UTILIZATION OF SEWAGE FOR VOLTAGE GENERATION IN DUAL CHAMBER MICROBIAL FUEL CELL

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ABSTRACT: *Electrical energy needs in Pakistan are expected to continue to rise. The use of petroleum as a source of energy still dominates, although oil reserves in Pakistan are increasingly being depleted. Therefore, there is a need to develop alternative sources of sustainable energy, such as, microbial fuel cell (MFC). MFC is a device which is used to convert chemical energy into electrical energy by the microbes. In this study, sewage was as substrate, it contains organic matter available for microbe's energy recovery. Potassium permanganate as catholyte, carbon rod as electrode and salt bridge as a membrane were used. MFC generates more voltage with Potassium permanganate. Various electrolytes like Potassium permanganate, Potassium dichoromate and Potassium ferricyanide were used. Mmaximum generation of 0.73 V was produced by Potassium permanganate solution. Several MFCs were connected with each other in Series and Parallel connections; maximum voltage generation was seen in Series connections (6.18 V). When MFC was connected in series the voltage generation was high enough to glow LED for 3 hrs. The idea of salt bridge instead of the proton exchange membrane is to be more economical as it is cost effective and easily available.*

Keywords: Sewage, Voltage, Energy, MFC, Salt bridge,

INTRODUCTION

The demand of electricity supply and safe suitable water for drinking is increasing day by day. Environmental conditions play an important role in the settlement, growth, distribution, reproduction and survival of aquatic animals. It has a great impact on the life of organisms with its different physical and chemical properties [1]. Among the most important and basic natural resources essential for survival of man, is the freshwater. Unfortunately, due to a variety of natural and anthropogenic factors, the availability of quality water has emerged as the most critical global challenge in the 21st century [2]. Despite of tremendous progress in development and sustainable management of water resources, its quality, quantity and equity remain to be the basic challenge for the future of life to sustan[3]. Further, impacts resulting from global climate change have added a new dimension to the management of the emerging water crisis [4]. In the search for efficient conversion technologies of biomass into electricity, the new microbial fuel cell (MFC) technology has recently drawn much attention. MFC is an effective and safe way of producing energy if its application and use is boosted and spread throughout the world [5]. MFCs are devices that make the use of microorganisms (bacteria and yeast) to oxidize bio-waste [7]. In this mechanism, yeast or bacteria interacts with electrodes using electrons, which are either removed or supplied through an electrical circuit. Yeast can thus be used to produce stream of electrons between anode and cathode [6]. Mediators or shuttles can transfer electrons by the way of the direct membrane associated electron transferred generated by the yeast [8]. The MFC is classified as a mediator-less with no external mediators added to the system. It happens even though the electron transfer process remains unknown [9].

The characterizing attributes of MFCs are microbialy electrons liberation at the anode and the accompanying electron lessening at the cathode, when both of the components are helpful. The application of a conciliatory anode made out of Mg amalgam does not guarantee the framework as a MFC [10]. It is so in light of the fact that for the catalyzing the oxidation of the fuel does not require yeasts. Those systems which utilize enzymes or biocatalysts indirectly produced by yeast in useful manner are considered here as a Micro bio-fuel cells. MFC are operated more sustainably in mixed culture than those in pure cultures [3-5]. Clean energy can be produced by using bio waste from MFCs [8]. There are huge profits from utilizing MFCs from bio waste, for example, clean, sheltered, calm execution, low discharges, high proficiency and immediate power recuperation [6]. The aim of this research paper is to use MFC for voltage generation by utilizing of sewage as a substrate.

MATERIALS AND METHODS

Sewage wastewater was collected from Qasimabad Hyderabad (Pakistan). A two chambered fuel cell was constructed. Two plastic containers each with diameter 20 mm were taken and marked cathode and anode. Two holes of diameter 6 mm and 1.5 mm were made on each of the lids for the insertion of the salt-bridge and electrodes (Fig. 1). In the anode container, 100 mL of the Anodic Inoculation was used and in the cathode container 100 mL Potassium permanganate solution was used and the container lids were closed and sealed with tape (Fig. 1). The salt-bridge was made with 5 mm diameter level tube. The salt-bridge contained a mixture of 1M Potassium chloride with 5% Agar. The mixture was sucked into the level tube.

Fig. 1: Microbial Fuel Cell set-up using Salt-bridge

This salt-bridge was inserted into both the containers through one hole on both containers and sealed with tape. Pencil lead with diameter 1 mm and length 18 mm was used as electrodes to collect the electrons in both anode and cathode with copper wire connections at the other hole on both the containers and sealed with tape. Carbon rod of 2 mm (diameter) X 20 mm (length) and Graphite sheet of o.5 mm (thick) × 10 mm (breadth) were used as electrodes. These electrodes were relatively inexpensive and available easily. The electrodes were first soaked in 100% ethanol for 30 min. After the electrodes were washed in 1 M HCl followed by NaOH, each for 1 hr to remove possible metal and inorganic contaminations and to neutralize them. They were then stored in distilled water before use. 100 mL of slaughterhouse wastewater was directly inoculated in the anodic chamber. For the cathode chamber, 0.1 M Potassium permanganate solution was prepared. Variations were done using 0.1 M potassium dichromate and 0.1 M potassium ferricyanide solutions. The voltage was checked with a multimeter (UNITY DT-830 D). All the solutions were carried out with different electrodes and electrolytes. The MFCs were operated for 20 days at room temperature of 28 ^{o}C. The specific MFCs with various electrodes and electrolytes which showed the maximum voltage generation was recorded and connected in parallel and series connections to give maximum electricity. The voltage generation was noted. It was connected to LED to see if it glowed.

RESULT AND DISCUSSION

The microbes adhering to the anode surface to degrade organic matter under anaerobic conditions. As a consequence of the degradation reaction, CO_2, protons and electrons are thought to be produced [5]. The electrons flow by a circuit and the protons by the salt bridge that is attached to the cathode [7]. Sewage contains various types of anaerobic microbes [3] and I therefore used as a sample in MFC for voltage generation. By alteration of MFC configuration, change in voltage is possible [1]. There is increase in voltage generation associated with the catholytes used [9].

Table1. Sewage wastewater with Potassium permanganate and Carbon rod

Time (hrs)	Carbon rod Voltage (V)
0	0.79
24	0.82
48	0.84
72	0.89
96	0.97
120	1.05
144	1.12
168	1.19
192	1.25
216	1.34
240	1.44
264	1.48
288	1.41
312	1.34
336	1.30
360	1.25
384	1.21
408	1.18
432	1.14
456	1.09
480	1.02

MFC using permanganate generated ore voltage than that produced by hexacyanoferrate [8]. Sewage generated voltage with various electrolytes like Potassium permanganate, Potassium dichoromate and Potassium ferricyanide (Fig. 2), with a maximum generation of 0.73 V with Potassium permanganate solution. When different electrodes like Pencil lead, Graphite sheet and Carbon rod were used; the wastewater generated more voltage with Carbon rod (Fig.3), with a maximum generation of 1.48 V. On analysis, it was found that, MFCs using Potassium permanganate as catholyte and Carbon rod as electrode yielded more voltage (Table 1). Connecting various stacked MFCs in series enabled to generation of increased voltages [10]. Now when several MFCs were connected with each other in Series and Parallel connections, it was seen that, maximum voltage generation was seen in Series connections (6.18 V) as shown in Table 2. This was quite higher when compared to the Parallel connection output (Fig. 4) enough to glow LED for 3 hrs (Fig. 5). MFC which contains a salt bridge as membrane, it is a a simplest type of biological fuel cell. It is easy to design and fabrication [3]. MFC treatment can be reduced BOD in wastewaters by degrading organic materials [7]. MFCs can be the coming era power devices innovation and hence may assume an imperative part energy protection, power production, bio-hydrogen generation and wastewater treatment and in addition in interchange fuel using microbes to produce power [5].

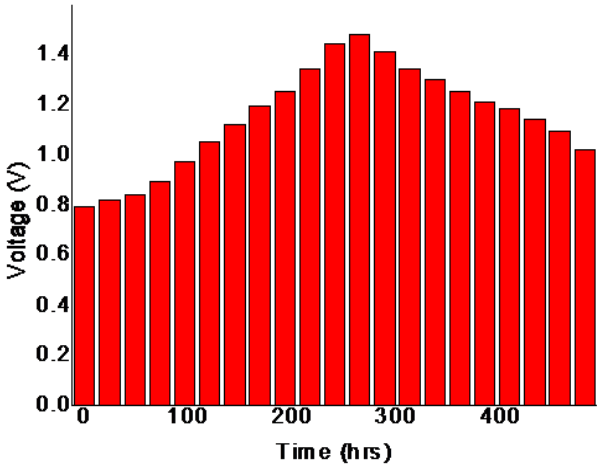

Fig.2: Generation of voltage from Sewage wastewater with Potassium permanganate and Carbon rod

Table 2. Sewage wastewater with Carbon rod and Potassium permanganate in Series and Parallel connections using 5 MFCs

Time hrs	Series Connection, Voltage (V)	Parallel Connection, Voltage (V)
0	3.97	0.64
24	4.12	0.66
48	4.44	0.63
72	4.69	0.69
96	4.97	0.71
120	5.15	0.74
144	5.32	0.66
168	5.49	0.79
192	5.65	0.85
216	5.84	0.88
240	5.98	1.03
264	6.18	1.06
288	6.01	1.01
312	5.84	1.00
336	5.62	0.88
360	5.58	0.87
384	5.31	0.88
408	5.28	0.82
432	5.09	0.79
456	4.95	0.66
480	4.87	0.65

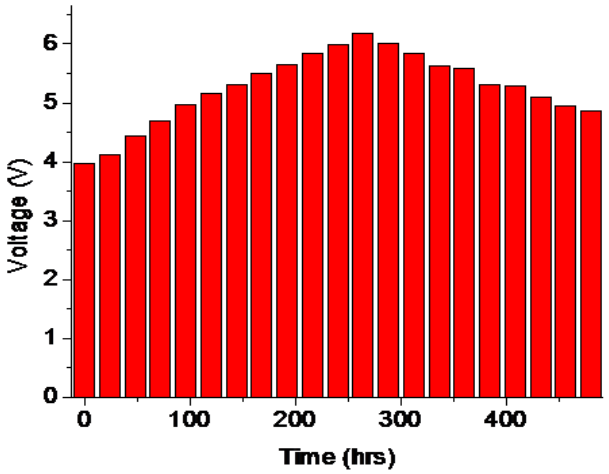

Fig.3: Voltage generation by MFC using Sewage wastewater with Pencil lead when connected in series

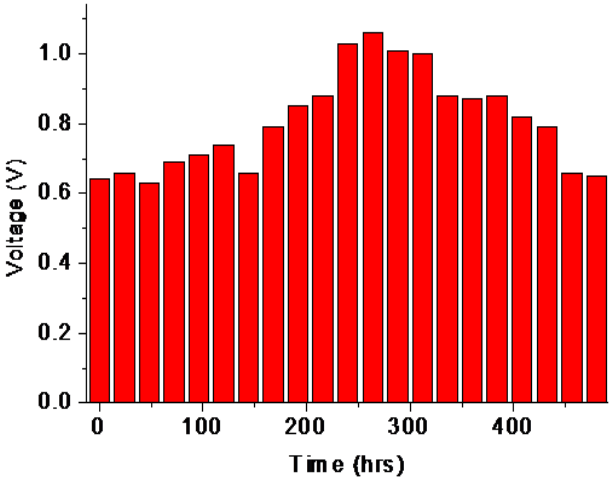

Fig.4: Voltage generation by MFC using Sewage wastewater with various electrodes when connected in parallel

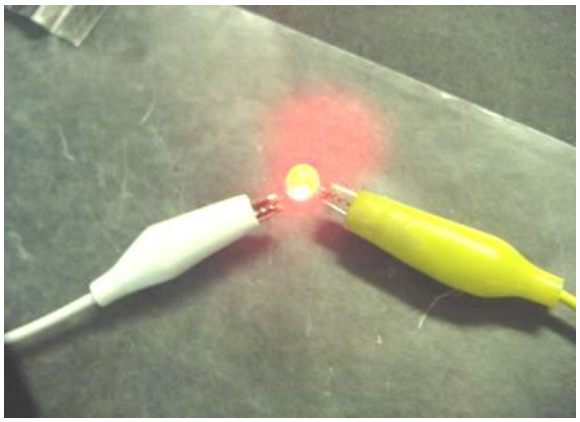

Fig.5: Glowing LED by voltage generation using a set up of MFC

CONCLUSION

In this study, sewage was as substrate, it contains organic matter available for microbe's energy recovery. Potassium permanganate as catholyte, carbon rod as electrode and salt bridge as a membrane were used. MFC generate more voltage with Potassium permanganate. Various electrolytes like Potassium permanganate, Potassium dichoromate and Potassium ferricyanide were used. Maximum generation of 0.73 V was produced with Potassium permanganate solution. Several MFCs were connected with each other in series and parallel connections. The maximum voltage generation was observed in series connections (6.18 V). When MFCs were connected in series the voltage generation was high enough to glow LED for 3 hrs. The idea of salt bridge instead of the proton exchange membrane is more economic as it is cost effective and easily available.

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