
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.94 SNIP 2.184
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.902 SNIP 2.233
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.113 SNIP 2.334
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.209 SNIP 2.108
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.702 SNIP 1.908
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.568 SNIP 1.757
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.319 SNIP 1.69
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.399 SNIP 1.662
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.432 SNIP 1.55

Original language: English
Keywords: Volatile fatty acid, Biosensor, Microbial electrolysis cell, Anaerobic digestion, Hydrogen

Electronic versions:
WR_S_16_04126.pdf. Embargo ended: 30/12/2017
DOIs:
10.1016/j.watres.2016.12.045

Research output: Research - peer-review › Journal article – Annual report year: 2017
Biological caproate production by Clostridium kluyveri from ethanol and acetate as carbon sources

Caproate is a valuable industrial product and chemical precursor. In this study, batch tests were conducted to investigate the fermentative caproate production through chain elongation from acetate and ethanol. The effect of acetate/ethanol ratio and initial ethanol concentration on caproate production was examined. When substrate concentration was controlled at 100 mM total carbon, hydrogen was used as an additional electron donor. The highest caproate concentration of 3.11 g/L was obtained at an ethanol/acetate ratio of 7:3. No additional electron donor was needed upon an ethanol/acetate ratio ≥7:3. Caproate production increased with the increase of carbon source until ethanol concentration over 700 mM, which inhibited the fermentation process. The highest caproate concentration of 8.42 g/L was achieved from high ethanol strength wastewater with an ethanol/acetate ratio of 10:1 (550 mM total carbon). Results obtained in this study can pave the way towards efficient chain elongation from ethanol-rich wastewater.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Tsinghua University
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Peer-reviewed: Yes

Publication information
Journal: Bioresource Technology
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ISSN (Print): 0960-8524
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.28 SJR 2.029 SNIP 1.799
Web of Science (2017): Impact factor 5.807
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.94 SJR 2.215 SNIP 1.932
Web of Science (2016): Impact factor 5.651
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.47 SJR 2.243 SNIP 1.897
Web of Science (2015): Impact factor 4.917
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.3 SJR 2.399 SNIP 2.087
Web of Science (2014): Impact factor 4.494
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.97 SJR 2.405 SNIP 2.477
Web of Science (2013): Impact factor 5.039
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.25 SJR 2.334 SNIP 2.461
Web of Science (2012): Impact factor 4.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.56 SJR 2.308 SNIP 2.507
Web of Science (2011): Impact factor 4.98
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Efficient treatment of aniline containing wastewater in bipolar membrane microbial electrolysis cell-Fenton system

Aniline-containing wastewater can cause significant environmental problems and threaten the human's life. However, rapid degradation of aniline with cost-efficient methods remains a challenge. In this work, a novel microbial electrolysis cell with bipolar membrane was integrated with Fenton reaction (MEC-Fenton) for efficient treatment of real wastewater containing a high concentration (4460 ± 52 mg L⁻¹) of aniline. In this system, H₂O₂ was in situ electro-synthesized from O₂ reduction on the graphite cathode and was simultaneously used as source of radical dotOH for the oxidation of aniline wastewater under an acidic condition maintained by the bipolar membrane. The aniline was effectively degraded following first-order kinetics at a rate constant of 0.0166 h⁻¹ under an applied voltage of 0.5 V. Meanwhile, a total organic carbon (TOC) removal efficiency of 93.1 ± 1.2% was obtained, revealing efficient mineralization of aniline. The applicability of bipolar membrane MEC-Fenton system was successfully demonstrated with actual aniline wastewater. Moreover, energy balance showed that the system could be a promising technology for removal of biorefractory organic pollutants from wastewaters.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Li, X., Jin, X., Zhao, N., Angelidaki, I., Zhang, Y.
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Peer-reviewed: Yes

Publication information
Journal: Water Research
Volume: 119
ISSN (Print): 0043-1354
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.55 SJR 2.601 SNIP 2.358
Web of Science (2017): Impact factor 7.051
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
Web of Science (2016): Impact factor 6.942
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 6.63 SJR 2.665 SNIP 2.482
Web of Science (2015): Impact factor 5.991
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.13 SJR 2.946 SNIP 2.702
Web of Science (2014): Impact factor 5.528
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 6.02 SJR 2.956 SNIP 2.676
Web of Science (2013): Impact factor 5.323
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.15 SJR 2.914 SNIP 2.442
Web of Science (2012): Impact factor 4.655
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.43 SJR 2.862 SNIP 2.355
Web of Science (2011): Impact factor 4.865
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.592 SNIP 2.192
Web of Science (2010): Impact factor 4.546
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.319 SNIP 2.224
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.073 SNIP 2.178
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.94 SNIP 2.184
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.902 SNIP 2.233
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.113 SNIP 2.334
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.209 SNIP 2.108
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.702 SNIP 1.908
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.568 SNIP 1.757
Electricity generation and microbial community in response to short-term changes in stack connection of self-stacked submersible microbial fuel cell powered by glycerol

Stack connection (i.e., in series or parallel) of microbial fuel cell (MFC) is an efficient way to boost the power output for practical application. However, there is little information available on short-term changes in stack connection and its effect on the electricity generation and microbial community. In this study, a self-stacked submersible microbial fuel cell (SSMFC) powered by glycerol was tested to elucidate this important issue. In series connection, the maximum voltage output reached to 1.15 V, while maximum current density was 5.73 mA in parallel. In both connections, the maximum power density increased with the initial glycerol concentration. However, the glycerol degradation was even faster in parallel connection. When the SSMFC was shifted from series to parallel connection, the reactor reached to a stable power output without any lag phase. Meanwhile, the anodic microbial community compositions were nearly stable. Comparatively, after changing parallel to series connection, there was a lag period for the system to get stable again and the microbial community compositions became greatly different. This study is the first attempt to elucidate the influence of short-term changes in connection on the performance of MFC stack, and could provide insight to the practical utilization of MFC.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhao, N., Angelidaki, I., Zhang, Y.
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Journal: Water Research
Volume: 109
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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.55 SJR 2.601 SNIP 2.358
Web of Science (2017): Impact factor 7.051
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.663 SNIP 2.563
Web of Science (2016): Impact factor 6.942
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 6.63 SJR 2.665 SNIP 2.482
Web of Science (2015): Impact factor 5.991
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 6.13 SJR 2.946 SNIP 2.702
Web of Science (2014): Impact factor 5.528
Electrochemical monitoring of ammonia during anaerobic digestion

Ammonia is known as key inhibitor to methanogens in anaerobic digestion (AD) process. It’s of importance to develop efficient tool for ammonia monitoring. In this study, an electrolysis cell (EC) coupled with a complete nitrification reactor was developed as sensor for real time and online monitoring of ammonia in AD. The AD effluent was pumped into...
nitrification reactor first, in which ammonia was converted to nitrate. Afterwards, the nitrate-rich effluent was introduced into cathode chamber of EC. The correlation between currents and ammonia levels was first evaluated with synthetic ammonia-rich digesters. It was observed that the initial transient currents (0 min) were linearly corresponding to the ammonia levels (from 0 to 95.75 mg/L NH4+-N, $R^2 = 0.9673$). Finally, this new sensor was tested with real AD effluent and the results showed no significant difference with that measured by conventional methods. The sensor developed here has great potential for online, cost-saving, fast and accurate ammonia monitoring in AD process.

**General information**

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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhao, N., Angelidaki, I., Zhang, Y.
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Peer-reviewed: Yes
Event: Abstract from 15th IWA World Conference on Anaerobic Digestion Conference, Beijing, China.
Keywords: Anaerobic digestion, Ammonia, Electolysis cell, Transient current

High efficient ethanol and VFAs production from gas fermentation: effect of acetate, gas and inoculum microbial composition

In bioindustry, syngas fermentation is a promising technology for biofuel production without the use of plant biomass as sugar-based feedstock. The aim of this study was to identify optimal conditions for high efficient ethanol and volatile fatty acids (VFA) production from synthetic gas fermentation. Therefore, the effect of different gases (pure CO, H2, and a synthetic syngas mixture), media (acetate medium and acetate-free medium), and biocatalyst (pure and mixed culture) were studied. Acetate was the most dominant product independent on inoculum type. The maximum concentration of volatile fatty acids and ethanol was achieved by the pure culture (Clostridium ragsdalei). Depending on the headspace gas composition, VFA concentrations were up to 300% higher after fermentation with Clostridium ragsdalei compared to fermentation with mixed culture. The preferred gas composition with respect to highest VFA concentration was pure CO (100%) regardless of microbial composition of the inoculum and media composition. The addition of acetate had a negative impact on the VFA formation which was depending on the initial gas composition in head space.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Damietta University, City of Scientific Research and Technology Applications, Technical University of Denmark
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Peer-reviewed: Yes

**Publication information**

Journal: Biomass & Bioenergy
Volume: 105
ISSN (Print): 0961-9534
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4 SJR 1.235 SNIP 1.436
Web of Science (2017): Impact factor 3.358
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.71 SJR 1.198 SNIP 1.385
Web of Science (2016): Impact factor 3.219
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.03 SJR 1.51 SNIP 1.596
Web of Science (2015): Impact factor 3.249
Integrated electrochemical-biological process as an alternative mean for ammonia monitoring during anaerobic digestion of organic wastes

Ammonia monitoring is important to control anaerobic digestion (AD) process due to inhibition effect. Here, an electrolysis cell (EC) was integrated with a complete nitrification reactor as an alternative approach for online monitoring of ammonia during AD processes. The AD effluent was pumped into nitrification reactor to convert ammonia to nitrate, followed by the introduction of nitrate-rich effluent to EC cathode. It was first evaluated with synthetic ammonia-rich digesters and was observed that the current at 5min were linearly corresponding to the ammonia levels (from 0 to 7.5mM NH4+-N, R2=0.9673). The linear relationship was always observed regardless of different wastewater pH and external voltage. Pre-removal of other electron acceptors from digestate at cathode could eliminate their disturbances to sensor performance. Finally, the accuracy of biosensor was verified with real digestate test. The simple and reliable biosensor showed great promising for online ammonia monitoring of AD processes.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhao, N., Li, X., Jin, X., Angelidaki, I., Zhang, Y.
Number of pages: 7
Pages: 735-741
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Chemosphere
Volume: 195
ISSN (Print): 0045-6535
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.62 SJR 1.435 SNIP 1.448
Web of Science (2017): Impact factor 4.427
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.39 SJR 1.447 SNIP 1.625
Web of Science (2016): Impact factor 4.208
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.04 SJR 1.497 SNIP 1.567
Web of Science (2015): Impact factor 3.698
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.76 SJR 1.59 SNIP 1.639
Web of Science (2014): Impact factor 3.34
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.92 SJR 1.721 SNIP 1.751
Web of Science (2013): Impact factor 3.499
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.5 SJR 1.794 SNIP 1.618
Web of Science (2012): Impact factor 3.137
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 3.61 SJR 1.962 SNIP 1.508
Web of Science (2011): Impact factor 3.206
ISI indexed (2011): ISI indexed yes
Microbial electrochemical sensor for online ammonia monitoring of waste streams

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhao, N., Angelidaki, I., Zhang, Y.
Number of pages: 1
Publication date: 2017
Peer-reviewed: Yes
Event: Abstract from 6th International society for microbial electrochemistry and technology ISMET6, Lisbon, Portugal.
Electronic versions:
Abstract_for_ISMET6.pdf
Source: PublicationPreSubmission
Source-ID: 133985244
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Microbial electrolytic capture, separation and regeneration of CO2 for biogas upgrading
Biogas upgrading to natural gas quality is essential for the efficient use of biogas in various applications. Carbon dioxide (CO2) which constitutes a major part of the biogas is generally removed by physicochemical methods. However, most of the methods are expensive and often present environmental challenges. In this study, an innovative microbial electrolytic system was developed to capture, separate and regenerate CO2 for biogas upgrading without external supply of chemicals, and potentially to treat wastewater. The new system was operated at varied biogas flow rates and external
applied voltages. CO2 was effectively separated from the raw biogas and the CH4 content in the outlet reached as high as 97.0±0.2% at the external voltage of 1.2 V and gas flow rate of 19.6 mL/h. Regeneration of CO2 was also achieved in the regeneration chamber with low pH (1.34±0.04). The relatively low electric energy consumption (≤0.15 kWh/m3) along with the H2 production which can contribute to the energy input makes the overall energy need of the system low, and thereby makes the technology promising. This work provides the first attempt for development of a sustainable biogas upgrading technology and potentially expands the application of microbial electrochemical technologies.

General information
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Contributors: Jin, X., Zhang, Y., Li, X., Zhao, N., Angelidaki, I.
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Peer-reviewed: Yes

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ISSN (Print): 0013-936X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.58 SJR 2.535 SNIP 1.941
Web of Science (2017): Impact factor 6.653
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.559 SNIP 1.902
Web of Science (2016): Impact factor 6.198
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.61 SJR 2.546 SNIP 1.838
Web of Science (2015): Impact factor 5.393
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.5 SJR 2.777 SNIP 2.003
Web of Science (2014): Impact factor 5.33
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.52 SJR 2.952 SNIP 2.102
Web of Science (2013): Impact factor 5.481
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.17 SJR 3.115 SNIP 2.043
Web of Science (2012): Impact factor 5.257
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.16 SJR 3.18 SNIP 1.945
Web of Science (2011): Impact factor 5.228
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.979 SNIP 1.726
Web of Science (2010): Impact factor 4.827
Novel bio-electro-Fenton technology for azo dye wastewater treatment using microbial reverse-electrodialysis electrolysis cell

Development of sustainable technologies for treatment of azo dyes containing wastewaters has long been of great interest. In this study, we proposed an innovative concept of using microbial reverse-electrodialysis electrolysis cell (MREC) based Fenton process to treat azo dye wastewater. In such MREC-Fenton integrated process, the production of \( \text{H}_2\text{O}_2 \) which is the key reactant of fenton-reaction was driven by the electrons harvested from the exoelectrogens and salinity-gradient between sea water and fresh water in MREC. Complete decolorization and mineralization of 400 mg L\(^{-1}\) Orange G was achieved with apparent first order rate constants of 1.15 ± 0.06 and 0.26 ± 0.03 h\(^{-1}\), respectively. Furthermore, the initial concentration of orange G, initial solution pH, catholyte concentration, high and low concentration salt water flow rate and air flow rate were all found to significantly affect the dye degradation. This study provides an efficient and cost-effective system for the degradation of non-biodegradable pollutants.
Salinity-gradient energy driven microbial electro-synthesis of hydrogen peroxide

Hydrogen peroxide (H₂O₂) as a strong oxidant, is widely used in various chemical industries and environmental remediation processes. In this study, we developed an innovative method for cost-effective production of H₂O₂ by using a microbial reverse-electrodialysis electrolysis cell (MREC). In the MREC, electrical potential generated by the exoelectrogens and the salinity-gradient between salt and fresh water were utilized to drive the high-rate H₂O₂ production. Operational parameters such as air flow rate, pH, cathodic potential, flow rate of salt and fresh water were investigated. The optimal H₂O₂ production was observed at salt and fresh water flow rate of 0.5 mL min⁻¹, air flow rate of 12–20 mL min⁻¹, cathode potential of −0.485 ± 0.025 V (vs Ag/AgCl). The maximum H₂O₂ accumulated concentration of 778 ± 11 mg L⁻¹ was obtained at corresponding production rate of 11.5 ± 0.5 mg L⁻¹ h⁻¹. The overall energy input for the synthesis process was 0.45 ± 0.03 kWh kg⁻¹ H₂O₂. Cathode potential was the key factor for H₂O₂ production, which was mainly affected by the air flow rate. This work for the first time proved the potential of MREC as an efficient platform technology for simultaneous electro-synthesis of valuable chemicals and utilization of salinity-gradient energy.
The impact of anode acclimation strategy on microbial electrolysis cell treating hydrogen fermentation effluent

The impact of different anode acclimation methods for enhancing hydrogen production in microbial electrolysis cell (MEC) was investigated in this study. The anodes were first acclimated in microbial fuel cells using acetate, butyrate and corn stalk fermentation effluent (CSFE) as substrate before moving into MECs, respectively. Subsequently, CSFE was used as feedstock in all the three MECs. The maximum hydrogen yield with the anode pre-acclimated with butyrate (5.21 ± 0.24 L H2/L CSFE) was higher than that pre-acclimated with acetate (4.22 ± 0.19 L H2/L CSFE) and CSFE (4.55 ± 0.14 L H2/L CSFE). The current density (480 ± 11 A/m3) and hydrogen production rate (4.52 ± 0.13 m3/m3/d) with the anode pre-acclimated with butyrate were also higher that another two reactors. These results demonstrated that the anode biofilm pre-acclimated with butyrate has significant advantages in CSFE treatment and could improve the performance of hydrogen production in MEC.

General information
State: Published
System and method to control H2O2 level in advanced oxidation processes

The present invention relates to a bio-electrochemical system (BES) and a method of in-situ production and removal of H2O2 using such a bio-electrochemical system (BES). Further, the invention relates to a method for in-situ control of H2O2 content in an aqueous system of advanced oxidation processes (AOPs) involving in-situ generation of hydroxyl radical (OH) by using such a bio-electrochemical system (BES) and to a method for treatment of wastewater and water disinfection. The bio-electrochemical system (BES) according to the invention comprises: - an aqueous cathode compartment comprising a first cathode and a second cathode, - an aqueous anode compartment comprising an anode at least partly covered in biofilm, wherein the first cathode is connected to a first circuit and the second cathode is connected to a second circuit, wherein the first and the second circuit are connected to the system by an external switch.

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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Angelidaki, I., Zhang, Y.
Publication date: 6 May 2016

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IPC: C25B 9/00 A I
Patent number: WO2016066648
Date: 06/05/2016
Priority date: 27/10/2014
Priority number: EP20140190480
Original language: English
Electronic versions:
WO2016066648A1.pdf
Source: espacenet
Source-ID: WO2016066648
Research output: Research - peer-review; Journal article – Annual report year: 2017

Alternate switching between MFC and MEC for H2O2 synthesis and residual removal in Bioelectro-Fenton system
Sustainable H2O2 supply and elimination of residual H2O2 are two key challenges to the Fenton processes treating recalcitrant contaminants. In this study, an innovative Bioelectro-Fenton system capable of alternate switching between microbial electrolysis cell (MEC) and microbial fuel cell (MFC) mode of operation was developed to meet the challenges. In the MEC mode, H2O2 was electrochemically produced which reacts with Fenton’s reagent (Fe II) to form hydroxyradical. The residual H2O2 (unused H2O2) is removed as electron acceptor by switching the system to MFC mode. Complete decolorization and mineralization of 50 mg L-1 methylene blue (MB) was achieved in the MEC mode with apparent first order rate constants of 0.43 and 0.22 h⁻¹, respectively. After switching to the MFC mode, residual H2O2 of 180 mg L⁻¹ was removed at a removal rate of 4.61 mg L⁻¹ h⁻¹ while generating a maximum current density of 0.49 A m⁻². The MB degradation and residual H2O2 removal were affected by external resistance, cathode pH and initial MB
concentration. Furthermore, the system performance was enhanced under stack operation. This study provides a proof-in-concept new system for efficient and cost-effective H2O2 control and recalcitrant pollutants removal.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhang, Y., Angelidaki, I.
Pages: 91-91
Publication date: 2016

Ammonia inhibition on hydrogen enriched anaerobic digestion of manure under mesophilic and thermophilic conditions
Capturing of carbon dioxide by hydrogen derived from excess renewable energy (e.g., wind mills) to methane in a microbially catalyzed process offers an attractive technology for biogas production and upgrading. This bioconversion process is catalyzed by hydrogenotrophic methanogens, which are known to be sensitive to ammonia. In this study, the tolerance of the biogas process under supply of hydrogen, to ammonia toxicity was studied under mesophilic and thermophilic conditions. When the initial hydrogen partial pressure was 0.5 atm, the methane yield at high ammonia load (7 g NH4+-N L\(^{-1}\)) was 41.0% and 22.3% lower than that at low ammonia load (1 g NH4+-N L\(^{-1}\)) in mesophilic and thermophilic condition, respectively. Meanwhile no significant effect on the biogas composition was observed. Moreover, we found that hydrogenotrophic methanogens were more tolerant to the ammonia toxicity than acetoclastic methanogens in the hydrogen enriched biogas production and upgrading processes. The highest methane production yield was achieved under 0.5 atm hydrogen partial pressure in batch reactors at all the tested ammonia levels. Furthermore, the thermophilic methanogens at 0.5 atm of hydrogen partial pressure were more tolerant to high ammonia levels (≥5 g NH4+-N L\(^{-1}\)), compared with mesophilic methanogens. The present study offers insight in developing resistant hydrogen enriched biogas production and upgrading processes treating ammonia-rich waste streams.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Wang, H., Zhang, Y., Angelidaki, I.
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An innovative process for biogas upgrading by the microbial electrolysis cell

Biogas as an alternative energy source is getting more attention which can facilitate to reduce fossil fuel utilization and greenhouse gas emissions. However, biogas is a mixture of gases and typically composed of 60-70% v/v methane (CH₄) and 30-40% v/v carbon dioxide (CO₂), small amounts of hydrogen sulfide (H₂S) and other gases. Rude biogas exhibits a significantly low Wobbe index, heating value and energy efficiency which hinder its application. Therefore, CH₄ enrichment prior to use is crucial to improve the quality of biogas. In this work, a novel bipolar membrane-microbial electrolysis cell (BPMEC) was proposed to realize biogas upgrading. The system was composed of the anode, middle and cathode chamber which were separated by a bipolar membrane (BM) and an anion exchange membrane (AEM), respectively. With an external potential, water dissociation occurred and acid was produced in the middle chamber while electrolysis happened and alkali was generated in the cathode chamber. When rude biogas was injected into the cathode chamber, CO₂ was absorbed chemically into the solution and migrated via AEM as the form of CO₃²⁻ and HCO₃⁻ into the middle chamber where they reacted with H⁺ and CO₂ was regenerated and released from the solution. The gas flow rates were varied, as well as the external voltage. Results revealed the highest cathodic pH was 10.03±0.21 and the lowest pH in the middle chamber was 1.34±0.21. The highest CO₂ removal efficiency can be reached at 98.76±1.32% and the maximum CH₄ content can be 98.13±1.12% with 19.64 ml/h gas flow rate and 1.2 V external potential. Organic matter was removed remarkably and COD of the last day was below 60 mg/l. Hydrogen (H₂) was produced and collected in the enriched gas which is another benefit of the system. This study provides a simple, efficient and sustainable way to extend the application of electrochemical technology.

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Innovative microbial electrochemical process for H₂O₂ synthesis and residual H₂O₂ removal for wastewater treatment

Sustainable H₂O₂ synthesis and residual H₂O₂ removal are key challenges to the treatment of recalcitrant wastewater using Fenton processes. In this study, an innovative bioelectrochemical system was developed to meet the challenges by alternate switching between microbial electrolysis cell (MEC) and microbial fuel cell (MFC) mode of operation. In the MEC mode, H₂O₂ was produced and then reacted with Fenton's reagent (Fe II) to form hydroxyl radical. When the system was switched to MFC mode, the unused H₂O₂ as residual is removed at the cathode as electron acceptor. For wastewater containing 50 mg L⁻¹ methylene blue (MB), complete decolorization and mineralization was achieved in the MEC mode with apparent first order rate constants of 0.43 and 0.22 h⁻¹, respectively. After switching the system to the MFC mode, unused H₂O₂ at concentration of 180 mg L⁻¹ was removed. The removal rate was 4.61 mg L⁻¹ h⁻¹ while maximum current density of 0.49 A m⁻² was generated. The MB degradation and removal of unused H₂O₂ were affected by different operational parameters such as external resistance, cathode pH and initial MB concentration. Furthermore, stack operation greatly improved the system performance. This study for the first time demonstrated an efficient and cost-effective bioelectrochemical system for H₂O₂ generation, residual removal and treatment of recalcitrant pollutants.

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Microbial electrochemical monitoring of volatile fatty acids during anaerobic digestion

Volatile fatty acid (VFA) concentration is known as an important indicator to control and optimize anaerobic digestion (AD) process. In this study, an innovative VFA biosensor was developed based on the principle of a microbial desalination cell. The correlation between current densities and VFA concentrations was firstly evaluated with synthetic digestate. Two linear relationships were observed between current densities and VFA levels from 1 to 30 mM (0.04 to 8.50 mA/m², R²=0.97) and then from 30 to 200 mM (8.50 to 10.80 mA/m², R²=0.95). The detection range was much broader than that of other existing VFA biosensors. The biosensor had no response to protein and lipid which are frequently found along with VFAs in organic waste streams from AD, suggesting the selective detection of VFAs. The current displayed different responses to VFA levels when different ionic strengths and external resistances were applied, though linear relationships were always observed. Finally, the biosensor was further explored with real AD effluents and the results did not show significance differences with those measured by GC. The simple and efficient biosensor showed promising potential for online, inexpensive and reliable measurement of VFA levels during AD and other anaerobic processes.

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Microbial Electrochemical Systems and Technologies: It Is Time To Report the Capital Costs

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Microbial electrosynthesis of hydrogen peroxide in microbial reverse-electrodialysis electrolysis cell

Microbial reverse-electrodialysis electrolysis cell (MREC) as a novel type of microbial electrochemical technologies has been proposed to produce H2 and CH4. In this study, we developed MREC to produce the strong oxidant H2O2. In the MREC, electrical potential generated by the exoelectrogens and the salinity-gradient between sea water and river water were utilized to drive the high-rate H2O2 production without external power supply. Operational parameters such as air flow rate, pH, cathodic potential, flow rate of high and low concentration solution were investigated. The optimal H2O2 production were observed at high and low concentration solution flow rate of 0.5 mL/min, air flow rate of 8-20 mL/min, cathode potential of -0.485 ± 0.025 V (vs Ag/AgCl). Under the optimal conditions, the maximum H2O2 yield of 778 ± 11 mg/L could be obtained. Cathode potential was found as the key factor for H2O2 production, which can be controlled through adjusting the air flow rate without power supply and potentiostat. This study shows for the first time high yield synthesis of H2O2 from oxygen reduction in a microbial electrochemical system without external power supply.

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Monitoring of volatile fatty acids during anaerobic digestion using a microbial electrochemical sensor

Volatile fatty acid (VFA) concentration is known as an important indicator to control and optimize anaerobic digestion (AD) process. In this study, an innovative VFA biosensor was developed based on the principle of a microbial desalination cell. The bulk substrate was dosed into the middle chamber innovatively which was separated from the anode chamber by an anion exchange membrane. The detection range can be broadened as only part of the ionized VFAs can transport through the membrane and the biofilm can be protected from inhibitors and toxicants.

The correlation between current densities and VFA concentrations was firstly evaluated with synthetic digestate. Two linear relationships were observed between current densities and VFA levels from 1 to 30 mM (0.04±0.01 to 8.50±0.32 mA/m2, R2=0.97) and then from 30 to 200 mM (8.50±0.32 to 10.80±1.26 mA/m2, R2=0.95). The detection range was much broader than that of other existing VFA biosensors. The biosensor had no response to protein and lipid which are frequently found along with VFAs in organic waste streams from AD, suggesting the selective detection of VFAs. The current displayed different responses to VFA levels when different ionic strengths and external resistances were applied, though linear relationships were always observed. Finally, the biosensor was further explored with real AD effluents and the results did not show significant differences with those measured by GC. The simple and efficient biosensor showed promising potential for online, inexpensive and reliable measurement of VFA levels during AD and other anaerobic processes. The outcomes will expand the application of bio-electrochemical system application.

General information
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Recovery of ammonia and sulfate from waste streams and bioenergy production via bipolar bioelectrodialysis

Ammonia and sulfate, which are prevalent pollutants in agricultural and industrial wastewaters, can cause serious inhibition in several biological treatment processes, such as anaerobic digestion. In this study, a novel bioelectrochemical approach termed bipolar bioelectrodialysis was developed to recover ammonia and sulfate from waste streams and thereby counteracting their toxicity during anaerobic digestion. Furthermore, hydrogen production and wastewater treatment were also accomplished. At an applied voltage of 1.2 V, nitrogen and sulfate fluxes of 5.1 g NH₄⁺-N/m²/d and 18.9 g SO₄²⁻/m²/d were obtained, resulting in a Coulombic and current efficiencies of 23.6% and 77.4%, respectively. Meanwhile, H₂ production of 0.29 L/L/d was achieved. Gas recirculation at the cathode increased the nitrogen and sulfate fluxes by 2.3 times. The applied voltage, initial (NH₄)₂SO₄ concentrations and coexistence of other ions were affecting the system performance. The energy balance revealed that net energy (≥16.8 kWh/kg-N recovered or ≥4.8 kWh/kg-H₂SO₄ recovered) was produced at all the applied voltages (0.8-1.4 V). Furthermore, the applicability of bipolar bioelectrodialysis was successfully demonstrated with cattle manure. The results provide new possibilities for development of cost-effective technologies, capable of waste resources recovery and renewable energy production.
Alternate switching between microbial fuel cell and microbial electrolysis cell operation as a new method to control H₂O₂ level in Bioelectro-Fenton system

Sustainable H₂O₂ supply and cost-effective elimination of residual H₂O₂ are two key challenges associated with the successful application of Fenton reaction for contaminant removal. In this study, an innovative Bioelectro-Fenton system capable of alternate switching between microbial electrolysis cell (MEC) and microbial fuel cell (MFC) mode of operation
was developed to meet the challenges. In the MEC mode, a bioelectrochemical system (BES) produces $\text{H}_2\text{O}_2$ which reacts with Fenton's reagent (Fe II) to form hydroxyradical. The unused $\text{H}_2\text{O}_2$ (residual $\text{H}_2\text{O}_2$) is removed as electron acceptor by switching the system to MFC mode of operation. Complete decolorization and mineralization of 50 mg L$^{-1}$ methylene blue (MB) was achieved in the MEC mode with apparent first order rate constants of 0.43 and 0.22 h$^{-1}$, respectively. After switching to the MFC mode, residual $\text{H}_2\text{O}_2$ of 180 mg L$^{-1}$ was removed at a removal rate of 4.61 mg L$^{-1}$ h$^{-1}$ while generating a maximum current density of 0.49 A m$^{-2}$. The MB degradation and residual $\text{H}_2\text{O}_2$ removal were affected by external resistance, cathode pH and initial MB concentration. Furthermore, the system performance was enhanced under stack operation. This study provides a proof-in-concept new system for efficient and cost-effective $\text{H}_2\text{O}_2$ control and recalcitrant pollutants removal.

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Bioelectrochemical recovery of waste-derived volatile fatty acids and production of hydrogen and alkali

Volatile fatty acids (VFA) are organic compounds of great importance for various industries and environmental processes. Fermentation and anaerobic digestion of organic wastes are promising alternative technologies for VFA production. However, one of the major challenges is development of sustainable downstream technologies for VFA recovery. In this study, an innovative microbial bipolar electrodialysis cell (MBEDC) was developed to meet the challenge of waste-derived VFA recovery, produce hydrogen and alkali, and potentially treat wastewater. The MBEDC was operated in fed-batch mode. At an applied voltage of 1.2 V, a VFA recovery efficiency of 98.3%, H2 of 18.4 mL and alkali production presented as pH of 12.64 were obtained using synthetic fermentation broth. The applied voltage, initial VFA concentrations and composition were affecting the VFA recovery. The energy balance revealed that net energy (5.20 e6.86 kWh/kg-VFA recovered) was produced at all the applied voltages (0.8e1.4 V). The coexistence of other anionic species had no negative effect on VFA transportation. The VFA concentration was increased 2.96 times after three consecutive batches. Furthermore, the applicability of MBEDC was successfully verified with digestate. These results demonstrate for the first time the possibility of a new method for waste-derived VFA recovery and valuable products production that uses wastewater as fuel and bacteria as catalyst. © 2015 Elsevier Ltd. All rights reserved.
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Scopus rating (2017): CiteScore 7.55 SJR 2.601 SNIP 2.358
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Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.209 SNIP 2.108
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Scopus rating (2003): SJR 1.702 SNIP 1.908
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.568 SNIP 1.757
Countering ammonia inhibition during anaerobic digestion by recovery using submersible microbial desalination cell

Ammonia inhibition is one of the most frequent and serious problems in biogas plants. In this study, a novel hybrid system consisting of a submersible microbial desalination cell (SMDC) and a continuous stirred tank reactor (CSTR) was developed for countering ammonia inhibition during anaerobic digestion (AD) with simultaneous in situ ammonia recovery and electricity production. The SMDC was powered by acetate in a buffer solution, while synthetic ammonia-rich wastewater was used as the feeding of the CSTR. Under continuous operation, ammonia recovery rate of 86 g-N/m2/day and current density of 4.33 A/m2 were achieved at steady-state condition. As a result, 112% extra biogas was produced due to ammonia recovery by the SMDC. High-throughput sequencing showed that ammonia recovery had an impact on the microbial community structures in the SMDC and CSTR. Considering the additional economic benefits of biogas enhancement and possible wastewater treatment, the SMDC may represent a cost-effective and environmentally friendly method for waste resources recovery and biomethanation of ammonia-rich residues. Biotechnol. Bioeng. 2015;9999: 1-5.

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Innovative bioelectrochemical-an aerobic-digestion coupled system for ammonia recovery and biomethane production from ammonia-rich residues

General information
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Innovative bioelectrochemical-anaerobic-digestion integrated system for ammonia recovery and bioenergy production from ammonia-rich residues

Ammonia (NH4+/NH3) inhibition during anaerobic digestion process is one of the most frequent problems existing in biogas plants, resulting in unstable process and reduced biogas production. In this study, we developed a novel hybrid system, consisted of a submersed microbial resource recovery cell (SMRC) and a continuous stirred tank reactor (CSTR), to prevent ammonia toxicity during anaerobic digestion by in-situ ammonia recovery and electricity production (Figure 1). In batch experiment, the ammonia concentration in the CSTR decreased from 6 to 0.7 g-N/L with an average recovery rate of 0.18 g-N/L(CSTR)/d. Meanwhile, a maximum power density of 0.71±0.5 W/m2 was produced (10 Ω). Both current driven NH4+ migration and free NH3 diffusion were identified as the mechanisms responsible for the ammonia transportation. With an increase in initial ammonia concentration and a decrease in external resistance, the SMRC performance was enhanced. In addition, the coexistence of other cations in CSTR or cathode had no negative effect on the ammonia transportation. In continuous reactor operation, 112% extra biogas production was achieved due to ammonia recovery. High-throughput molecular sequencing analysis showed an impact of ammonia recovery on the microbial community composition in the integrated system. Results clearly indicate the great potential of the SMRC-CSTR-coupled system for efficient and cost-effective ammonia recovery, energy production and treatment of ammonia-rich residues.

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Microbial electrochemical monitoring of volatile fatty acids during anaerobic digestion

Due to increasing environmental concerns of using fossil fuels and decreasing in their reserves, the promotion of renewable energy technologies is crucial. Anaerobic digestion (AD), a well-developed technology converting organic waste into biogas, is gaining increased attention in recent years. Bioelectrochemical systems (e.g. MFC, MDC, MEC et al.) which transfer chemical energy to electricity by degrading organic waste have attracted great interest due to their environmental friendly and sustainability. In this study, to control and optimize AD process, a smart bioelectrochemical system (microbial desalination cell, MDC) was built to realize the on-line measuring the concentration of volatile fatty acid (VFA). The correlation between current densities of the biosensor and VFA concentrations was firstly evaluated with synthetic digestate. Two linear relationships were observed between current densities and VFA levels from 1 mM to 200 mM. The detection range was much broader than that of other existing VFA biosensors. The MDC biosensor had no response to protein and lipid which are frequently found along with VFAs in the organic waste streams from AD, suggesting the selective detection of VFAs. The current displayed different responses to VFA levels when different ionic strengths and external resistances were applied, though linear relationships were always observed. Finally, the biosensor was further explored with real AD effluents and the results did not show significance differences with those measured by GC. The simple MDC-based biosensor showed promising potential for online, inexpensive and reliable measurement of
VFA levels. The outcomes offer a powerful tool for cost-effective monitoring and optimization of AD process and expand the application of bioelectrochemical system.

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**Salinity-Gradient Energy Driven Microbial Electrosynthesis of Hydrogen Peroxide from Oxygen Reduction**
Hydrogen peroxide (H2O2) is widely used in various chemical industries and environmental remediation. Recently, bioelectrochemical systems (BES) have gained increasing attention for synthesizing H2O2 with simultaneous wastewater treatment[1]. However, in order to get high-yield H2O2 requires additional electrical energy to power these BES or control the cathode potential. In this study, we develop an innovative BES called microbial reverse-electrodialysis electrolysis cell (MREC) to produce H2O2 in cathode. In the MREC (See Fig. 1), the salinity-gradient energy between seawater and river water can be used to generated renewable electrical energy to replace the external power supply[2]. Operational parameters such as air flow rate, pH, cathodic potential, flow rate of high and low concentration NaCl solution in RED were investigated as to improve the H2O2 yield. The optimal parameters for H2O2 production are air gas flow rate of 8-20 ml/min, cathode potential of -0.485 ± 0.025 V vs Ag/AgCl, the corresponding dissolved oxygen is 6.80 ± 0.30 mg/l in catholyte. Under the optimal conditions, a maximum H2O2 yield of 770 ± 18 mg/L could be obtained with corresponding H2O2 production rates of 0.44 ± 0.04 g/m2/h and current density of 1.40 ± 0.13 A/m2. Results indicate the air gas flow rate and cathode potential are the key parameters for H2O2 production in MREC. This study indicate for the first time high yield synthesis of H2O2 from oxygen reduction in BES without external power supply, furthermore, we also discover the cathode potential can be controlled through adjusting the air flow rate without power supply and potentiostat.

**Submersible microbial desalination cell for simultaneous ammonia recovery and electricity production from anaerobic reactors containing high levels of ammonia**
High ammonia concentration in anaerobic reactors can seriously inhibit the anaerobic digestion process. In this study, a submersible microbial desalination cell (SMDC) was developed as an innovative method to lower the ammonia level in a continuous stirred tank reactor (CSTR) by in situ ammonia recovery and electricity production. In batch experiment, the ammonia concentration in the CSTR decreased from 6 to 0.7g-N/L during 30days, resulting in an average recovery rate of 80g-N/m2d. Meanwhile, a maximum power density of 0.71±0.5W/m2 was generated at 2.85A/m2. Both current driven NH4+ migration and free NH3 diffusion were identified as the mechanisms responsible for the ammonia transportation. With an increase in initial ammonia concentration and a decrease in external resistance, the SMDC performance was enhanced. In addition, the coexistence of other cations in CSTR or cathode had no negative effect on the ammonia transportation.

**General information**
A bio-electrochemical system for removing inhibitors of anaerobic digestion processes from anaerobic reactors

Inhibition of anaerobic digestion process by high level of ammonia (NH4+/NH3) is the most serious problem existing in biogas plants. No viable/applicable method to overcome this problem has been found up to now. This invention proposes an innovative submersible bio-electrochemical membrane reactor to recover ammonia from anaerobic digestion reactor, and thereby alleviate or counteract ammonia inhibition and enhance the conversion of ammonia-rich wastes to biogas. The invention may further reduce overall cost, giving synergistic advantages for both ammonia recycling and biogas plants by recovering acid (e.g., H2SO4, HCl), that can be used to treat the recovered ammonia.

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An innovative bioelectrochemical-anaerobic digestion-coupled system for in-situ ammonia recovery and biogas enhancement: process performance and microbial ecology

Ammonia (NH4+/NH3) inhibition during anaerobic digestion process is one of the most frequent problems existing in biogas plants, resulting in unstable process and reduced biogas production. In this study, we developed a novel hybrid system, consisted of a submersed microbial resource recovery cell (SMRC) and a continuous stirred tank reactor (CSTR), to prevent ammonia toxicity during anaerobic digestion by in-situ ammonia recovery and electricity production. In batch experiment, the ammonia concentration in the CSTR decreased from 6 to 0.7 g-N/L with an average recovery rate of 0.18 g-N/L(CSTR)/d. Meanwhile, a maximum power density of 0.71±0.5 W/m2 was produced (10 Ω). Both current driven NH4+ migration and free NH3 diffusion were identified as the mechanisms responsible for the ammonia transportation. With an increase in initial ammonia concentration and a decrease in external resistance, the SMRC performance was enhanced. In addition, the coexistence of other cations in CSTR or cathode had no negative effect on the ammonia transportation. In continuous reactor operation, 112% extra biogas production was achieved due to ammonia recovery. High-throughput
molecular sequencing analysis showed an impact of ammonia recovery on the microbial community composition in the integrated system. Results clearly indicate the great potential of the SMRC-CSTR-coupled system for efficient and cost-effective ammonia recovery, energy production and treatment of ammonia-rich residues.

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Bioelectrode-based approach for enhancing nitrate and nitrite removal and electricity generation from eutrophic lakes
Nitrate and nitrite contamination of surface waters (e.g. lakes) has become a severe environmental and health problem, especially in developing countries. The recent demonstration of nitrate reduction at the cathode of microbial fuel cell (MFC) provides an opportunity to develop a new technology for nitrogen removal from surface waters. In this study, a sediment-type MFC based on two pieces of bioelectrodes was employed as a novel in situ applicable approach for nitrogen removal, as well as electricity production from eutrophic lakes. Maximum power density of 42 and 36 mW/m² were produced respectively from nitrate- and nitrite-rich synthetic lake waters at initial concentration of 10 mg-N/L. Along with the electricity production a total nitrogen removal of 62% and 77% was accomplished, for nitrate and nitrite, respectively. The nitrogen removal was almost 4 times higher under close-circuit condition with biocathode, compared to either the open-circuit operation or with abiotic cathode. The mass balance on nitrogen indicates that most of the removed nitrate and nitrite (84.7±0.1% and 81.8±0.1%, respectively) was reduced to nitrogen gas. The nitrogen removal and power generation was limited by the dissolved oxygen (DO) level in the water and acetate level injected to the sediment. Excessive oxygen resulted in dramatically decrease of nitrogen removal efficiency and only 7.8% removal was obtained at DO level of 7.8 mg/l. The power generation and nitrogen removal increased with acetate level and was nearly saturated at 0.84 mg/g-sediment. This bioelectrode-based in situ approach is attractive not only due to the electricity production, but also due to no need of extra reactor construction, which may broaden the application possibilities of sediment MFC technology.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhang, Y., Angelidaki, I.
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Event: Abstract from 2nd European International Society for Microbial Electrochemistry and Technology Meeting, Madrid, Spain.
Source: PublicationPreSubmission
Source-ID: 99454585
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2014

Microbial electrolysis cells turning to be versatile technology: recent advances and future challenges
Microbial electrolysis cells (MECs) are an electricity-mediated microbial bioelectrochemical technology, which is originally developed for high-efficiency biological hydrogen production from waste streams. Compared to traditional biological technologies, MECs can overcome thermodynamic limitations and achieve high-yield hydrogen production from wide range of organic matters at relatively mild conditions. This approach greatly reduces the electric energy cost for hydrogen production in contrast to direct water electrolysis. In addition to hydrogen production, MECs may also support several energetically unfavorable biological/chemical reactions. This unique advantage of MECs has led to several alternative applications such as chemicals synthesis, recalcitrant pollutants removal, resources recovery, bioelectrochemical research platform and biosensors, which have greatly broaden the application scopes of MECs. MECs are becoming a versatile platform technology and offer a new solution for emerging environmental issues related to waste streams treatment and energy and resource recovery. Different from previous reviews that mainly focus on hydrogen production, this paper provides an up-to-date review of all the new applications of MECs and their resulting performance, current challenges and prospects of future.

General information
State: Published
Nanomodification of the electrodes in microbial fuel cell: impact of nanoparticle density on electricity production and microbial community

The nano-decoration of electrode with nanoparticles is one effective way to enhance power output of microbial fuel cells (MFCs). However, the amount of nanoparticles used for decoration has not been optimized yet, and how it affects the microbial community is still unknown. In this study, different densities of gold (Au) nanoparticles were sputtered on carbon paper as electrodes of MFCs. The results show that power generation increased with Au nanoparticle density on the electrodes. The highest power density was obtained by depositing carbon paper with an Au thickness of 50 nm and 100 nm on each side, respectively, which was 1.22-1.88 times higher than that obtained with plain carbon paper electrode (control). Furthermore, the Coulombic efficiency was increased with the Au density. Consequently, the maximum lag time before stable power generation was shortened by 1.22 times the lag time of the control. Different densities of Au nanoparticles also resulted in different microbial communities on the anode. More diverse bacterial communities were found with higher Au nanoparticle densities. These results provide new dimensions in understanding electrode modification with nanoparticles in MFC systems.
Original language: English
Keywords: Microbial fuel cell, Nanoparticles, Electricity generation, Electrodes modification, Microbial community
DOIs:
10.1016/j.apenergy.2013.11.058
Photomicrobial fuel cell (PFC) for simultaneous organic carbon, nutrients removal and energy production

A sediment-type photomicrobial fuel cell (PFC), based on the synergistic interaction between microalgae (Chlorella vulgaris) and electrochemically active bacteria, was developed to remove carbon and nutrients from wastewater, and produce electricity and algal biomass simultaneously. Under illumination, stable power density of 68±5 mW/m² and biomass of 0.56±0.02 g/L were generated at initial algae concentration of 3.5 g/L. Accordingly, the removal efficiency of organic carbon, nitrogen and phosphorus was 99.6%, 87.6% and 69.8%, respectively. Mass balance analysis suggested the main removal mechanism of nitrogen and phosphorus was algae biomass uptake (75% and 93%, respectively), while nitrification and denitrification process contributed to part of nitrogen removal (22%). In addition, the effect of illumination period on the performance of PFC was investigated. Except notable fluctuation of power generation, carbon and nutrients removal was not significantly affected after changing the light/dark photoperiod from 24 h/0 h to 10 h/14 h. This work represents the first successful attempt to develop an effective bacteria-algae coupled system, capable for extracting energy and removing carbon, nitrogen and phosphorus from wastewater in one-step.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Technical University of Denmark
Contributors: Zhang, Y., Safa, J., Angelidaki, I.
Publication date: 2014

A new method for in situ nitrate removal from groundwater using submerged microbial desalination-denitrification cell (SMDDC)

A considerable increase in nitrate concentration in groundwater has become a serious concern worldwide. We developed a novel submerged microbial desalination-denitrification cell (SMDDC) to in situ remove nitrate from groundwater, produce electric energy, and potentially treat wastewater. The SMDDC, which was composed of an anode and a cathode chamber, can be easily applied to subsurface environments. When current was produced by bacteria on the anode, NO3- and Na+ were transferred into the anode and cathode through anion and cation exchange membrane, respectively; the anode effluent was directed to the cathode where NO3- was reduced to N2 through autotrophic denitrification. For proof-of-concept, the SMDDC was fed with synthetic wastewater as fuel and submerged into a glass reactor filled with synthetic groundwater. The SMDDC produced 3.4 A/m² of current density, while removing 90.5% of nitrate from groundwater with 12 h wastewater hydraulic retention time (HRT) and 10 Ω of external resistance. The nitrate concentration and ionic strength of groundwater were the main limiting factors to the system performance. Besides, the external resistance and HRT were also affecting the system performance. Furthermore, the SMDDC showed improved performance with high ionic strength of groundwater (2200 μS/cm) and was able to reduce groundwater salinity as well. External nitrification was beneficial to the current generation and nitrate removal rate, but was not affecting total nitrogen removal. Results clearly indicate that this system holds a great potential for efficient and cost-effective treatment of nitrate-containing groundwater and energy recovery.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhang, Y., Angelidaki, I.
Pages: 1827–1836
Publication date: 2013
Peer-reviewed: Yes
A simple and rapid method for monitoring dissolved oxygen in water with a submersible microbial fuel cell (SBMFC)

A submersible microbial fuel cell (SBMFC) was developed as a biosensor for in situ and real-time monitoring of dissolved oxygen (DO) in environmental waters. Domestic wastewater was utilized as sole fuel for powering the sensor. The sensor performance was firstly examined with tap water at varying DO levels. With an external resistance of 1000 Ω, the current density produced by the sensor (5.6±0.5–462.2±0.5 mA/m²) increased linearly with DO level up to 8.8±0.3 mg/L (regression coefficient, R²=0.9912), while the maximum response time for each measurement was less than 4 min. The current density showed different response to DO levels when different external resistances were applied, but a linear relationship was always observed. Investigation of the sensor performance at different substrate concentrations indicates that the organic matter contained in the domestic wastewater was sufficient to power the sensing activities. The sensor ability was further explored under different environmental conditions (e.g., pH, temperature, conductivity, alternative electron acceptor), and the results indicated that a calibration would be required before field application. Lastly, the sensor was tested with different environmental waters and the results showed no significant difference (p>0.05) with that measured by DO meter. The simple, compact SBMFC sensor showed promising potential for direct, inexpensive and rapid DO monitoring in various environmental waters.
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 7.83 SJR 2.373 SNIP 1.65
Web of Science (2017): Impact factor 8.173
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 7.22 SJR 2.095 SNIP 1.619
Web of Science (2016): Impact factor 7.78
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 7.07 SJR 2.044 SNIP 1.671
Web of Science (2015): Impact factor 7.476
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 6.57 SJR 2.057 SNIP 1.716
Web of Science (2014): Impact factor 6.409
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 6.34 SJR 2.029 SNIP 1.726
Web of Science (2013): Impact factor 6.451
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 5.7 SJR 2.397 SNIP 1.592
Web of Science (2012): Impact factor 5.437
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 5.85 SJR 2.126 SNIP 1.704
Web of Science (2011): Impact factor 5.602
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.143 SNIP 1.609
Web of Science (2010): Impact factor 5.361
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.991 SNIP 1.771
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.495 SNIP 1.782
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.111 SNIP 1.962
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.911 SNIP 1.658
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.455 SNIP 1.596
Scopus rating (2004): SJR 1.436 SNIP 1.603
Scopus rating (2003): SJR 1.245 SNIP 1.568
Scopus rating (2002): SJR 1.016 SNIP 1.252
Scopus rating (2001): SJR 1.188 SNIP 1.558
Scopus rating (2000): SJR 1.11 SNIP 1.33
Scopus rating (1999): SJR 0.985 SNIP 0.919
Bioelectrode-based approach for enhancing nitrate and nitrite removal and electricity generation from eutrophic lakes

Nitrate and nitrite contamination of surface waters (e.g., lakes) has become a severe environmental and health problem, especially in developing countries. The recent demonstration of nitrate reduction at the cathode of microbial fuel cell (MFC) provides an opportunity to develop a new technology for nitrogen removal from surface waters. In this study, a sediment-type MFC based on two pieces of bioelectrodes was employed as a novel in situ applicable approach for nitrogen removal, as well as electricity production from eutrophic lakes. Maximum power density of 42 and 36 mW/m² were produced respectively from nitrate- and nitrite-rich synthetic lake waters at initial concentration of 10 mg-N/L. Along with the electricity production a total nitrogen removal of 62% and 77% was accomplished, for nitrate and nitrite, respectively. The nitrogen removal was almost 4 times higher under close-circuit condition with biocathode, compared to either the open-circuit operation or with abiotic cathode. The mass balance on nitrogen indicates that most of the removed nitrate and nitrite (84.7±0.1% and 81.8±0.1%, respectively) was reduced to nitrogen gas. The nitrogen removal and power generation was limited by the dissolved oxygen (DO) level in the water and acetate level injected to the sediment. Excessive oxygen resulted in dramatically decrease of nitrogen removal efficiency and only 7.8% removal was obtained at DO level of 7.8 mg/l. The power generation and nitrogen removal increased with acetate level and was nearly saturated at 0.84 mg/g-sediment. This bioelectrode-based in situ approach is attractive not only due to the electricity production, but also due to no need of extra reactor construction, which may broaden the application possibilities of sediment MFC technology.
Energy recovery from waste streams with microbial fuel cell (MFC)-based technologies

Microbial fuel cell (MFC)-based technologies are promising technologies for direct energy production from various wastewaters and waste streams. Beside electrical power production, more emphasis is recently devoted to alternative applications such as hydrogen production, bioremediation, seawater desalination, and biosensors. Although the technologies are promising, a number of hurdles need to be overcome before that field applications are economically feasible. The main purpose of this work was to improve the performance, reduce the construction cost, and expand the application scopes of MFC-based bio-electrochemical systems. To reduce the energy cost in nitrogen removal and during the same process achieve phosphorus elimination, a sediment-type photomicrobial fuel cell was developed based on the cooperation between microalgae (Chlorella vulgaris) and electrochemically active bacteria. The main removal mechanism...
of nitrogen and phosphorus was algae biomass uptake, while nitrification and denitrification process contributed to part of nitrogen removal. The key factors such as algae concentration, COD/N ratios and photoperiod were systemically studied. A self-powered submersible microbial electrolysis cell was developed for in situ biohydrogen production from anaerobic reactors. The hydrogen production increased along with acetate and buffer concentration. The hydrogen production rate of 32.2 mL/L/d and yield of 1.43 mol-H2/mol-acetate were achieved. Alternate exchanging the function between the two cell units was found to be an effective approach to inhibit methanogens. A sensor, based on a submersible microbial fuel cell, was developed for in situ monitoring of microbial activity and biochemical oxygen demand in groundwater. Presence or absence of a biofilm on the anode was a decisive factor for the applicability of the sensor. Temperature, pH, conductivity and inorganic solid content were significantly affecting the sensitivity of the sensor. The sensor showed good performance both with artificial and real groundwater. A submersible microbial fuel cell sensor was developed for in situ and real time monitoring of dissolved oxygen (DO) in environmental waters. The current density produced by the sensor increased linearly with DO level up to 8.8±0.3 mg/L. The sensor ability was further explored under different environmental conditions. The sensor can measure DO in different environmental waters with less deviations. To improve the voltage output of MFC from lake sediment, an innovative self-stacked submersible MFC was developed. The system successfully produced a maximum power density of 294 mW/m2 and had an open circuit voltage (OCV) of 1.12 V. In addition, voltage reversal was studied in detail in terms of its cause, determining parameters and elimination method. The internal resistance and OCV were the most important parameters for predicting voltage reversal. Use of a capacitor was found to be an effective way to prevent voltage reversal and at the same time store power. A sediment-type MFC based on two pieces of bioelectrodes was employed as a novel in situ applicable approach for nitrate/nitrite removal, as well as electricity production from eutrophic lakes. The nitrogen removal and power generation were limited by the DO level in the water and acetate level injected to the sediment. The proposed approach may broad the application of sediment MFC technology. A novel submersible microbial desalination cell was developed as an in situ and non-invasive approach for nitrate removal from groundwater. The system performance in terms of power generation and nitrate removal efficiency were investigated. The effects of hydraulic retention time, external resistance, other ionic species in the groundwater and external nitrification on the system performance were also elucidated. Over 90% of nitrate was removed from groundwater without energy input, water pressure, draw solution, additional electron donor or risk of bacteria discharge. Such a new system may offer a promising avenue for drinking water treatment and energy recovery.

Innovative self-powered submersible microbial electrolysis cell (SMEC) for biohydrogen production from anaerobic reactors

A self-powered submersible microbial electrolysis cell (SMEC), in which a specially designed anode chamber and external electricity supply were not needed, was developed for in situ biohydrogen production from anaerobic reactors. In batch experiments, the hydrogen production rate reached 17.8 mL/L/d at the initial acetate concentration of 410 mg/L (5 mM), while the cathodic hydrogen recovery (RH2) and overall systemic coulombic efficiency (CEos) were 93% and 28%, respectively, and the systemic hydrogen yield (YH2) peaked at 1.27 mol-H2/mol-acetate. The hydrogen production increased along with acetate and buffer concentration. The highest hydrogen production rate of 32.2 mL/L/d and YH2 of 1.43 mol-H2/mol-acetate were achieved at 1640 mg/L (20 mM) acetate and 100 mM phosphate buffer. Further evaluation of the reactor under single electricity-generating or hydrogen-producing mode indicated that further improvement of voltage output and reduction of electron losses were essential for efficient hydrogen generation. In addition, alternate exchanging the electricity-assisting and hydrogen-producing function between the two cell units of the SMEC was found to be an effective approach to inhibit methanogens. Furthermore, 16S rRNA genes analysis showed that this special operation strategy resulted same microbial community structures in the anodic biofilms of the two cell units. The simple, compact and in situ applicable SMEC offers new opportunities for reactor design for a microbial electricity-assisted biohydrogen production system.
Electric energy can be harvested from aquatic sediments by utilizing microbial fuel cells (MFCs). A main challenge of this application is the limited voltage output. In this study, an innovative self-stacked submersible MFC (SSMFC) was developed to improve the voltage generation from lake sediments. The SSMFC successfully produced a maximum power density of 294 mW/m² and had an open circuit voltage (OCV) of 1.12 V. However, voltage reversal was observed in one cell at high current density. Investigation on the cause for voltage reversal revealed that voltage reversal was occurring only when low external resistance (≤400 Ω in this study) was applied. In addition, the internal resistance and OCV were the most important parameters for predicting which cell unit had the highest probability to undergo voltage reversal. Use of a capacitor was found to be an effective way to prevent voltage reversal and at the same time store power. These results provide new insight into the development of effective MFC system, capable of extracting energy and promoting bioremediation of organic pollutants from sediments.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhang, Y., Angelidaki, I.
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Publication information
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Issue number: 1
ISSN (Print): 0956-5663
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 7.83 SJR 2.373 SNIP 1.65
Web of Science (2017): Impact factor 8.173
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 7.22 SJR 2.095 SNIP 1.619
Web of Science (2016): Impact factor 7.78
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 7.07 SJR 2.044 SNIP 1.671
Web of Science (2015): Impact factor 7.476
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 6.57 SJR 2.057 SNIP 1.716
Web of Science (2014): Impact factor 6.409
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 6.34 SJR 2.029 SNIP 1.726
Web of Science (2013): Impact factor 6.451
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 5.7 SJR 2.397 SNIP 1.592
Web of Science (2012): Impact factor 5.437
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 5.85 SJR 2.126 SNIP 1.704
Web of Science (2011): Impact factor 5.602
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.143 SNIP 1.609
Web of Science (2010): Impact factor 5.361
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.991 SNIP 1.771
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.495 SNIP 1.782
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.111 SNIP 1.962
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.911 SNIP 1.658
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.455 SNIP 1.596
Scopus rating (2004): SJR 1.436 SNIP 1.603
Scopus rating (2003): SJR 1.245 SNIP 1.568
Scopus rating (2002): SJR 1.016 SNIP 1.252
Scopus rating (2001): SJR 1.188 SNIP 1.558
Scopus rating (2000): SJR 1.11 SNIP 1.33
Scopus rating (1999): SJR 0.985 SNIP 0.919

Original language: English
Keywords: Microbial fuel cell, Submersible, Sediment, Stackable configuration, Voltage reversal, External resistance
DOIs:
10.1016/j.bios.2012.02.059
Source: dtu
Source-ID: u:3596
Research output: Research - peer-review > Journal article – Annual report year: 2012
Surface Area Expansion of Electrodes with Grass-like Nanostructures to Enhance Electricity Generation in Microbial Fuel Cells

Microbial fuel cells (MFCs) have applications possibilities for wastewater treatment, biotransformation, and biosensor, but the development of highly efficient electrode materials is critical for enhancing the power generation. Two types of electrodes modified with nanoparticles or grass-like nanostructure (termed nanograss) were used. A two-chamber MFC with plain silicium electrodes achieved a maximum power density of 0.002 mW/m², while an electrode with nanograss of titanium and gold deposited on one side gave a maximum power density of 2.5 mW/m². Deposition of titanium and gold on both sides of plain silicium showed a maximum power density of 86.0 mW/m². Further expanding the surface area of carbon paper electrodes with gold nanoparticles resulted in a maximum stable power density of 346.9 mW/m² which is 2.9 times higher than that achieved with conventional carbon paper. These results show that fabrication of electrodes with nanograss could be an efficient way to increase the power generation.

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BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.28 SJR 2.029 SNIP 1.799
Web of Science (2017): Impact factor 5.807
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.94 SJR 2.215 SNIP 1.932
Web of Science (2016): Impact factor 5.651
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.47 SJR 2.243 SNIP 1.897
Web of Science (2015): Impact factor 4.917
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.3 SJR 2.399 SNIP 2.087
Web of Science (2014): Impact factor 4.494
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.97 SJR 2.405 SNIP 2.477
Web of Science (2013): Impact factor 5.039
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.25 SJR 2.334 SNIP 2.461
Web of Science (2012): Impact factor 4.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.56 SJR 2.308 SNIP 2.507
Web of Science (2011): Impact factor 4.98
Electricity generation and microbial community response to substrate changes in microbial fuel cell

The effect of substrate changes on the performance and microbial community of two-chamber microbial fuel cells (MFCs) was investigated in this study. The MFCs enriched with a single substrate (e.g., acetate, glucose, or butyrate) had different acclimatization capability to substrate changes. The MFC enriched with glucose showed rapid and higher power generation, when glucose was switched with acetate or butyrate. However, the MFC enriched with acetate needed a longer adaptation time for utilizing glucose. Microbial community was also changed when the substrate was changed. Clostridium and Bacilli of phylum Firmicutes were detected in acetate-enriched MFCs after switching to glucose. By contrast, Firmicutes completely disappeared and Geobacter-like species were specifically enriched in glucose-enriched MFCs after feeding acetate to the reactor. This study further suggests that the type of substrate fed to MFC is a very important parameter for reactor performance and microbial community, and significantly affects power generation in MFCs.

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Organisations: Department of Environmental Engineering
Contributors: Zhang, Y., Min, B., Huang, L., Angelidaki, I.
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Journal: Bioresource Technology
Simultaneous organic carbon, nutrients removal and energy production in a photomicrobial fuel cell (PFC)

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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Contributors: Zhang, Y., Noori, J. S., Angelidaki, I.
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Publication date: 2011
Peer-reviewed: Yes

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 30.87 SJR 14.59 SNIP 4.819
Web of Science (2017): Impact factor 30.067
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 26.39 SJR 12.283 SNIP 4.325
Web of Science (2016): Impact factor 29.518
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 19.28 SJR 7.769 SNIP 4.001
Web of Science (2014): Impact factor 20.523
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 14.81 SJR 6.019 SNIP 2.996
Web of Science (2013): Impact factor 15.49
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 11.84 SJR 5.868 SNIP 2.599
Web of Science (2012): Impact factor 11.653
Submersible microbial fuel cell for electricity production from sewage sludge

A submersible microbial fuel cell (SMFC) was utilized to treat sewage sludge and simultaneously generate electricity. Stable power generation (145±5 mW/m², 470 Ω) was produced continuously from raw sewage sludge for 5.5 days. The maximum power density reached 190±5 mW/m². The corresponding total chemical oxygen demand (TCOD) removal efficiency was 78.1±0.2% with initial TCOD of 49.7 g/L. The power generation of SMFC was depended on the sludge concentration, while dilution of the raw sludge resulted in higher power density. The maximum power density was saturated at sludge concentration of 17 g-TCOD/L, where 290 mW/m² was achieved. When effluents from an anaerobic digester that was fed with raw sludge were used as substrate in the SMFC, a maximum power density of 318 mW/m², and a final TCOD removal of 71.9±0.2% were achieved. These results have practical implications for development of an effective system to treat sewage sludge and simultaneously recover energy.
Scopus rating (2014): CiteScore 1.14 SJR 0.585 SNIP 0.683
Web of Science (2014): Impact factor 1.106
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.3 SJR 0.571 SNIP 0.701
Web of Science (2013): Impact factor 1.212
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.13 SJR 0.597 SNIP 0.659
Web of Science (2012): Impact factor 1.102
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.25 SJR 0.594 SNIP 0.631
Web of Science (2011): Impact factor 1.122
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.529 SNIP 0.597
Web of Science (2010): Impact factor 1.056
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.592 SNIP 0.693
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.583 SNIP 0.694
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.736 SNIP 0.766
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.696 SNIP 0.789
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.767 SNIP 0.841
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.875 SNIP 0.897
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.882 SNIP 0.897
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.877 SNIP 0.894
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.758 SNIP 0.967
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.887 SNIP 0.866
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.885 SNIP 0.91

Original language: English
Keywords: Sewage sludge, TCOD removal efficiency, Submersible microbial fuel cell, Electricity generation, Anaerobic digestion

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10.2166/wst.2011.678
Source: orbit
Source-ID: 279507
Research output: Research - peer-review; Journal article – Annual report year: 2011
Submersible microbial fuel cell sensor for monitoring microbial activity and BOD in groundwater: Focusing on impact of anodic biofilm on sensor applicability

A sensor, based on a submersible microbial fuel cell (SUMFC), was developed for in situ monitoring of microbial activity and biochemical oxygen demand (BOD) in groundwater. Presence or absence of a biofilm on the anode was a decisive factor for the applicability of the sensor. Fresh anode was required for application of the sensor for microbial activity measurement, while biofilm-colonized anode was needed for utilizing the sensor for BOD content measurement. The current density of SUMFC sensor equipped with a biofilm-colonized anode showed linear relationship with BOD content, to up to 250 mg/L (∼233 ± 1 mA/m²), with a response time of...
Electricity Generation from Organic Matters in Biocatalyst-Based Microbial Fuel Cells (MFCs)

Microbial fuel cells (MFCs) are a novel technology for converting organic matter directly to electricity via biocatalytic reactions by microorganisms. MFCs can also be used for wastewater treatment by the oxidations of organic pollutants during the electricity generation. Several factors for optimum power generation in MFC have been investigated at previous studies. A submersible microbial fuel cell (SMFC), which is a novel configuration, was developed by immersing an anode electrode and a cathode chamber in an anaerobic reactor. Domestic wastewater without any amendments was used as the medium and the inoculum in the experiments. The SMFC could successfully generate a stable voltage of 0.428±0.003V with a fixed 470Ω resistor from acetate. From the polarization test, the maximum power density of 204mWm−2 was obtained at current density of 595mAm−2 (external resistance = 180Ω). The power generation showed a saturation-type relationship as a function of wastewater strength, with a maximum power density (Pmax) of 218mWm−2 and a saturation constant (Ks) of 244 mg L−1. We also achieved a successful power generation (123 mW/m2) from wheat straw hydrolysate in a two chamber microbial fuel cells (MFCs). These results demonstrate that MFC has a great potential for a sustainable power generation and wastewater treatment with a better understanding and optimization of microbial electricity generation.
Submersible microbial fuel cell for electricity production from sewage sludge
A submersible microbial fuel cell (SMFC) was utilized to treatment of sewage sludge and simultaneous generate electricity. Stable power generation (145±5 mW/m²) was produced continuously from raw sewage sludge for 5.5 days. The corresponding total chemical oxygen demand (TCOD) removal efficiency was 78.1±0.2% with initial TCOD of 49.7 g/L. The power generation of SMFC was depended on the sludge concentration. The maximum power density generated from raw sludge reached 190±5 mW/m². Dilution of the raw sludge resulted in higher power density. The power density was saturated at sludge concentration 17 g-TCOD/L, where maximum power density of 290 mW/m² was achieved. When effluents from an anaerobic digester were used as substrate in the SMFC a maximum power density of 318 mW/m², and a final TCOD removal of 71.9±0.2% was achieved. These results have practical implications for development of an effective system to treatment of sewage sludge and simultaneous recover energy.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Technical University of Denmark
Contributors: Zhang, Y., Olias, L. G., Kongjan, P., Angelidaki, I.
Publication date: 2010

Host publication information
Title of host publication: The 12th World Congress on Anaerobic Digestion (AD12). Water Science and Technology : CD-ROM
Publisher: IWA International Water Association
Keywords: Sewage sludge, TCOD removal efficiency, Submersible microbial fuel cell, Anaerobic digestion, Electricity generation
Source: orbit
Source-ID: 286761
Research output: Research - peer-review › Article in proceedings – Annual report year: 2011

Enhanced bio-decolorization of azo dyes by co-immobilized quinone-reducing consortium and anthraquinone
In the present study, the accelerating effect of co-immobilized anthraquinone and quinone-reducing consortium was investigated in the bio-decolorization process. The anthraquinone and quinone-reducing consortium were co-immobilized by entrapment in calcium alginate. The co-immobilized beads exhibited good catalytic activity and increased the decolorization rate for many kinds of azo dyes. The reusability of the co-immobilized beads was evaluated with repeated-batch decolorization experiments. After ten repeated experiments, the decolorization rate of co-immobilized beads retained over 92.8% of their original value. Furthermore, acclimatized quinone-reducing consortium was analyzed by denaturing gradient gel electrophoresis (DGGE) and 16S rDNA gene sequencing to get the complete picture of its diversity. This study explored a great improvement of conventional treatment system and the new bio-treatment concept. (C) 2009 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Department of Environmental Engineering
Pages: 2982-2987
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: Bioresource Technology
Volume: 100
Issue number: 12
ISSN (Print): 0960-8524
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.28 SJR 2.029 SNIP 1.799
Web of Science (2017): Impact factor 5.807
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.94 SJR 2.215 SNIP 1.932
Web of Science (2016): Impact factor 5.651
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.47 SJR 2.243 SNIP 1.897
Web of Science (2015): Impact factor 4.917
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.3 SJR 2.399 SNIP 2.087
Web of Science (2014): Impact factor 4.494
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.97 SJR 2.405 SNIP 2.477
Web of Science (2013): Impact factor 5.039
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 5.25 SJR 2.334 SNIP 2.461
Web of Science (2012): Impact factor 4.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 5.56 SJR 2.308 SNIP 2.507
Web of Science (2011): Impact factor 4.98
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.089 SNIP 2.344
Web of Science (2010): Impact factor 4.365
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.915 SNIP 2.236
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.736 SNIP 2.74
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.403 SNIP 2.396
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.314 SNIP 2.003
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.278 SNIP 1.98
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.19 SNIP 1.655
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.942 SNIP 1.665
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.908 SNIP 1.294
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.537 SNIP 1.2
Scopus rating (2000): SJR 0.653 SNIP 1.023
Scopus rating (1999): SJR 0.659 SNIP 1.033
Original language: English
DOIs:
10.1016/j.biortech.2009.01.029
Generation of Electricity and Analysis of Microbial Communities in Wheat Straw Biomass-Powered Microbial Fuel Cells

Electricity generation from wheat straw hydrolysate and the microbial ecology of electricity producing microbial communities developed in two chamber microbial fuel cells (MFCs) were investigated. Power density reached 123 mW/m² with an initial hydrolysate concentration of 1000 mg-COD/L while Coulombic efficiencies (CEs) ranged from 37.1 to 15.5% corresponding to the initial hydrolysate concentrations from 250 to 2000 mg-COD/L. The suspended bacteria found were different from the bacteria immobilized in the biofilm, and they played different roles in electricity generation from hydrolysate. Bacteria in the biofilm were consortia with sequences similar to Bacteroidetes (40% of sequences), Alphaproteobacteria (20%), Bacilli (20%), Deltaproteobacteria (10%), and Gammaproteobacteria (10%), while suspended consortia were predominated by Bacilli (22.2%). Results from this study can contribute to improve understanding and optimizing the electricity generation in microbial fuel cells.
Cathodic reduction of hexavalent chromium [Cr(VI)] coupled with electricity generation in microbial fuel cells

A novel approach to Cr(VI)-contaminated wastewater treatment was investigated using microbial fuel cell technologies in fed-batch mode. By using synthetic Cr(VI)-containing wastewater as catholyte and anaerobic microorganisms as anodic biocatalyst, Cr(VI) at 100 mg/l was completely removed during 150 h (initial pH 2). The maximum power density of 150 mW/m² (0.04 mA/cm²) and the maximum open circuit voltage of 0.91 V were generated with Cr(VI) at 200 mg/l as electron acceptor. This work verifies the possibility of simultaneous electricity production and cathodic Cr(VI) reduction.

Keyword: Electron acceptor, Power density, Cr(VI) reduction, Microbial fuel cell
Electricity generation in microbial fuel cells: Using humic acids as a mediator

General information
State: Published
Organisations: Dalian University of Technology
Contributors: Zhang, Y., Huang, L., Chen, J., Qiao, X., Cai, X.
Pages: 474-475
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Journal of Biotechnology
Volume: 136
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.64 SJR 0.929 SNIP 0.86
Web of Science (2017): Impact factor 2.533
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.88 SJR 1.004 SNIP 0.929
Web of Science (2016): Impact factor 2.599
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.87 SJR 1.068 SNIP 0.988
Web of Science (2015): Impact factor 2.667
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.95 SJR 1.116 SNIP 1.13
Web of Science (2014): Impact factor 2.871
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.22 SJR 1.183 SNIP 1.175
Web of Science (2013): Impact factor 2.884
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 3.4 SJR 1.238 SNIP 1.312
Web of Science (2012): Impact factor 3.183
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.87 SJR 1.165 SNIP 1.043
Web of Science (2011): Impact factor 3.045
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.135 SNIP 1.175
Web of Science (2010): Impact factor 2.97
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.224 SNIP 1.231
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.147 SNIP 1.265
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.133 SNIP 1.27
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.109 SNIP 1.394
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.193 SNIP 1.358
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.028 SNIP 1.442
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.943 SNIP 1.224
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.787 SNIP 1.038
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.754 SNIP 0.972
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.927 SNIP 0.889
Scopus rating (1999): SJR 0.841 SNIP 1.035
Original language: English
DOIs: 10.1016/j.jbiotec.2008.07.1105
Source: orbit
Source-ID: 285068
Research output: Research - peer-review › Journal article – Annual report year: 2008

Projects:

**EcoFuel: Boosting biomass derived syngas-to-biofuels conversion with microbial electrochemical fermentation**
The ever-increasing global energy demands, together with the negative environmental impact of fossil fuels, have reinforced the efforts to develop alternative fuel sources. The conversion of biomass-derived syngas (CO, H2 and CO2) into biofuels (mostly as ethanol) and commodity chemicals by microbial catalysts has gained considerable attention in past years as an alternative avenue to address the challenge. Though promising, low ethanol yield and accumulation of byproducts (mainly acetic acid) which is toxic to the process at high level are key challenges hindering the commercialization of syngas fermentation technology. In this context, EcoFuel is a timely and ambitious investigation, which proposes to address the aforementioned challenges by means of an innovative platform technology namely microbial electrochemical fermentation.

Zhang, Y., Project Participant, Department of Environmental Engineering, Residual Resource Engineering
Angelidaki, I., Project Coordinator, Department of Environmental Engineering
Project ID: NNF16OC0021568
01/07/2017 → 01/07/2020
Keywords: microbial electrochemical fermentation, Syngas, Biofuels, Biomass
Project: Research
Lake remediation by microbial fuel cells
Haxthausen, K. R. A., PhD Student, Department of Environmental Engineering
Trapp, S., Main Supervisor, Department of Environmental Engineering
Gosewinkel, U. B., Supervisor
Zhang, Y., Supervisor, Department of Environmental Engineering
Samfinansieret - Andet
01/02/2018 → 31/01/2021
Award relations: Lake remediation by microbial fuel cells
Project: PhD

Bioinorganic artificial photosynthesis of single cell protein from carbon dioxide.
Xu, M., PhD Student, Department of Environmental Engineering
Angelidaki, I., Main Supervisor, Department of Environmental Engineering
Zhang, Y., Supervisor, Department of Environmental Engineering
Privatist
01/11/2017 → 31/10/2020
Award relations: Bioinorganic artificial photosynthesis of single cell protein from carbon dioxide.
Project: PhD

Microbial electrochemistry meet UV: For effektive degradation of organic matter
Zou, R., PhD Student, Department of Environmental Engineering
Angelidaki, I., Main Supervisor, Department of Environmental Engineering
Zhang, Y., Supervisor, Department of Environmental Engineering
Stipendie fra udlandet
01/12/2017 → 30/11/2020
Award relations: Microbial electrochemistry meet UV: For effektive degradation of organic matter
Project: PhD

Innovative-bio-electrochemical-anaerobic-digestion coupled system for ammonia recovery and energy production from food-waste residues
Zhao, N., PhD Student, Department of Environmental Engineering
Angelidaki, I., Main Supervisor, Department of Environmental Engineering
Zhang, Y., Supervisor, Department of Environmental Engineering
Stipendie fra udlandet
01/10/2015 → 28/02/2019
Award relations: Innovative-bio-electrochemical-anaerobic-digestion coupled system for ammonia recovery and energy production from food-waste residues
Project: PhD

Innovative microbial electrolysis cell-anaerobic digestion coupled system for ammonia recovery and energy production from ammonia-rich residues
Li, X., PhD Student, Department of Environmental Engineering
Angelidaki, I., Main Supervisor, Department of Environmental Engineering
Kougias, P., Examiner, Department of Environmental Engineering
Thomsen, A. B., Examiner
Verstraete, W., Examiner
Stipendie fra udlandet
15/12/2014 → 18/04/2018
Award relations: Innovative microbial electrolysis cell-anaerobic digestion coupled system for ammonia recovery and energy production from ammonia-rich residues
Project: PhD

Deciphering the microbial ecology in biogas reactors for optimizing the anaerobic digestion process
Zhu, X., PhD Student, Department of Environmental Engineering
Kougias, P., Supervisor, Department of Environmental Engineering
Treu, L., Supervisor, Department of Environmental Engineering
Zhang, Y., Examiner, Department of Environmental Engineering
Lund Nielsen, J., Examiner
de Sousa, D. Z. M., Examiner
Institut stipendie (DTU)
Bioelectrochemical-anaerobic digestion-coupled system for simultaneous recovery and bioenergy production

Jin, X., PhD Student, Department of Environmental Engineering
Angelidaki, I., Main Supervisor, Department of Environmental Engineering
Zhang, Y., Supervisor, Department of Environmental Engineering
Kougias, P., Examiner, Department of Environmental Engineering
He, Z. J., Examiner
Norddahl, B., Examiner
15/10/2014 → 20/12/2017
Award relations: Bioelectrochemical-anaerobic digestion-coupled system for simultaneous recovery and bioenergy production
Project: PhD

Development of new microbial fuel cell configuration for optimization of electricity production with simultaneous wastewater treatment

Zhang, Y., PhD Student, Department of Environmental Engineering
Angelidaki, I., Main Supervisor, Department of Environmental Engineering
Karakashev, D. B., Examiner, Department of Environmental Engineering
Norddahl, B., Examiner
Verstraete, W., Examiner
Institut/centerfinansieret
01/10/2009 → 30/09/2012
Award relations: Development of new microbial fuel cell configuration for optimization of electricity production with simultaneous wastewater treatment
Project: PhD

Sustainable Production and Utilization of Microalgae for industrial wastewater treatment

Podevin, M. P. A., PhD Student, Department of Environmental Engineering
Angelidaki, I., Main Supervisor, Department of Environmental Engineering
Fotidis, I., Project Participant, Department of Environmental Engineering
Zhang, Y., Examiner, Department of Environmental Engineering
Zhang, Y., Examiner, Department of Environmental Engineering
Schmidt, J. E., Examiner, Department of Environmental Engineering
Schmidt, J. E., Examiner, Department of Environmental Engineering
Institut stipendie (DTU) Samf.
01/08/2012 → 30/08/2017
Award relations: Sustainable Production and Utilization of Microalgae for industrial wastewater treatment
Project: PhD

ElectroAD: Innovative bioelectrochemical-anaerobic-digestion coupled system for ammonia recovery and energy production from ammonia-rich residues

Inhibition of anaerobic digestion process by high levels of ammonia (NH4+/NH3) is the most serious problem existing in Danish biogas plants. No viable/applicable method to overcome this problem has been found up to now. This project proposes an innovative process which integrates bioelectrochemical system (BES) with anaerobic digestion to recover ammonia, and thereby enhance biomethanation of ammonia-rich residues. In this process, ammonia recovery and electricity production will be realized in a novel BES submersed in an anaerobic reactor. Moreover, removal of ammonia from anaerobic reactor will alleviate or counteract ammonia inhibition and enhance the conversion of ammonia-rich wastes to biogas, giving synergistic advantages for both ammonia recycling and increase of biogas production. The system performance and potential limitations will be addressed and technical solutions will be developed.
Zhang, Y., Project Participant, Department of Environmental Engineering, Residual Resource Engineering
Angelidaki, I., Project Coordinator, Department of Environmental Engineering, Residual Resource Engineering
Fotidis, I., Project Participant, Department of Environmental Engineering, Residual Resource Engineering
01/10/2013 → 30/09/2017
Keywords: Bioelectrochemistry, Anaerobic digestion, Ammonia recovery, Bioenergy, Biocatalysis, Wastewater handling, Open land, Sustainability
Project: Research
**ElectroAD1: A novel method to recover ammonia from biogas plants**

In this project, we will develop an innovative technology to recover inhibitors from anaerobic digestion

Zhang, Y., Project Participant, Department of Environmental Engineering, Residual Resource Engineering
Angelidaki, I., Project Participant, Department of Environmental Engineering, Residual Resource Engineering

Project ID: 30992
01/04/2013 → 31/10/2013
Keywords: Biocatalysis, Biogas, Biohydrogen, Bioelectrochemistry, Monitoring, Control, Bioenergy
Project: Research

**Activities:**

**Bioelectrochemical systems serve anaerobic digestion process for process monitoring and biogas upgrading**

Period: 12 Sep 2018
Xiangdan Jin (Speaker)
Irini Angelidaki (Speaker)
Yifeng Zhang (Speaker)

Department of Environmental Engineering
Residual Resource Engineering

**Description**
EU-ISMET 2018, 12th-14th September 2018, Newcastle upon Tyne, United Kingdom
Degree of recognition: International

**Related event**

**4th EU-ISMET 2018**
12/09/2018 → 14/09/2018
Tyne, United Kingdom
Activity: Talks and presentations › Conference presentations