Quest Journals
Journal of Electronics and Communication Engineering Research
Volume 4 ~ Issue 2 (Mar.-Apr. 2018) pp: 01-04
ISSN(Online): 2321-5941
www.questjournals.org

Research Paper

Analysis of Biomass Cells for Bioelectricity Generation using Dung Slurry and Vinegar

Gagandeep Kaur
Faculty of Engineering, Department of Electrical Engineering
I.K.Gujral Punjab Technical University Jalandhar, Kapurthala, Punjab, India

Abstract-- *Microbial Fuel Cells (MFC) has natural ability to convert substrate into electricity, being an abundant microorganism. This theory conceived the idea of biomass cell technology which further helped for development of biomass cells. By using various combinations of cattle dung, water, and vinegar, different biomass cells have been developed for bioelectricity generation. Biomass cells are under observations for period of 30 days, and needed electrical parameters are recorded. The maximum voltage achieved is 1.10 V with substrate having cattle dung, water and small amount of vinegar. C ells have been fabricated and analyzed to explore the possibility of sustainable source of energy for electrification in rural areas.*

Index Terms-- *biomass cells, cattle dung, substrate, open circuit voltage (OCV), bioelectricity.*

I. INTRODUCTION

The demand for energy is rising exponentially being large network of industrialization. Globally power market is facing energy crisis. Innovative methods of electricity generation from renewable resources with zero carbon footprints are much needed [1]. Recently, Biomass Cells based on concept of Microbial Fuel Cells (MFC) and Fuel Cells have attracted the world in generating electricity directly from organic matters [2-5]. MFC is a noble form of renewable energy technology that can generate electricity from organic waste.

MFC is a bio electrochemical system inoculated with microorganism that mediate the conversion of chemical energy stored in organic matter into electricity [6]. MFC is an impersonator and biological setup in which bacteria do not right way transfer their characteristics electron acceptor; rather, the process of transportation is afterwards conducted over an anode, a resistance, or power users and a cathode. Following this manner, the bacterial energy is directly converted to electrical energy [7]. MFC can be considered as bioreactor using bacteria as biocatalysts, which convert chemical energy stored in biomass to electricity [8-9]. Electricity production through this organic matter is with normal living process of bacteria taking and processing of energy [10]. Biomass cells inspired from MFC has been designed and named biomass cell. The animal dung, in form of slurry with are perfect candidate for bioelectricity generation as there is high
organic matter content which is easily degradable.

II. MATERIALS AND METHODS

The following materials and methods have been adopted for experimentation of biomass cells.

A. ***Collection of Biomass Fuels as Samples***

Cattle dung samples of different large animals by following standard procedure of sample collection were collected. The preliminary study has already been carried out only on dung with water in different ratio proportions. The studies were further extended with cattle dung, water making slurry and added vinegar.

B. ***Fabrication of Biomass Cells***

For cells formation, copper and zinc plates of equal dimensions are used as electrode to convert substrate into electricity through biological process. The different compositions of cattle dung, water, and vinegar are used as biomass substrate. The zinc and copper plates are placed in parallel and can act as small biomass grid in the plastic container. The Table I and Figure 1 gives the dimensions and the structure of biomass cell. Distance between the

electrodes should be minimum to overcome the electrical leakage and to have less internal resistance [11].

TABLE I
Specifications of Biomass Cells

Material	Copper & Zinc Plates
Surface area of plates	Length= 4″, Width= 2″, Thickness= 2 mm, Surface area of each plate= 16 Sq inches
Distance between plates	2″
Substrate	Cattle Dung+ Water+ Vinegar

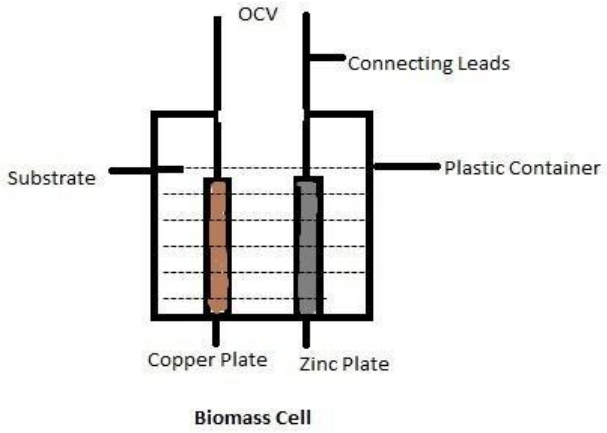

Fig. 1. Structure of Biomass Cell

III. EXPERIMENTAL SET UP AND ANALYSIS

Biomass cells are devices that can be bacterial metabolism to produce an electric current from wide range organic substrate. It happens as there is conversion of chemical energy into electrical energy. Bio electricity can be generated when two electrodes with different potentials immersed in a biomass substrate made of dung, water and vinegar. The various experimental setups have been established with above substrates to check the biomass cells potential. It is known that bacteria will grow as long as there are nutrients. The rate of bacterial metabolism at the anode increases when the electrical potential of the anode increases. The electrical potential is equivalent to the concentration of electrons and electrons are precisely what the bacteria transfer to anode [12]. Accordingly to get high voltages, bacteria rich substrates should be used, and need to replenish them at regular interval.

SETUP 1: Dung+ Water+ Vinegar

In this setup the ratio of dung and water is taken 1:4 and volume of dung + water mixture is 1250 ml for all the biomass cells. The addition of vinegar has done in symmetrical way for all the cells of setup . After addition of vinegar, substrate is mixed well and kept under observation for 30 days. The OCV of all the cells is measured on regular basis with multimeter. Reactions taking place in the biodegradation of a biomass substrate:

$CH_3 COOH + 2 H_2O = 2 CO_2 + 8H^+ + 8 e^-$

Table II shows the amount of addition of vinegar for cells 21, 22, 23, 24, 25, 29, 32, 33, 34 & 35. to each other. The addition of 150- 450 ml vinegar in standard substrate has improved the OCV for further applications.

TABLE II
Substrate Composition for Setup

Cell No.	Amount of Dung (ml)	Amount of Water (ml)	Amount of Vinegar (ml)
21	250	1000	50
22	250	1000	100
23	250	1000	150
24	250	1000	200
25	250	1000	250
29	250	1000	300
32	250	1000	350
33	250	1000	400
34	250	1000	450
35	250	1000	500

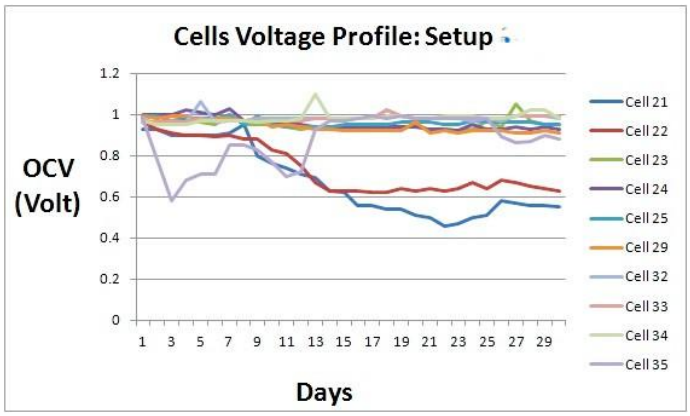

Fig. 2. Biomass Cells OCV Vs Days for Setup

Fig. 3. Biomass Cells 24, 25 & 26 under observations

IV. RESULTS

The present work is an effort to study and explore the ability of microbial bacteria in biomass cells. Microbial bacteria are responsible for bioelectricity generation in biomass cells. The various combinations of cattle dung, water, and vinegar as substrate for cells and OCV of all cells are recorded for 30 days. It is concluded from that in setup 3 the mixing of vinegar with dung + water substrate has given the promising OCVs for cells 23, 24, 25, 29, 32, 33 and 34. The magnitudes of voltages are much better than all other cells. The maximum voltages for cell 23 is 1.05 V on day 27 and range of voltages are 0.93 to 1.05 V. The maximum voltages for cell 24 is 1.03 V on day 7 and range of voltages are 0.93 to 1.03 V. The maximum voltages for cell 25, 29, 32, 33 and 34 are 1.00 V on day 7, 0.99 V on day 1, 3 &4, 1.06 V on day 5, 1.02 V on day 18, 1.10 V on day 13 and corresponding range of voltages are 0.94 to 1.00 V, 0.91 to 099 V, 0.95 to 1.06 V, 0.96 to 1.02 V, 0.95 to 1.10 V.

V. CONCLUSION

This study demonstrated that cattle dung can be used as fuel to generate electricity using biomass cell technology. The biomass cells with different compositions of dung, water, vinegar are kept for study for 30 days. The output voltages obtained from most of cells were almost stable throughout this span. The maximum achieved voltage is 1.10 V and most of the cells have OCV in range of 0.85-1.10V in this duration. Cells with the consistent and higher magnitude of OCV are kept under observation for more than 30 days and have given stable voltages. Cattle dung is an organic waste, which is easily available in rural areas. Because of its natural availability, sustainable energy source and great potential of power generation, biomass cells have an immense prospectus in future. So it can be the promising technology for electrification in rural areas.

REFERENCES

[1]. Lovely DR, "Microbial fuel cells: novel microbial physiologies and engineering approaches," Current Opinion in Biotechnology, Vol.17, No..3, pp.327-332, 2006.

[2]. Chaudhuri SK, Lovely DR.," Electricity generation by direct oxidation of glucose in mediator less microbial fuel cells", Nature Biotechnology vol. 21, pp.1229-1232, 2003.

[3]. Rabaey K, G Lissens, "A microbial fuel cell capable of converting glucose to electricity at high rate and efficiency," Biotechnology Letters, vol.25, no. 18, pp. 1531-1535, 2003.

[4]. Liu H, Logan BE, "Electricity generation using an air cathode single chambers microbial fuel cell in the presence and absence of a proton exchange membrane," Environ Science and Technology, vol.38, no. 14,

[5]. pp. 4040-4046, 2004.

[6]. Min B, Logan BE, "Continuous electricity generation from domestic wastewater and organic substrates in a flat plate microbial fuel cell," Environment Science and Technology, vol.38, no.14, pp. 5809-5858, 2004.

[7]. Joline E1-Chakhtoura, Mutasem E1- Fadel, Hari Ananda Rao, Dong Li, Sophia Ghanimeh, Pascal E. Saikal, " Electricity generation and microbial community structure of air cathode microbial fuel cells powered with organic fraction of municipal solid waste and inoculated with different seeds," Biomass and Biotechnology, vol. 67, pp. 24-31, 2014.

[8]. Rabaey K, Boon Nico, Sicilliano Steven D, Verhaege Marc, Verstraete Willy, "Biofuel cells select for microbial consortia that self-mediate electron transfer," Applied and Environmental Microbiology, vol.70,pp.5373-5382, 2004.

[9]. Keith Scott and Cassandro Murano, "Microbial fuel cells utilizing carbohydrates," Journal of Chemical Technology and Biotechnology, vol.82, no.1,pp. 92-100, 2007.

[10]. Frank D, Seamus P.J Higson, "Biofuel cells- recent advances and applications," Biosensors and Bioelectronics, vol. 22, no.7,pp. 1224-1235, 2007.

[11]. Longfei Mao, Wynand S Verwoerd, "Selection of organism for systems biology study of microbial electricity generation: a review,".International Journal of Energy and Environmental Engineering, pp. 4-17, 2013.

[12]. Jae Kyung Jang, The Hai Pham, In Seop chang, Kui Hyun Kang, Hyunsoo Moon, Kyung Suk Cho, Byung Hong Kim, " Construction and operation of a novel mediator- and membrane-less microbial fuel cell," Process Biochemistry, vol. 39, no.8, pp. 1007-1012, 2004.

[13]. Marcus, A.K, B. Rittmann, " New insights into fuel cell that uses bacteria to generate electricity from waste," New archive of the biodesign institute, Arizone State University.Jan 3, 2008