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Studies on the Feasibility of Cow's Urine as Non-Conventional Energy Sources

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***Abstract*—**Bio-batteries represent an entirely new long-term, reasonable, reachable, and eco-friendly approach to generation of sustainable energy. In the present experimental work, we have studied the effect of the generation of power by bio-battery using different electrode pairs. The tests show that it is possible to generate electricity using cow's urine as an electrolyte. C-Mg electrode pair shows maximum Voltage and Short Circuit Current (SCC), while C-Zn electrode pair shows less Open Circuit Voltage (OCV) and SCC. By the studies of cow urine and different electrodes, it is found that C-Zn electrode battery is more economical. The cow urine battery with C-Zn electrode provides maximum power (707.4 mW) and durability (up to 145 h). This result shows that the bio-batteries have the potency to full fill the need of electricity demand for lower energy equipment.

***Keywords*—**Bio-batteries, cow's urine, electrodes, non-conventional.

I. Introduction

TODAY'S world is facing a serious problem of energy crisis. The gap between the demand and production is increasing day by day. We need clean efficient energy which does not emit large amount of carbon dioxide for sustainable and healthy growth of our environment with a new source of electricity generation from the renewable sources [1]-[4].

The excurse of bio-waste is an important renewable source for electric power generation. Several technologies are being implemented in order to enable the conversion of bio-waste in electric energy. It is even most important because they provide the comfort of electricity without causing major damage to nature [5]. The organic material makes the bio-batteries unique and different from existing chemical batteries. This type of voltaic cell is generally called as bio-cell (bio-electro motive force device). The essential feature of the bio-cell is the electrolyte used is an organic compound [6].

Cow wastes have been identified as viable source of energy with additional quality that greenhouse emissions are reduced significantly. The bio-battery performs dual roles of storing energy and producing electricity and it is similar to the principle of a chemical fuel cell. Bio-battery technology may provide a new method to generate electricity for rural household, making the technology more affordable for rural electrification [7].

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Generally, cow urine contains water - 95%, urea - 2.5%, minerals, hormones, salts and enzymes - 2.5%. Uric acid is a heterocyclic organic acid, and its structure is given in Fig. 1. Uric acid forms ion and salts named urates and acid urates, respectively. Uric acid is synthesized within the body system by oxidation of purine and excreted with urine. In mammals, enzyme uricase further oxidizes the uric acid to allantoin. Uric acid is a potent antioxidant because it has de-localized loan pair of electron. These electrons participate in generation of electricity from cow's urine [3], [8], [9]. The pH of cow urine was 9.

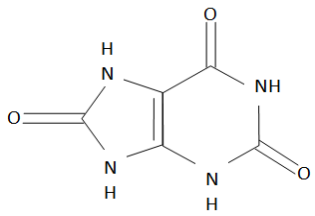

Fig. 1 Presenting the structure of Uric acid [3], [8], [9]

The bio-batteries are designed to support devices with high voltages and low power requirements, the cell can be employed to meet energy requirements. The conventional energy sources have been falling gradually and it is essential to replace this deficiency by new energy sources. An attempt has been made to generate power through natural means by bio-batteries which are anon-conventional energy source [6].

In this paper, we have proposed a renewable source of energy from cow's urine that can produce electricity by electrolytic conductions with different combination of electrode pairs.

II. Material and Method

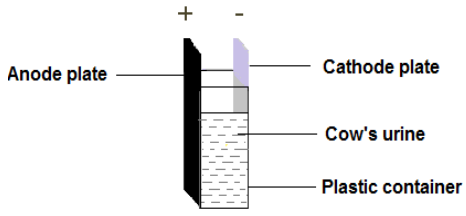

Fig. 2 Schematic representation of a single bio-voltaic cell

Sample of cow urine was collected from SadguruSewaSadan (Dairy) ChitrakootSatna (M.P.). The cow urine cell (battery) incorporates an anode made up of graphite electrode plate (4 sq.cm, thickness 0.2 cm) and a cathode

made up of zinc plate for the purpose of the renewable energy. Graphite plate was purchased from Graphite India Ltd. Kolkata, whereas different pairs of electrodes Cu, Mg, Zn, Al, and Fe (4 sq.cm, thickness 0.1 cm) were also used in the cow urine cell (battery). It is purchased from local market of Satna. Electrodes are freshly prepared for each experiment. All experiments have been carried out at room temperature 25±2 °C.

A plastic aerobic container was taken which contains 10 g cow urine. Electrode plates were used as anode and cathode respectively, which act as a battery cell as shown in Fig. 2. The anode and cathode terminals were connected to digital multi-meter (RISH Multi 14S) 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. In order to obtain the current-voltage (I-V) curve and current power (I-P) curve, the external resistance changed from 1 Ω - 100 kΩ. The single unit of battery was used for experimental purpose, and new battery was used for each experiment. Besides, connection of the wires must be good enough to get the desired output. Similarly, several experiments are performed with different electrodes pairs: The C-Mg, C-Zn, C-Al, C-Fe, C-Cu, Cu-Mg, Cu-Zn, Cu-Al, Cu-Fe, Fe-Mg, Fe-Zn, Fe-Al, Zn-Mg, Al-Zn and Al-Mg electrode pairs have been selected to construct the batteries.

The various types of electrodes have been used for further investigation. The results of various types of electrodes for cow urine are presented in Table II.

III. Results and Discussion

A. Selection of Electrode Pair

Comparative results of various electrode pairs with Cow-urine battery are represented in the following table- (1& 2) and Fig. 3. The SCC value for the batteries made using C-Mg, Cu-Mg, C-Zn, and Fe-Mg electrode pairs are comparatively much better than other electrode pairs. Out of these electrode pairs, a single C-Zn is most suitable pair because graphite has some useful properties that make it desirable as an electrode in some applications. The reasons is that graphite is cheap, plentiful, very stable over a broad range of operating conditions, scalable, durable/hard, and a good electrical conductor and heat conductor. In all respect therefore C-Zn electrode pairs were selected for further investigations.

TABLE I
Cost Analysis of Electrodes

S N	Electrodes	Rs./kg	Reference
1	Carbon (C)	500	[12]
2	Magnesium (Mg)	1500	[13]
3	Zinc (Zn)	225	[14]
4	Aluminum (Al)	125	[15]
5	Copper (Cu)	406	[16]
6	Iron (Fe)	49	[17]

B. Impact of Separation between Electrodes Pairs (C-Zn, 4 sq. cm.)

The separation 0.5-1.0 cm between electrodes gives maximum power (mW) value. Equal and rectangular shape of electrode pairs gives much better response in terms of power. This is presented in Fig. 4.

C. Effect of Variation in Parallel Electrode Size

The different size of anode and cathode electrodes was tested for obtaining the highest maximum power (mW) value. It was found that when anode and cathode electrodes take equal size it shows maximum power. We have finally chosen C-Zn paired electrode (4 sq.cm.) for further investigation.

Available space was increased using through Flat (parallel electrode plates) cell designs for the cathode mix (electrolytes) because the package and electrical contacts are minimized, thereby increasing the energy density. A rectangular construction reduces wasted space in multi-cell assemblies. The volumetric energy density of an assembled battery using flat cells is almost two times the cylindrical cell [10]. The result of the study is presented in Fig. 5.

TABLE II
Comparative Results of Various Electrode Pair with Cow-Urine Battery (Electrodes: C-Zn, Size 4sq.cm. and Separation= 1 cm.) RT: 25±2 °C

SN	Electrode pairs	OCV (mV)	SCC (μA)	Pmax (mW)	Current corresponding to Pmax (μA)	Internal resistance (kΩ)
1	C-Mg	1850±100	7800±100	4090.2	4010	0.2-0.7
2	C-Zn	1030±100	3800± 100	707.4	1315	0.3-0.5
3	C-Al	870± 50	910± 50	174.7	471	1.06-3.3
4	C-Fe	610± 50	1900± 100	208.38	906	0.4-1.1
5	C-Cu	220± 50	860± 50	31.24	284	0.3-0.4
6	Cu-Mg	1580±100	6500±100	1290.96	2934	0.2-2.8
7	Cu-Zn	810± 50	1500±100	428.45	1045	0.3-0.4
8	Cu-Al	870± 50	910± 50	174.27	471	1.06-3.3
9	Cu-Fe	320± 50	950± 50	50	250	0.4-0.5
10	Fe-Mg	1710±100	6500±100	2386	3225	0.1-1.2
11	Fe-Zn	840± 50	3100± 100	795.2	1420	0.1-0.8
12	Fe-Al	640± 50	680± 30	130.24	407	0.7-1.5
13	Zn-Mg	770 ± 50	8500±100	3569	8300	0.04-0.9
14	Al-Zn	40± 10	78± 10	5.5	180	0.08-0.8
15	Al-Mg	1190± 100	3800±100	677	2708	0.3-4.9

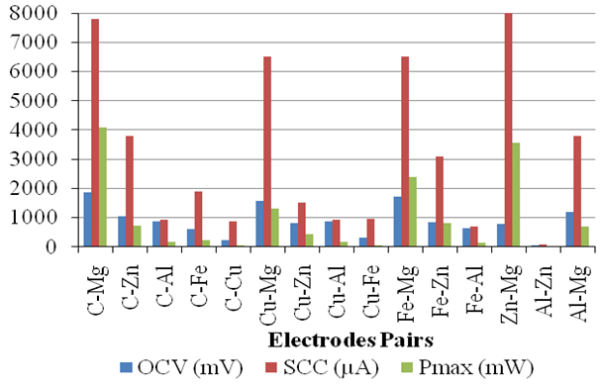

Fig. 3 Comparative result of various electrode pair with OCV, SCC and Maximum Power

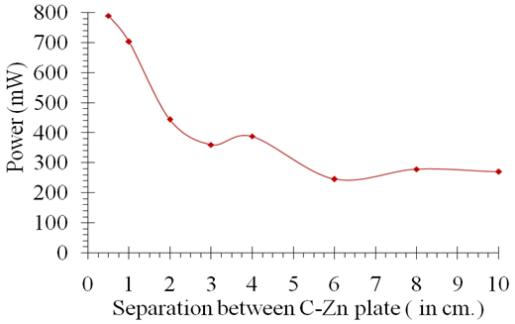

Fig. 4 Separation between C-Zn plates (in cm.) for cow's urine RT: 25±2 °C

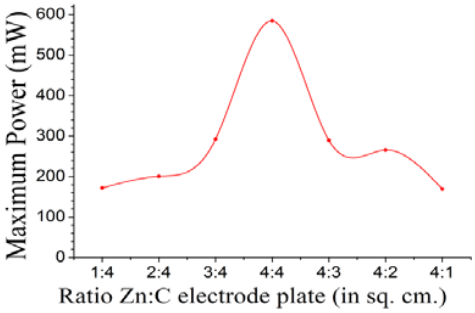

Fig. 5 Effect of variation in parallel electrodes size

D. Characteristics of Cow-Urine Battery

In the present study, the characteristics of the cow urine battery have been presented in Figs. 6 and 7. The cow urine was found to be more suitable as it generates approximately 1030 mV OCV, while SCC was found to be 3800 µA, represented in Table II. Battery was discharged across 100 kΩ load resistance. Time to reach out-off voltage, energy density and power density were computed from discharge characteristics. Usually the cut off voltage is said at the knee of the discharge curve (i.e. one third of the OCV) [9], [11]. In our work, the cut-off voltage is taken as one third of the OCV, and the discharge curve is presented in Fig. 7. We estimated in our study that the cow urine battery provides services up to 145 h. The internal resistance of batteries was found to vary between 0.3 and 0.5 kΩ. The power of battery is determined by connecting external load resistance in the circuit. From the curve of current-power characteristics, we found that the maximum power of cow urine battery was 707.4 mW as shown in Fig. 6.

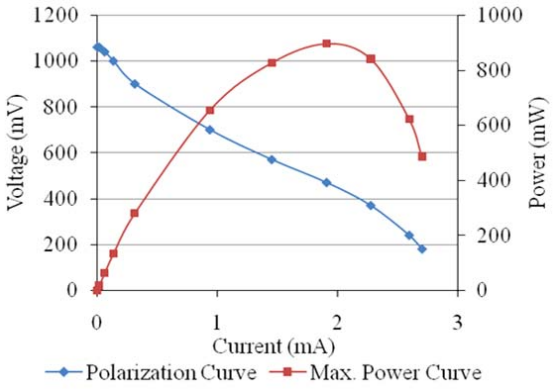

Fig. 6 Characteristics of cow-urine battery (C-Zn, 4 sq. cm.)

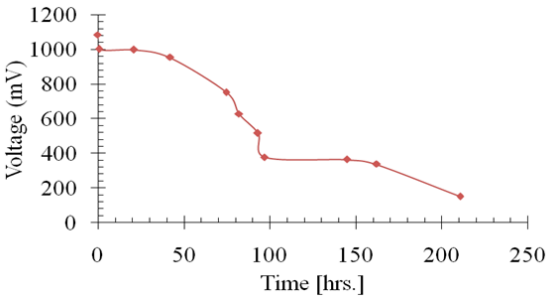

Fig. 7 Discharge characteristics of cow-urine battery (C-Zn, 4sq.cm)

IV. Conclusion

In the present study, different batteries were made up of different electrode pairs using cow's urine. The maximum power obtained was 707.4 mW from C-Zn electrode pair and on the basis of result it could be concluded that single unit of cow's urine batteries is suitable to energize any low power consuming electronic gadgets. The cow's urine battery provides services up to 145 h. Therefore, it is concluded that bio-activity plays dominant role in the energy generation mechanism. The performance of the system is satisfactory. Here, to understand the feasibility of the system needs to build a longer scale of the system & test it for a longer period of time. Moreover, options, processes and systems may vary to use cow's urine based plant for households as well. Study also recommends the further tuning of the technology for the better usage of the waste towards the commercial utilization for the generation of alternate energy to sustain the demand of future.

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