Microbial Fuel Cell & Earth Cell Batteries as A Renewable Power Source for Smart Cities

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Abstract— Earth battery and Microbial fuel cell are the renewable power sources which can be utilise for smart and growing cities with less pollution effects. Microbial fuel cells (MFCs) can give the electric current and hydrogen as product of bacterial metabolism from organic waste under anaerobic conditions. Enormous supply of bacteria-soil nearly every place on Earth, microbial fuel cells has potential to give renewable electricity nearly anywhere round the globe and earth battery is an erstwhile concept designed to generate electricity by using to dissimilar electrode buried I the ground it can produce low voltage and current for a finite interval of time. this is the reason lots of research has swift in this field now days. It has been known for many years that by breaking down organic substrates with the help of bacteria the generation of electricity are possible. The recent energy limitations and hazards have rested interests in MFCs among researchers as to produce electric power or hydrogen gas form organic waste without affecting the ecosystem. The MFCs has a potential to give clean energy without emission of carbon. The MFCs can become very powerful tool for municipal ,industrial, agriculture and domestic waste management because of generation of electricity while consume and break down environmental pollutants in order to built green ecosystem. Although being very promising source of eco energy the amount of energy is low at present so its uses are limited. Present paper is for discuss the opportunity to use MFCs and Earth batteries as sustainable source of electric energy by understand its working phenomenon, application and limitation. This paper is also gives the idea to use these sources to generate electricity in houses, industries and municipal corporation by using small and bigger flowerpot, garden or farms. This method also can be used in organic dump yard and houses wastage yards.

Key words: Bio hydrogen, Electricity generation, Microbial fuel cells (MFCs), Renewable energy technology, Wastewater treatment, Earth battery

I. INTRODUCTION

As it all known that due to present energy source crisis new and alternative renewable source is required for better future. In the view of global energy crisis to be caused by natural end of oil and gas within next 50 to 60 years time, it has become very important to look for alternative energy sources. Many kind of different research is conducted for different renewable resources, but it seems that any one solution cannot replace for all. It should be collection of solutions which has to be less carbon emmisive, simple and does not have hazardous effect on human kind and nature. Discovery that bacteria can be used to produce electricity from waste and renewable biomass has gained much attention. Recently the increased interest in microbial fuel cell (MFC) technology was highlighted by the naming of Geobacter sulfurreducens KN400, a bacterial strain capable of high current production, as one of the top 50 most important inventions for 2009 by Time Magazine. The discovery that microbial metabolism could provide energy in the form of an electrical current has lead to an increasing interest and a dramatic raise in the number of publications in the field of MFC research. These systems are very adaptable and hold much promise to provide energy in a sustainable fashion but major improvements are required if widespread applications will be feasible. This review article will examine MFC's currently in use, potential future applications and the limitations to implementing those applications. We suggest methods for improving the current output of a MFC. We also examine earth battery and its voltage change with respect of time. This review will hopefully highlight some of the potential of and limitations to MFC technology implementation.

II. MICROBIAL FUEL CELLS

Microbial fuel cell is a typical cell which converts chemical energy into electrical energy. It can be in one single unit or can be divided into chamber containing the anode and cathode, respectively. This chamber is separated by a membrane which allows proton exchange. The microbes present in chamber with full of soil or favourable substrate which is anaerobically consumed and degraded to release electron. These electrons flow to anode and then to cathode via external circuit. Soil acts as membrane which allows electively passes through the charge.

Fig. 1: Microbial Fuel Cell experimental setup

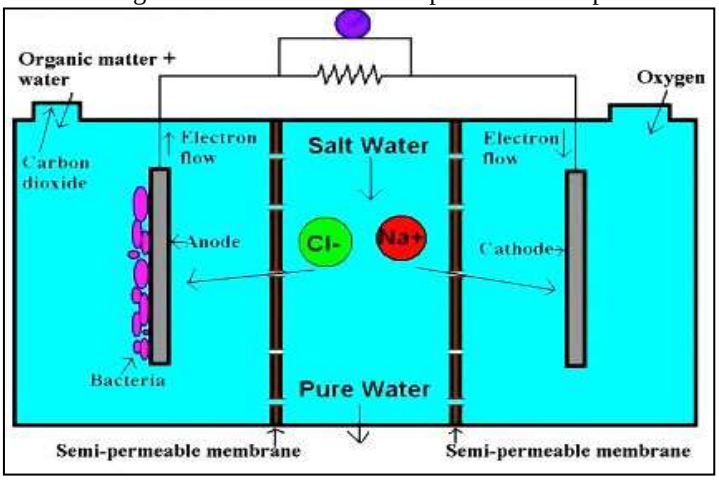


Fig. 2: Circuit digrame of microbial fuel cell

Microbial fuel cell A MFC divided into two chambers those are anodic and cathodic chamber containing the anode and cathode. These chambers are separated by a proton exchange membrane. The microbes present in the anodic chamber are provided with a organic substrate which is degraded in the absence of oxygen to release electrons which are transported from the anode to the cathode via external circuit. The protons are also generated which passed through the exchange membrane. Both these products produced due to the action of the microbes in the anodic compartment travel to the cathode and react with oxygen to produce water. MFCs are devices that can convert chemical energy into electrical energy by the process of oxidation of various carbon sources or even organic wastes.

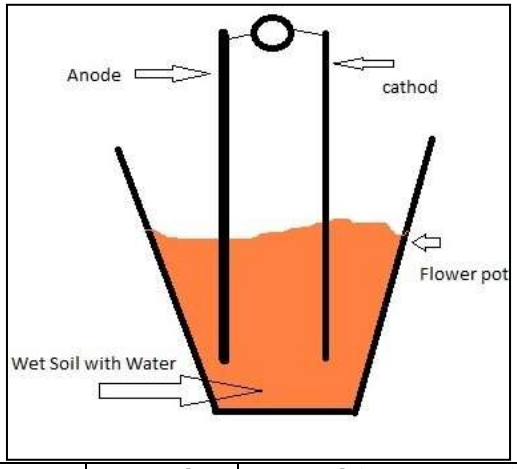
A. Chemical Equation

When microorganisms degrade a organic substance in aerobic conditions, they produce carbon dioxide and water as described below-

$$C_{12}H_{22}O_{11} + 13H_2O \rightarrow 12CO_2 + 48H^+ + 48e^-$$

B. Earth Batteries

The Earth battery is basically just like a normal battery with anode and cathode and soil act as a membrane which allows the flow of ion. The soil and organic waste use as electrolyte since it has moisture characteristics and contains various minerals which will allow smoother ion flow from the anode to cathode electrode. This battery is not hazardous to human being and also eco-friendly. This battery can use to drive a small load such as light emitting diode or a digital watch. a previously study that the best soil to be used as an electrolyte is the clay soil and use of organic waste can improve the density of current and voltage.



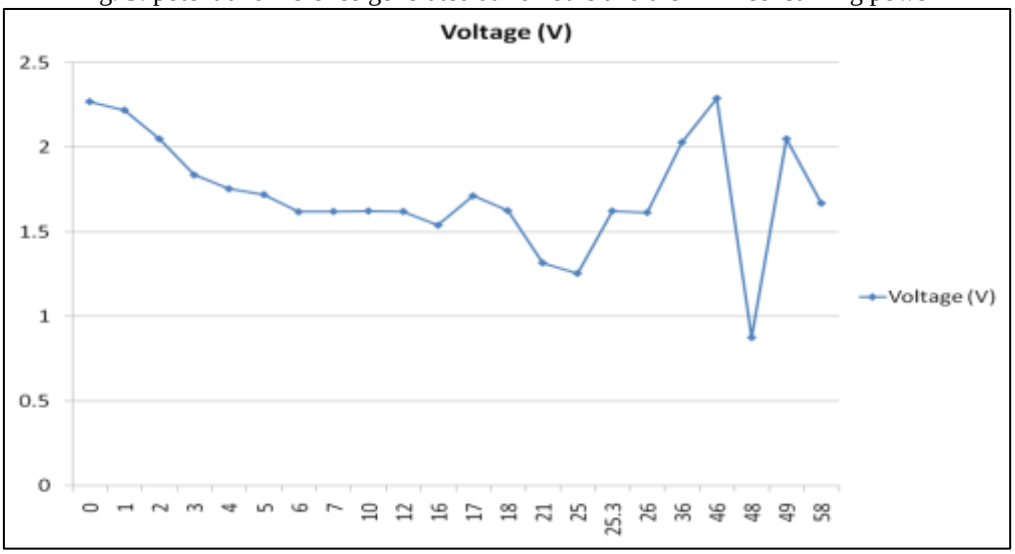
Sr. No.	Metal	Potential (Vs $Cu/CuSO_4$)
1	Zinc	-1.10
2	Aluminium	-.822
3	steel	-0.50 to 0.80
4	Cast iron	-0.50
5	Copper	-0.20
6	Carbon	+0.30
7	Coke	+0.30

Table 1: [2]

C. Experimental Observations

The following observations were made over a period of 58 hours. The data obtained from the observations is tabulated as under:

Fig. 3: potential difference generated at 46 hours and the LED consuming power



Sr. No.	Time period between two successive readings (Hours)	Voltage (V)
1	0	2.27
2	1	2.22
3	2	2.05
4	3	1.837
5	4	1.755
6	5	1.721
7	6	1.619
8	7	1.621
9	10	1.624
10	12	1.621
11	16	1.54
12	17	1.713
13	18	1.626
14	21	1.317
15	25	1.255
16	25.3	1.624
17	26	1.615
18	36	2.03
19	46	2.29
20	48	0.876
21	49	2.05
22	58	1.67

Table 2: Variation of potential difference with time

III. RESULTS

In the present research work three earth cell were connected in series, used for experimentation which generates an average potential difference of 1.17 volt , utilising this an LED was lightened for 24 hours continually .the potential difference generated over a period of 58 hours is ploted in figure shown above Further it indicates the potentiality of earth cell and microbial fuel cell that if number of cells are increased and connected in series, a considerable amount of bio energy can be generated which can be utilized to run small electrical devices.

IV. CONCLUSION

From the above experimentation it shows that a very small house hold earth cell can be used to light a LED continually for 24 hours. If the same model is extended to "N" number of cells than a considerable amount of energy can be obtain from such a model which can be incorporated in smart city model. Energy can be obtained from household gardens of smart cities, the septic tank with a few modifications can be used as a microbial fuel cell and roadside greenery can be converted to earth cell. Further the municipal waste and at the same time waste water treatment can be used as a potential energy source without having any polluting effects.

REFERENCES

[1] Microbial fuel cells in bioelectricity production Akshay D. Tharali, Namrata Sain & W. Jabez Osborne
[2] PotterM.C.,Electrical effects accompanying the decomposition of organic compounds, Proc.R.Soc.Lond.B.Biol.Sci.Vol.84,1911,260–276.
[3] ChoiY.,JungS.andKimS.;DevelopmentofMicrobialFuelCellsUsingProteusvulgaris, BulletinoftheKoreanChemicalSociety,21(1),2000,44–48
[4] YueP.L.andK.Lowther,EnzymaticOxidationofC1CompoundsinaBiochemicalFuelCell,Chem.Eng.J.,Vol.33,1986,B692B77.
[5] KatzEugenii, AndrewN.Shipwayand ItamarWillner, Biochemical fuelcells, in Handbook of FuelCells–Fundamentals, Technology and Applications,Volume 1, Fundamentals and Survey of Systems, Vielstich Wolf,HubertA.GasteigerandArnoldLamm;(Ed.),JohnWiley&Sons,Ltd.,2003.
[6] Bennetto,H.P.,ElectricityGeneration byMicro2organisms,BiotechnologyEducation,Vol. 1,No.4, 1990, 1632168.
[7] Bennetto, H. P., Stirling, J. L., Tanaka, K. and Vega C. A., Anodic Reaction in Microbial Fuel Cells, BiotechnologyandBioengineering,Vol.25,1983,5592568
[8] JiangJunqiu,ZhaoQingliang,ZhangJinna,ZhangGuodongandLeeDuu2Jong,Electricitygenerationfrom bio2treatment of sewage sludge with microbial fuel cell, Bioresource Technology, Vol. 100, Issue 23,
[9] December2009,5808–5812,International Journal of Energy, Information and Communications International Journal of Energy, Information and Communications International Journal of Energy, Information and Communications International Journal of Energy, Information and Communications

[10] Hwang, M.H., Jang, N.J., Hyun, S.H., Kim, I.S., Anaerobic bio2hydrogen production from ethanol fermentation:theroleofpH.,J.Biotechnol.111,2004,297–309.
[11] SislerF.D.,BiochemicalFuelCells,inProgressinIndustrialMicrobiology,D.J.D.Hockenhull(Ed),J.&A. Churchill,London,Vol.9,1971,1–11.
[12] Turner A. P. F., W. J. Aston, I. J. Higgins, G. Davis and H. A. O. Hill, Applied Aspects of
[13] Bioelectrochemistry:FuelCells,Sensors,andBioorganicSynthesis,inFourthSymposiumonBiotechnology inEnergyProductionandConservation,C.D.Scott(Ed),Interscience,NewYork,401,1982.
[14] PalmoreG.T.R. and G.M.Whitesides, MicrobialandEnzymaticBiofuelCellsinEnzymatic Conversion of Biomass forFuelsProduction,M.E.Himmel,J.O.BakerandR.P.Overend(Eds),ACSSymposiumSeries No.566,AmericanChemicalSociety,Washington,DC,1994,271–290.
[15] BartlettP.N.,P.Tebbutt and R.C.Whitaker, KinematicAspects of the Use of Modified Electrodes and mediatorsinbioelectrochemistry,Prog.ReactionKinetics,Vol.16,1991,552155.
[16] KatzEugenii,AndrewN.Shipwayand ItamarWillner, Biochemical fuelcells in Handbook of FuelCells–Fundamentals,TechnologyandApplications,Volume1,FundamentalsandSurveyofSystems,VielstichWolf,HubertA.Gasteiger andArnoldLamm;(Ed.),JohnWiley&Sons,Ltd.,2003.
[17] SuzukiS.andI.Karube,EnergyProductionWithImmobilized.Cells,Appl.Biochem.Bioeng.,Vol.4,1983,