IJASRM International Journal of Advanced Scientific Research and Management, Special Issue 5, April 2019
www.ijasrm.com
ISSN 2455-6378

Studies and development of the bio-batteries using cow's excreta (dung and urine) as an electrolyte

Raj Kumar Rajak

Research Scholar
Mahatma Gandhi Chitrakoot Gramodaya Vishwavidhyalaya Chitrakoot, Satna (M.P.)

Abstract

Bio-battery represents a completely new, long-term, moderate, available and ecological way to deal with the generation of sustainable energy. Experimental testing results that different batteries was made up of different electrode pairs using cow excreta (dung and urine) as an electrolyte, in which according to the analysis of a few physico-chemical and electrical parameters, C-Zn electrode pair were found most suitable for generating power than others. These outcomes demonstrate that the bio-battery has the power to meet the energy required for low energy equipment.

Keywords: *Bio-batteries, Cow's excreta, Electrodes, Non-conventional.*

1. Introduction

The modern era is facing a serious energy crisis and energy demand continues to increase at an unsustainable pace. Various methods are already proposed for power generation using non-conventional energy resources. Chiefly non-conventional energy resources are solar energy, wind energy, tidal energy, biomass energy, fuel cells, and geothermal energy [1], [11]. The requirement for new and alternative sources of energy is increasing day by day. Alternative sources of energy will be applied wherever in the coming days [2].

Cow excreta have been identified as a viable source of energy with additional quality, which has reduced considerably in greenhouse emissions. Since there is more quantity available in cow excreta, a power source can be used for lighting biomass batteries. The ultimate goal is to illuminate rural homes by using alternative sources of energy without using chemical batteries. The biomass battery performs dual roles of storing energy and producing electricity and it-follows the principle of a chemical fuel cell [2], [5].

Bio-battery is a novel innovation that can be utilized for power generation during oxidization of the natural substances presented in the substrate. To get an attractive performance, it is basic to comprehend the powerful factors on the Bio-battery. Among the various factors influencing the Bio-battery performance, substrate, microorganisms, electrodes material and the shape of electrodes, operating conditions, for example, temperature and pH are considered as the most vital factors. Among various substrates, wastewater is a sustainable rich medium which can be treated by Bio-battery. There are different kinds of exoelectrogenic microbes presented in wastewaters. Scaling up Bio-battery is a controversial issue which needs a thorough comprehension of these factors [3], [4], [7], [8], [9]. By using new economical materials to select electrodes for assembling Bio-battery, more cost-effective design for scalable wastewater treatment and high power generation can be achieved. Moreover, Bio-battery is an appropriate possibility for bioremediation of sewage and animal's excreta [6]. These factors and their effect on the Bio-battery performance have been studied in the investigation.

In this paper, different electrode materials were taken and used for comparative study in Bio-battery for producing electricity. The results of various physico-chemical, electrical parameters and performance of bio-battery indices like, Dry/Wet Weight Ratio (moisture content), pH impact as an electrolyte, Open Circuit Voltage (OCV), Short Circuit Current (SCC), Internal Resistance (R_{Int}), Maximum Power density (Max PD), current density (CD) corresponding to Max. PD, durability (in hours) etc. measured and also measured standard deviation (sd) of every one of these parameters.

2. Material and Method

The present investigation includes the bio-power generation from cow excreta. For the analysis of nonconventional energy, cow excreta samples (dung and urine) were collected from Sadguru Sewa Sadan (Dairy) Chitrakoot Satna (M.P.). Graphite electrode (thickness 0.2 cm, 16 sq.

cm) plate purchased from Graphite India Ltd. Kolkata and Cu, Zn, Al, and Fe (thickness 0.1 cm, 16 sq. cm) plates acquired from the nearby market of Satna. Electrodes are freshly prepared for each experiment. All experiments have been done at room temperature 25±2°C. The pH of cow excreta samples have been measured by using digital pH meter (EI Model- 122).

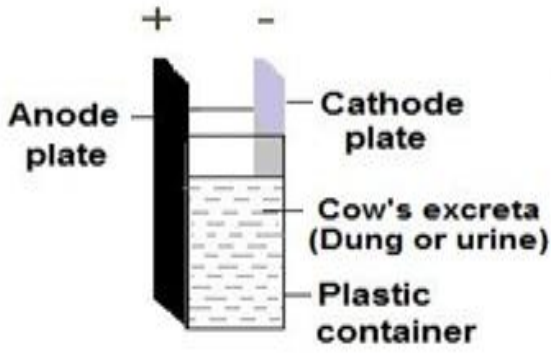

Fig. 1: Schematic diagram of bio-battery for experiments

A plastic aerobic container was taken which contains 250 g/ml cow excreta (dung and urine). Electrode pairs C-Zn, Cu-Zn, C-Al, Fe-Zn, Cu-Al, Zn-Al, Cu-Fe, C-Fe, Fe-Al, C-Cu, Zn-Zn, Al-Al, Cu-Cu, C-C and Fe-Fe were used as anode and cathode respectively, which act as a battery cell as shown in Fig. 1. Anode and cathode electrodes were taken equal size and separation 1cm because it gives the maximum power [10]. The anode and cathode terminals were associated with digital multi-meter (RISH Multi 14S and MASTECH MAS830L) and DPM (Agronic34A6) with help of connecting wires for measuring the current and voltage. The power output was monitored according to measuring voltage and current across the anode and cathode.

So as to get the current density-voltage curve and current density- power density curve (Fig. 3), the external resistance changed from 1 to 1500 Ω. The single unit of the battery was used for the experimental purpose, and a new battery was used for each experiment. In addition, the connection of the wires must be sufficient to get the desired output. This technique is performed with various electrodes pairs. Electrode pairs have been chosen to construct the bio-batteries for further investigation.

3. Result and Discussion

3.1 Selections of electrode pair

Physico-chemical properties of cow excreta (dung and urine) given in Table: 1. All the above mentioned electrode pairs and cow excreta (dung and urine) are found very reasonable for developing batteries. Comparative results of various electrode pairs with bio-battery are represented in the following table- (2 & 3). All the electrical parameter values of battery made from C-Zn electrodes pair are found much better and most suitable than the other. The reasons behind suitability of graphite is cheap, plentiful, very stable over a broad range of operating conditions, scalable, durable/hard, and a good electrical conductor and heat conductor [10]. At last C-Zn has been chosen because of maximum performance cost wise, durability, accessibility and every single electrical parameter for further investigations.

Table: 1. Physico-chemical properties of cow excreta (dung and urine)

S. N.	Parameter/ Content	Cow dung	Cow urine
1	Quantity (g/ml)	250	250
2	pH	7.7 ± 0.5	8.3 ± 1.5
4	Water/Moisture	76.8±2.1%	95 ±1.1%

Obtained result of the selected electrode pair C-Zn generated approximately OCV (1.017 ± 0.055, 1.13 ± 0.111V), SCC (12.3 ± 0.488, 34.5 ± 1.150 mA), max. PD (1040.6 ± 170.3, 2601.87 ± 515.2 mW/m^2) and R_{Int} (0.08– 0.44 and 0.04– 0.2 kΩ) was found using cow excreta (dung and urine) respectively. It was intriguing that the maximum power density of among batteries (dung and urine), urine battery has the highest power density i.e. 2601.87 ± 515.2 mW/m^2 represented in the following table (2 & 3) and fig. 2.

IJASRM
International Journal of Advanced Scientific Research and Management, Special Issue 5, April 2019
www.ijasrm.com
ISSN 2455-6378

Table: 2. Comparative result of various electrode pair with Cow-dung battery

Electrodes pairs	OCV± sd (V)	SCC ± sd (mA)	CD corresponding to max. PD ± sd (mA/m^2)	PD ± sd (mW/m^2)	R_{Int} (kΩ)
C-Zn	1.017 ± 0.055	12.3 ± 0.488	2812.5 ± 378.8	1040.6 ± 170.3	0.08-0.44
Cu-Zn	0.857 ± 0.055	8.9 ± 0.466	2375 ± 241.4	804.75 ± 145.6	0.1-0.4
C-Al	0.66 ± 0.05	6.5 ± 0.466	1581.2 ± 161.9	347.87 ± 59.37	0.14-0.23
Fe-Zn	0.352 ± 0.040	1.852 ± 0.204	537.5 ± 110.4	69.87 ± 7.26	0.2-0.4
Cu-Al	0.558 ± 0.049	2.85 ± 0.311	887.5 ± 142.5	202.3 ± 31.3	0.2-0.5
Zn-Al	0.318 ± 0.036	0.29 ± 0.024	60.62 ± 8.24	10.91 ± 2.09	1.1-1.45
Cu-Fe	0.54 ± 0.05	3.56 ± 1.163	812.5 ± 154.7	235.5 ± 22.04	0.1-0.28
C-Fe	0.71 ± 0.055	9.2 ± 0.444	1500 ± 153.7	450 ± 87.75	0.15-0.25
Fe-Al	0.52 ± 0.055	0.038 ± 0.004	587.5 ± 114.3	122.7 ± 16.5	0.3-0.5
C-Cu	0.165 ± 0.033	0.566 ± 0.061	76.25 ± 6.52	6.86 ± 0.97	0.3-0.7
Zn-Zn	0.048 ± 0.011	0.062 ± 0.009	8.75 ± 1.47	0.237 ± 0.03	1.2-1.5
Al-Al	0.106 ± 0.019	0.06 ± 0.012	8.75 ± 1.47	0.262 ± 0.04	4.7-14
Cu-Cu	0.034 ± 0.009	0.115 ± 0.015	14.37 ± 2.09	0.33 ± 0.05	6.4-22.2
C-C	0.029 ± 0.005	0.13 ± 0.359	20.62 ± 6.89	0.391 ± 0.08	0.1-0.4
Fe-Fe	0.006 ± 0.002	0.023 ± 0.005	5.62 ± 0.96	0.022 ± 0.003	0.1-0.3

Table: 3. Comparative result of various electrode pair with Cow-urine battery

Electrodes pairs	OCV± sd (V)	SCC ± sd (mA)	CD corresponding to max. PD ± sd (mA/m^2)	PD ± sd (mW/m^2)	R_{Int} (kΩ)
C-Zn	1.13 ± 0.111	34.5 ± 1.150	11312.5 ± 1054.9	2601.87 ± 515.2	0.04-0.2
Cu-Zn	0.87 ± 0.071	24 ± 0.721	2625 ± 666.4	1496.25 ± 201.5	0.4-0.85
C-Al	0.68 ± 0.055	6.8 ± 0.5	906.25 ± 202.5	262.81 ± 49.8	0.25-0.48
Fe-Zn	0.67 ± 0.056	30 ± 1.001	5750 ± 612.7	2300 ± 437.8	0.02-0.04
Cu-Al	0.666 ± 0.041	3.6 ± 0.251	1000 ± 103.9	280 ± 37.6	0.2-0.5
Zn-Al	0.36 ± 0.037	1.2 ± 0.2	128.12 ± 27.3	19.21 ± 1.63	0.7-1.3
Cu-Fe	0.35 ± 0.026	3.76 ± 0.370	1350 ± 328.5	229.5 ± 24.7	0.08-0.15
C-Fe	0.35 ± 0.032	5 ± 0.550	675 ± 55.05	148.5 ± 31.69	0.1-0.16
Fe-Al	0.3 ± 0.025	1.2 ± 0.175	243.75 ± 26.05	32.92 ± 3.81	0.3-0.55
C-Cu	0.19 ± 0.046	3.7 ± 0.351	778.12 ± 55.21	77.81 ± 6	0.075-0.085
Zn-Zn	0.14 ± 0.032	0.19 ± 0.041	34.37 ± 5.9	0.275 ± 0.05	0.052-0.135
Al-Al	0.032 ± 0.007	0.016 ± 0.003	2.5 ± 1.28	0.02 ± 0.005	5-9
Cu-Cu	0.03 ± 0.004	0.12 ± 0.03	33.75 ± 5.42	0.54 ± 0.047	0.2-0.27
C-C	0.025 ± 0.005	0.13 ± 0.067	25.62 ± 3.47	0.358 ± 0.028	0.26-0.33
Fe-Fe	0.011 ± 0.038	0.062 ± 0.011	20.62 ± 2.52	0.103 ± 0.011	0.18-0.23

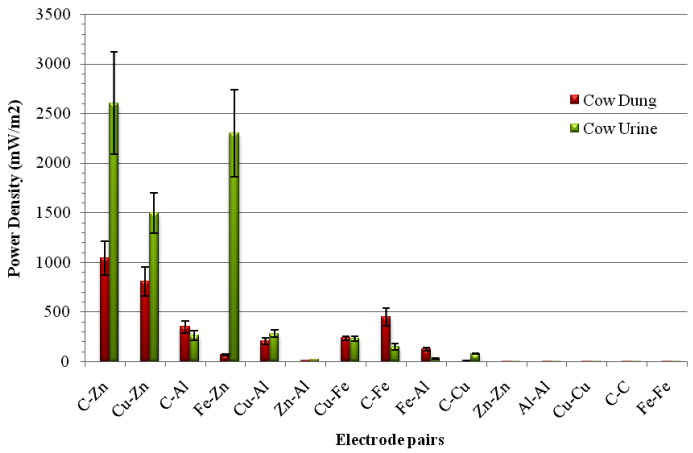

Fig. 2: Comparative result of various electrode pair with cow dung and Cow urine batteries. The error bars show standard deviation.

IJASRM
International Journal of Advanced Scientific Research and Management, Special Issue 5, April 2019
www.ijasrm.com
ISSN 2455-6378

3.2. Characteristics of Cow excreta (dung and urine) Batteries

The study reported the characteristics of the cow excreta (dung and urine) bio-batteries. From both batteries a constant current was found on high resistance while low resistance in a circuit gives increasing current and voltage fluctuation was occurred, that causes polarization of electrodes due to ohmic polarization of a cell. The natural cow excreta (dung and urine) battery was discharged across 100 kΩ load resistance. The C-Zn Electrode battery provides durability of 412 hrs corresponding to 0.688 V and 145 hrs corresponding to 0.757 V from cow dung and cow urine respectively (fig. 4). The cutoff voltage is proposed at the discharge curve (one third of the OCV) [12]. The maximum power density of cow dung and urine battery made by C-Zn electrode obtained from the Current density – Power density Characteristics curve (Fig. 3.).

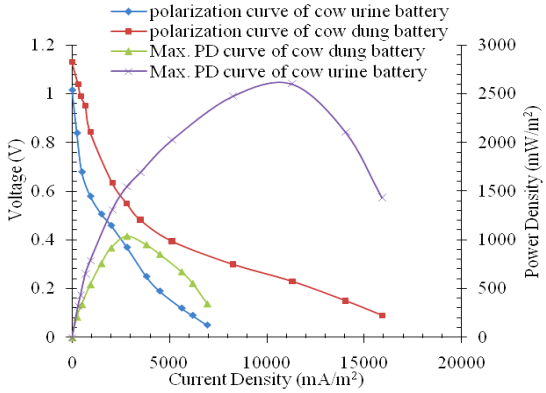

Fig. 3: Characteristics of Cow's excreta battery

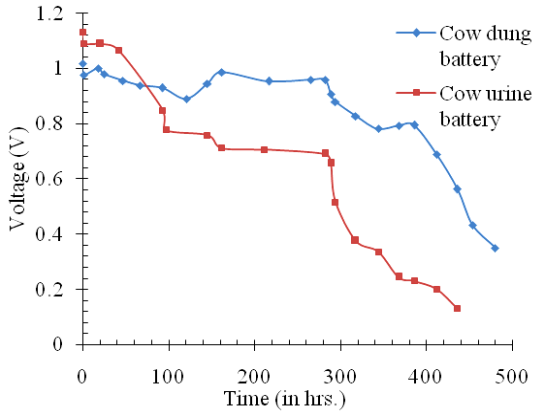

Fig. 4: Discharge characteristics of Cow's excreta battery

4. Conclusion

In the present investigation different batteries made up of different electrode pairs using cow excreta. The outcomes were found that the C-Zn Electrode provides max PD (1040.6 ± 170.3 and 2601.87 ± 515.2 mW/m^2) and durability (412 hrs corresponding to 0.688 V and 145 hrs corresponding to 0.757 V) from cow dung and cow urine respectively. Based on result it can be concluded that a single unit of cow excreta (dung and urine) batteries is appropriate to energize any low power consuming electronic gadget.

Reference

[1] Reddy M. S. K. and Rasool Ahemmed, S. K., Non Conventional Methods of Power Generation for Future Power Outage Problems, International Journal of Science and Research (IJSR), (2013) 2(4), 520-524.

[2] Sudhakar K., Ananthakrishnan R., Goyal A., and Darji H. K., A Novel Design of Multi-Chambered Biomass Battery, Int. Journal of Renewable Energy Development, (2013) 2(1), 31-34

[3] Sudhakar K. and Prasad J., Electricity generation from river water sediments using single chamber microbial fuel cell, academia edu., 2012, 107-110.

[4] Patil V. D., Patil D. B., Deshmukh M. B. and Pawar S. H. Comprative study of bioelectricity generation along with treatment of different sources of wastewater, Int. J. of Chem. Sci. and Appl., (2011) 2(2), 162-168.

[5] Oliveira1 M. O., Somariva R., Ando Junior O. H., Neto J. M., Bretas A. S., Perrone O. E., and Reversat J. H., Biomass Electricity Generation Using Industry Poultry Waste, International Conference on Renewable Energies and Power Quality (ICREPQ'12) Santiago de Compostela (Spain), (2012) 1(10), 1650-1654.

[6] Ramalingam S., Prabhu T., Manimaran K., Murugan S. and Nagarajan S. M., Bio-Emf Device (Bed) Using Hibiscus Leaf as Electrolyte, Asian Jr. of Microbiol. Biotech. Env. Sc., (2009) 11(1), 1-2.

[7] Wang H.M. and Ren Z. Y. J., A comprehensive review of microbial electrochemical systems as a platform technology, Biotechnol. Adv., (2013) 31, 1796–1807.

[8] Logan B.E., Exoelectrogenic bacteria that power microbial fuel cells, Nat. Rev. Microbiol. (2009) 7, 375–381.

[9] Simeng Li and Gang Chen., Factors Affecting the Effectiveness of Bioelectrochemical System Applications: Data Synthesis and Meta-Analysis, batteries, (2018) 4(34), 1-18.

[10] Rajak R. K. and Mishra B., Studies on the Feasibility of Cow's Urine as Non-Conventional Energy Sources, International Journal of Energy and Environmental Engineering, (2018) 12(5), 366-369.

[11] Kumar S., Kumar H. D. and Gireesh Babu K., A study on the electricity generation from the cow

dung using microbial fuel cell, J. Biochem. Tech., (2012) 3(4), 442-447.
[12] Mishra B., Jain K. M. and Hundet A., A source of non conventional energy – Green Leaves. Vigyan Parishad Anusandhan Patrika, (1999) 42(1), 39-52.