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Impact of Salt Bridge on Sewage Water Based Microbial Fuel Cells

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ABSTRACT

Energy is the prime mover of economic growth and sustenance of a country's economy. Future economic growth crucially depends on the long-term availability of energy sources that are affordable, accessible and environment friendly. Microbial fuel cells (MFC) may represent a completely new approach to waste water treatment with the production of sustainable and clean energy. MFC is a device that uses the substrate bacterial consortium to generate bioelectricity resulting in the breakdown of organic substrates. Bacteria gain energy for metabolism by transferring electrons from an electron donor, glucose or acetate to an electron acceptor, such as oxygen or nitrate, to an insoluble acceptor, such as the MFC anode. This transfer can occur by a salt bridge. The direct conversion of substrate energy to electricity enables high operational efficiency. MFCs operate efficiently at ambient, and even at low temperatures, distinguishing them from all current bioenergy processes. In general, MFCs have potential for widespread application in location lacking infrastructures and have potential to expand the diversity of fuels we use to satisfy our energy requirements. In the present study, efforts are made to analyze the impact of salt bridge over the production of electricity. Various designs of salt bridge based MFCs are constructed and the efficiency was tabulated. It is concluded that the number of salt bridge had an impact in energy production.

Key words: MFC, Salt Bridge, Bioenergy, Bioelectricity, Sewage water.

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INTRODUCTION

With increasing world population, it is vital to find alternative methods of energy production, organic waste utilization that are sustainable for future. Energy consumption has increased dramatically leading to an unbalanced energy management. Biofuel cells potentially offer solution to all these problems. They take readily available substrate from renewable sources and convert them into useful byproducts with the generation of bioelectricity [1].

The energy crisis in India has reached at alarming levels requiring immediate attention. It is now known that electricity can be produced directly from the degradation of organic matter in a microbial fuel cell, although the exact mechanisms of the process are still to be fully understood [2].

Wastes from households, industries etc are ideal candidates of substrates for energy generation because they contain a high amount of easily degradable organic matter. Biomass is ubiquitous in nature and has immense potential as a substrate for energy generation. Ethanol, butanol, methanol, methane, bio-diesel and bio-hydrogen and electricity can be produced from biomass [3].

In the present study, attempts have been made to produce bioelectricity from wastewater collected from SRM University sewage treatment plant. Investigations were done to understand the impact of salt bridge design and capacity on achieving high energy output.

MATERIALS AND METHODS

Wastewater which served as the substrate for the MFC was collected from SRM University-Sewage Treatment Plant. The inlet of the primary and lamellar filter served as the substrate. The phases were selected to avoid coarse and large particles found in raw waste water. The natural consortium present in the waste water was used in all studies.

Two plastic containers of various capacities based on the number of salt bridges were used as cathode and anode compartments. The terminal electron acceptor, carbon electrode was placed in the anode compartment containing the substrate and which was connected to an external circuit leading to carbon cathode. The salt bridge was cast with polyvinyl chloride of 2cm internal diameter and 12cm length. The salt bridge was made with 5% agar and 1M KCl while practicing extreme conditions to avoid bubble formation. The cork which seals the anodic chamber is reinforced using paraffin wax to contain no cracks or gaps, hence making it impermeable to oxygen. The salt bridge facilitates transport of protons produced during microbial metabolism to the carbon electrode which acts as a sink. An external circuit was established by connecting a multimeter which measures the voltage and current across the cell.

Substrate was added in the anodic chamber and was completely sealed to maintain anaerobic condition. The reactor was sparged with carbon dioxide before sealing completely to ensure removal of oxygen. A batch configuration was employed and readings were taken for a period of 21 days. The rise and decline in readings were noted for the given period. A standard reactor was always employed for the comparison of the modified parameter with that of the unaltered. A graph was generated (current Vs time) to visually represent the comparison at the end of the experiment.

Various designs of MFCs with two, three, four, five and eight salt bridges were investigated in the current study.

The output of the MFC is expressed by means of current (mA). Multimeter was used for the purpose and was calibrated each time before use. The multimeter was also used to measure Open Circuit Voltage (OCV). Ohm's law was used to calculate Power and hence the power density was also calculated. Power generated by MFC is computed as a product of current passing through an external resistor and voltage drop across the resistor.

Readings from the multimeter were noted only after a steady and constant value was obtained. The multimeter was connected in series with MFC which measures current and was connected in parallel while measuring OCV.

RESULTS

The current study proved that the number of salt bridge which conducts protons to the anode plays a role. In different designs of MFCs, constructed with different number of salt bridges, the MFC with eight salt bridges (maximum used in the study) produced 1675 micro amperes.

Table1: Maximum current obtained with 1M KCl

Number of the salt bridge	Maximum current (micro-amp)
1	1568
2	1521
3	156
4	208
5	636
8	1675

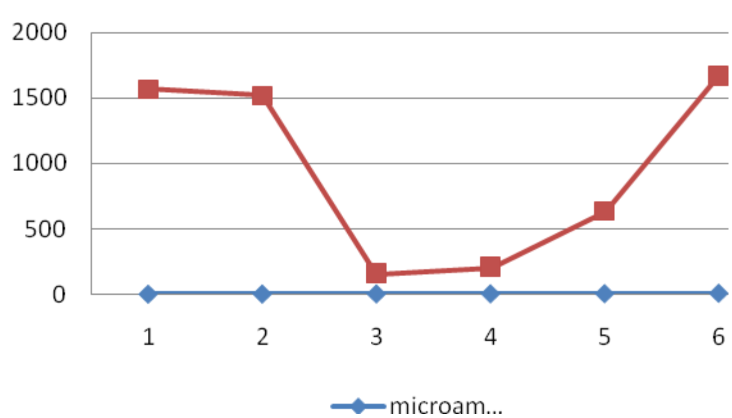

Figure 1. Graph showing electricity produced against number of salt bridge

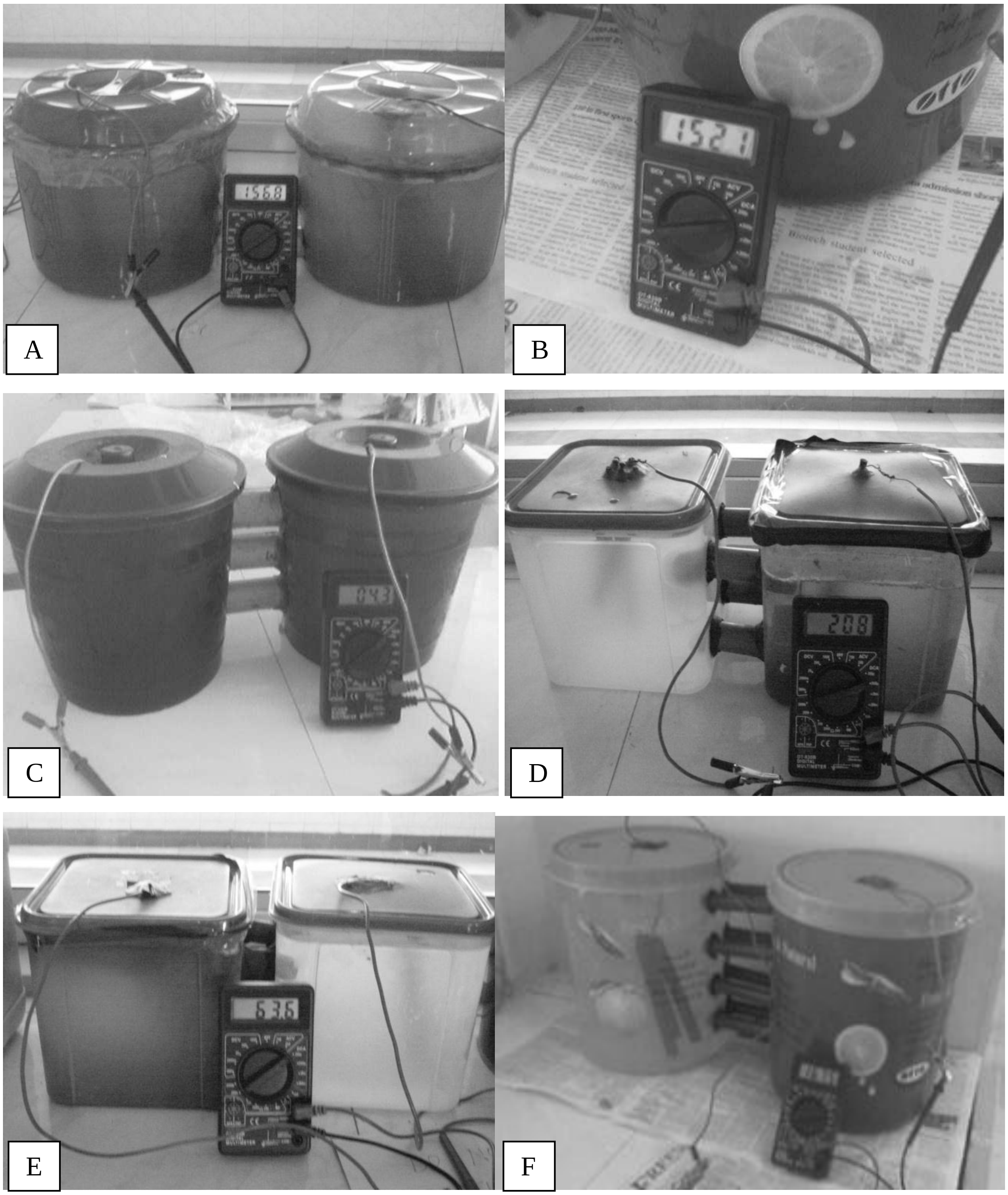

Figure 2.

A. 1 Salt Bridge MFC **B. 2 Salt Bridge MFC** **C. 3 Salt Bridge MFC**
D. 4 Salt Bridge MFC **E. 5 Salt Bridge MFC** **F. 8 Salt Bridge MFC**

CONCLUSION

MFCs are tested in the laboratory using a fixed internal resistance, which can be considered to be connected in series with the external resistor. The power output from MFCs has increased dramatically in just the past few years because of optimized designs that lowers its internal resistance. Scale up, will only be economical if volumetric loading rates can be increased without a decrease in columbic efficiency.

Power output is controlled by a number of factors, including the efficiency of electron transfer from microorganisms to electrodes, electrode surface area, the resistance of the electrolyte and the oxygen reaction kinetics in the cathode chamber [4].

Thus, it is clear from the given studies that maximizing power generation in MFCs requires innovative flow patterns and electrode orientation that minimize internal resistance and finding methods for improved cathode potential. The cost of materials employed for the construction of MFC will be a key factor for the successful application of the technology at large scales. Hence developing a cost effective procedure which is environmentally sound and sustainable due to utilization of wastewater as substrate is the need of the moment.

MFCs can also be modified to produce hydrogen gas by removing oxygen at the cathode by adding in a small voltage via the bio-electrochemically assisted microbial reactor or the bio-catalyzed electrolysis process. When bacteria are placed in the anode chamber of a specially designed fuel cell that is free of oxygen they attach to an electrode. Because, they do not have oxygen, they must transfer electrons that they obtain from consumption of food somewhere else than to oxygen that they transfer to an electrode. In a MFC, these electrons therefore go to the anode while the cathode is exposed to oxygen. At the cathode, the electrons, oxygen and protons combine to form water. The two electrodes are at different potential of about 0.5V creating a fuel cell.

REFERENCES

[1] Bond DR and Lovely DR. Appl Environ Microbial 2003; 69: 1548-1555.
[2] Rakesh Reddy N, Nirmal Raman K, Ajay Babu OK and Muralidharan A. Curr Res Topics in Appl Micro and Microbial Biotech 2007;1:322-326
[3] Muralidharan A, Ajay Babu OK, Nirmal Raman K and Ramya M. Ind Jour of Fund and Appl Life Sciences 2011;1(2):178-184
[4] Lui H, Ramnarayanan R and Logan BE. Environ Sci Tech 2004;38:2281-2285.