Artical ID:1006-3471(2007)02-0119-03

Electricity Generation from a Microbial Fuel Cell Employing *Desulfovibrio Salexigens*

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Abstract: A microbial fuel cell of laboratory scale employing *Desulfovibrio salexigens* in lactate based seawater substrate was proposed. Electricity was continuously harvested after inoculation. During 20 days of fermentation/discharge, COD values of the substrate decreased by 61.7%, in which 9.81% was converted to electricity.

Key words: MFC; *Desulfovibrio salexigens*; electricity generation

CLC Number: TM 911.45 **Document Code**: A

1 Introduction

Employing microorganisms as catalysts, microbial fuel cells (MFCs) convert biochemistry energy directly into electricity[1]. In addition to the advantages of conventional fuel cells, MFCs have their own operational and functional advantages. First, MFCs can use widespread bio-convertible substrate as fuels, including various of bio-mass, even domestic wastewater[2-3], underwater sediments[4-5] and some minerals[6]. Second, MFCs usually operate at ambient temperature and pressure, resulting in unnecessity to input energy. Third, MFCs have potential for application not only for harvest electric energy but also for bioremediation of organic contaminants.

For application purpose, it is convenient to use mixed cultured bacteria in MFCs[7]. With well-domesticated mixed consortium, power density as large as 3.6 W m^{-2} or 216 W m^{-3} was achieved[8]. However, use of axenic cultured bacteria[9] can reduce side fermentation (e.g. evolution of methane), and make it easier to analyze the mechanism. Herein we report a MFC based on a sulfate-reducing bacterium, *Desulfovibrio salexigens*.

2 Experimental Details

2.1 MFC Device

Figure 1 showed the schematic diagram and the photograph of the MFC of laboratory scale. The electrode cover and anodic/cathodic chamber were produced by PMMA. The anodic chamber was also fermentation room, with volume of 80 mL. The anode was made of two catalyst layers (CoS as catalyst[10]) compressed on a foam nickel collector. The cathode was a classical air cathode, which was made up of a catalyst layer (Pt-C as catalyst) and a waterproof lay-

Received date: 2007-01-15, accepted date: 2007-02-26 * Corresponding author, Tel: (86-571)87951513, E-mail: shaohb@zju.edu.cn

Sopported by the Zhejiang Provincial Natural Science Foundation of China under Grant No. Y406192

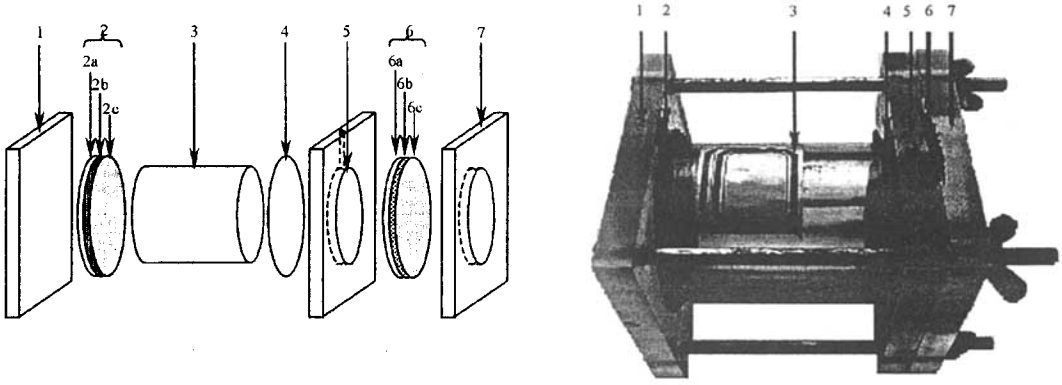

Fig. 1 Prototype of MFC based on Desulfovibrio salexigens
1) Cover of anode, 2) Anode (2a, 2c: catalyst layers, 2b: collector), 3) Anodic Chamber, 4) CEM, 5) Cathodic chamber, 6) Cathode (6a: catalyst layer, 6b: collector, 6c: water-proof layer), 7) Cover of cathode

er compressed on a silver wire net collector. Cation exchange membrane (CEM) was used to provide ionic conduction while separating the anodic and cathodic chamber.

2.2 Culture of Bacterium

The bacterium *Desulfovibrio salexigens* was separated from undersea sediment near Qingdao (provided by Research Institute 725, Qingdao Branch), and cultured in MFC with lactate based seawater substrate, which contained 9.0 mL $\cdot L^{-1}$ 60% sodium lactate, 1.0 g/L barm powder, 0.25 g/L vitamin C, 2.0 g $\cdot L^{-1}$ $MgSO_4$, 0.5 g $\cdot L^{-1}$ Na_2SO_4, 1.0 g $\cdot L^{-1}$ NH_4Cl, 0.5 g $\cdot L^{-1}$ K_2HPO_4 and 0.1 g $\cdot L^{-1}$ $CaCl_2$, with pH 7.2 and under 30 ℃.

2.3 Electrochemical Measurements

The discharge curve was carried out with Arbin BT-2000 battery testing system (Arbin Instruments, US). Electricity was continuously harvested from the MFC after inoculation, with an outer resistance load of 1000 Ω.

3 Results and Discussion

Fig. 2 showed the probable working principle of the MFC. Organic compounds, mainly lactate, were fermented by the bacterium to produce metabolite, mainly acetate and CO_2, while the electrons were transferred to sulfate, which was reduced to sulfide. Then the latter was oxidized at the anode to generate electricity. Meanwhile the by-product, proton, transferred through CEM to the cathode, and combined oxygen and electron to produce water.

The current dropped fast at the very beginning several hours (Fig. 3). However, it remained relatively constant at subsequent long time (about 360 h,

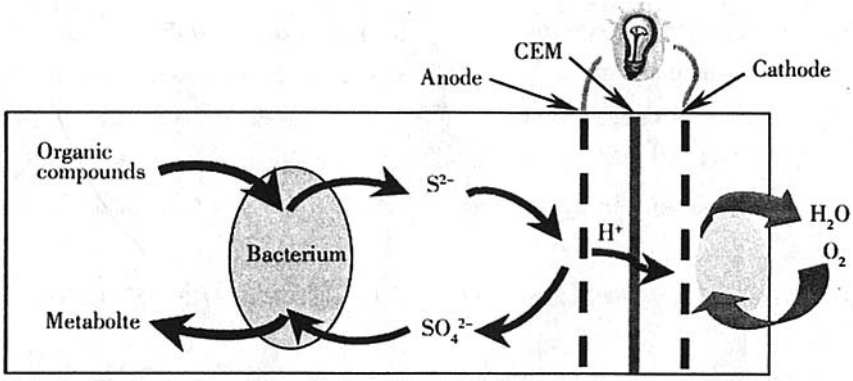

Fig. 2 Probable working principle of the MFC

15 d), which indicated that the system was in stable state. That is, sulfide generation rate was approximately equal to its consumption rate, and the remained sulfide kept constant concentration. Later, with the consumption of nutriments in substrate, metabolism of the bacterium was gradually inhibited, and the output current decreased sharply at the end of discharge.

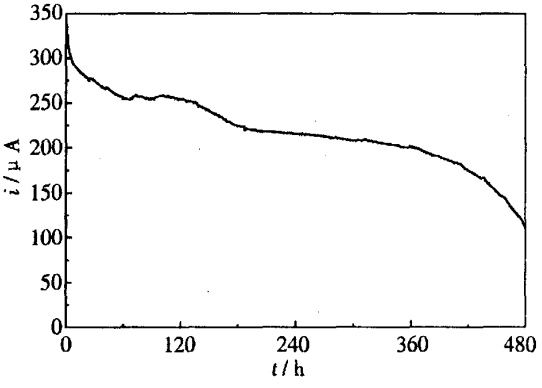

Fig. 3　Discharging curve of the MFC at constant resistance of 1000 ohm

In order to estimate the organic compound decomposed by the bacterium, COD values were measured before and after fermentation/discharge. The initial value 6480 mg · L^{-1} dropped to 2480 mg · L^{-1} after 20 days of fermentation/discharge. According to Faradic Law, it was calculated that 9.81% of the consumed COD was transferred to electricity.

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应用需盐脱硫弧菌的微生物燃料电池发电研究

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摘要: 本文提出了基于需盐脱硫弧菌以含乳酸盐的海水培养基为电解液的微生物燃料电池. 微生物接种后电池即开始放电,在 20 天中,培养基 COD 降低了 61.7%,其中有 9.81% 转化为电能.

关键词: 微生物燃料电池; 需盐脱硫弧菌; 发电