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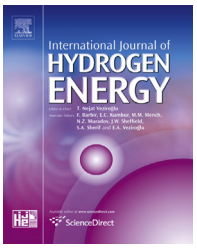

Bioelectricity generation from pig farm wastewater in microbial fuel cell using carbon brush as electrode

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ABSTRACT

As microbial fuel cell (MFC) technology is getting nearer to practical applications, the microorganisms can convert chemical energy from a wide range of organic substances into electric current directly. In this paper, the MFC with a spherical configuration as cathode compartment was constructed. The MFC with a brush-shaped anode, platinum/carbon cathode, pre-treated Nafion 117 were constructed using pig farm wastewater as substrate. The biofilm analysis was used by bacterial community structure and diversity by denaturing gradient gel electrophoresis (DGGE). A benthic strain of proteobacteria was isolated and identified, wastewater was treated with proteobacteria to decrease the chemical oxygen demand, phosphorus, nitrogen and to produce electricity, which had an excellent electrogenic qualities.

Introduction

It is well known that pig farm wastewater generate a great impact on environment. Pig wastewater was produced out of control, so they caused pollution of surface waters, aquifers, soil quality and deterioration of the air.

MFC is a promising biotechnology to generate electricity from the degradation of organic contaminants in wastewater treatment processes. Two chambers of MFC consist of aerobic cathode and anaerobic anode separated by a proton exchange membrane (PEM). In the anode chamber, substrates (e.g., glucose, organic contaminants in wastewater) are oxidized by anaerobic bacteria which electrons are produced [1]. The electrons are then transferred to the anode surface and eventually flow to the cathode surface through the external circuit. The generation of protons (H^+) caused by the substrate oxidation in the anode chamber migrate through the PEM and combine with the electrons and oxidants in the cathode chamber. There are two advantages of MFC for wastewater treatment. First, the contaminants in wastewater provide the endless carbon sources for the MFC. Second, electricity

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generated from contaminant removal could be sufficient to power the wastewater treatment processes and thus reducing the energy consumption [2].

Many studies have focused on the individual aspects of MFC, such as configuration, electrode materials [3], inoculums [4], and operational conditions. Estrada-arriaga et al. studied the wastewater treatment from a pig farm by a single chamber MFC. The maximum voltages reached in the MFC were between 63 mV and 218 mV [5]. They didn't reveal the bacterial community which one significantly affected by pig wastewater.

Not only a higher voltage was obtained but also strains were analyzed especially for pig farm wastewater. A benthic strain of proteobacteria in MFC was isolated and identified, which was advantageous to magnify the reactor and greatly improve the wastewater processing capacity.

Materials and methods

MFC configuration

A dual compartment MFC (spherical diameter 14 cm, bottom diameter 10 cm, height 10 cm) was constructed as Fig. 1 described. Compared with the research in the sludge substrate of dual-chamber microbial fuel cell, it has a better anti-leakage performance.

MFC operation

Anodes were carbon fiber brush electrodes constructed as described by Logan et al. [6], that had a two-wire Ti core that served as a current collector, and brushes made of carbon fibers (Jilin Carbon Plant, China, with Young's Modulus 210–220 GPa). All brushes were first cleaned by soaking them in pure acetone overnight. These brushes were then acid treated by soaking the brushes in a solution of ammonium peroxydisulfate (200 g/L) and concentrated sulfuric acid (100 mL/L) for 15 min. Brush electrodes were heat-treated in a muffle furnace at 450 °C for 30 min. All brushes were washed three times with distilled water before being used in MFCs. Carbon brush anodes achieved a good dispersion of the graphite filaments and contain an efficient current collector, making them useful as anodes for large-scale application of MFCs. The high Young's modulus of the carbon fibers was helpful for good dispersion of the fibers in the brush [7].

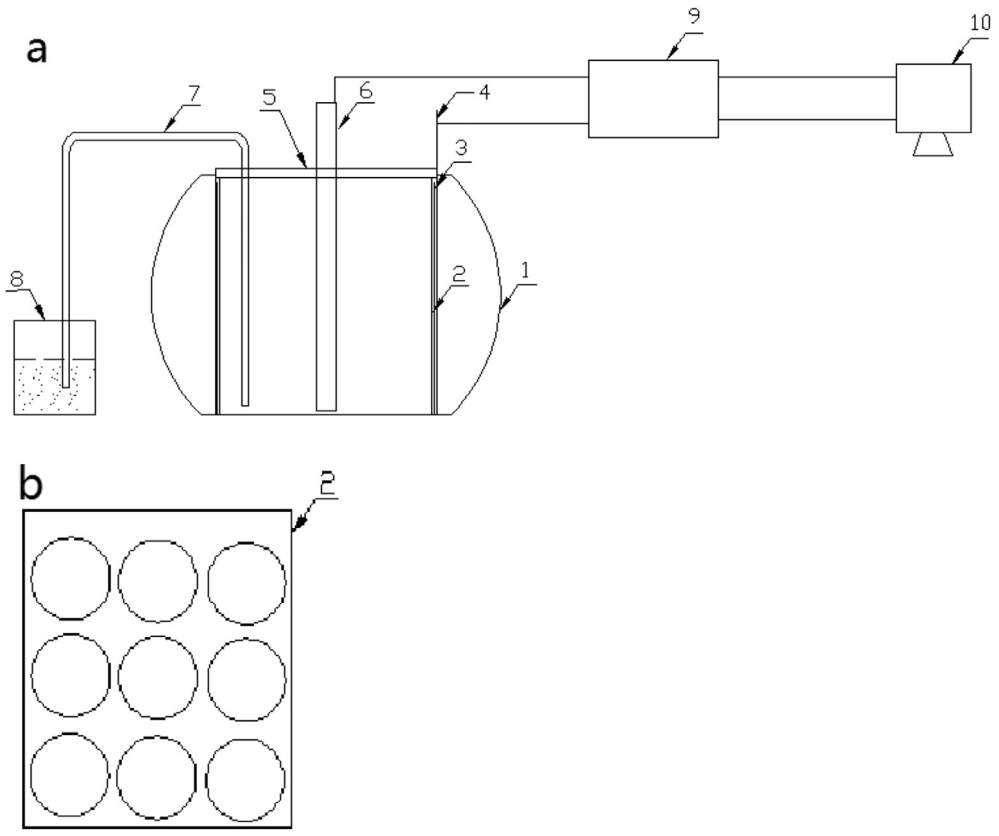

Fig. 1 – The construction of microbial fuel cell. a) the schematic diagram showing the components and assembly detail. In spherical cathode chamber (1) center there is a cylindrical anode chamber (2), a cylindrical anode outdoor wrapped with a membrane (3) and a cyclic carbon fabric platinum cathode (4), the anode chamber top has screwed sealing cover (5), with electrodes and electrochemical measuring exports entrance, Brush anode (6) through the electrode outlet upright cylindrical anode chamber to the closures, imported from the electrochemical measuring the inlet hose (7) beaker (8), used for seal and exhaust gas generated in the anode chamber; wire connecting the anode (6) and the cathode (4), and resistance box (9), wire connection resistance box (9) and a computer (10). b) The anode chamber is provided with a cylinder with some holes diameter of 2.5 cm.

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