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Customized Cow's Urine Battery Using MnO_2 Depolarizer

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***Abstract*—**Bio-battery represents an entirely new long term, reasonable, reachable and ecofriendly approach to production of sustainable energy. Types of batteries have been developed using MnO_2 in various ways. MnO_2 is suitable with physical, chemical, electrochemical, and catalytic properties, serving as an effective cathodic depolarizer and may be considered as being the life blood of the battery systems. In the present experimental work, we have studied the effect of generation of power by bio-battery using different concentrations of MnO_2. The tests show that it is possible to generate electricity using cow's urine as an electrolyte. After ascertaining the optimum concentration of MnO_2, various battery parameters and performance indicates that cow urine solely produces power of 695 mW, while a combination with MnO_2 (40%) enhances power of bio-battery, i.e. 1377 mW. On adding more and more MnO_2 to the electrolyte, the power suppressed because inflation of internal resistance. The analysis of the data produced from experiment shows that MnO_2 is quite suitable to energize the bio-battery.

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

I. Introduction

NOWADAYS, 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 [5].

The bio-batteries are designed to support devices with high voltages and low power requirements, and 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]. The energy produced from battery has voltaic and bio-contributions. The biological contribution can be increased by the proper selection of bio-waste. We selected cow urine. It is a better electrolyte for voltage and current increase, while voltaic contribution may be increased by the use of depolarizers.

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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], [7]. The pH of cow urine was 9.

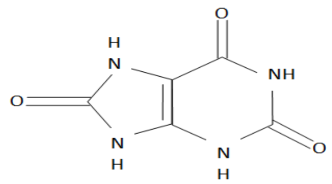

Fig. 1 The structure of uric acid [3], [7]

Energy is obtained from a bio-battery only when a reasonably current is drawn, but the potential of cell is decreased from its equilibrium potential because of irreversible losses. Several sources contribute to irreversible losses in a practical bio-battery. These losses influence the voltage of cell that is less than its reversible potential. The losses, which are often called polarization, overvoltage or over potential (η), originate primarily from three sources: (i) concentration polarization (η_{conc}), (ii) activation polarization (η_{act}), and (iii) ohmic polarization (η_{ohm}). These losses result in a cell voltage (V) for a fuel cell that is less than its ideal potential, E (V = E - Losses) [8]-[10]. The effect of polarization can be reduced by using depolarizer. The term depolarization was coined to explain the phenomenon. However, although the theory is no longer valid, the term has gained wide usage to find a permanent place in battery literature.

A well known depolarizer manganese dioxide (MnO_2) has therefore been used. Different types of MnO_2 based batteries have been developed and used in batteries in various ways. MnO_2 with suitable physical, chemical, electrochemical and catalytic properties is serving as an effective cathodic depolarizer and may be considered as being the life blood of the battery systems [8], [9], [11]-[15].

The reactions at MnO_2 mix cathode are very complex [16]-[18]. The main purpose however is to receive the electron continuously. The manganese dioxide gets reduced to a lower form of oxide during process.

In our experiments, chemical method was employed, in which the polarization of cell may be minimized by using some oxidizing agents like manganese dioxide that may convert hydrogen into water

$$H_2 + 1/2\ O_2 \rightarrow H_2O$$

Two types of reaction take place in zinc electrode during discharge.

$$Zn + 2OH \rightarrow Zn\,(OH)_2 + 2e^- \quad (1)$$

It is a useful electro chemical current producing reaction

$$Zn + H_2O \rightarrow Zn\,(OH)_2 + H_2 \quad (2)$$

The second reaction occurs during discharge as well as in ideal conditions of the cell and is a wasteful corrosion reaction. This in turn results in the reduction of the overall material efficiency of zinc electrode. The above reaction can be controlled by selecting an appropriate electrolyte.

The possible reactions which may take place in MnO_2, bio-battery during discharge are following.

At Anode

$$Zn \rightarrow Zn^{++} + 2e^-$$
$$Zn^{++} + 2OH^- \rightarrow Zn\,(OH)_2$$
$$\overline{Zn + 2OH^- \rightarrow Zn\,(OH)_2 + 2e^-}$$

At Cathode - when MnO_2 mix comes into contact with water present in urine, it may produce the following possible reactions.

$$2MnO_2 + 2H_2O + 2e^- \rightarrow Mn_2O_3 + H_2O + 2OH^-$$

$$2\,MnO_2 + 2e^- + 2H^+ \rightarrow Mn_2O_3 + H_2O$$

This reaction is governed by the purity of the metal as also that of the electrolyte.

In the present work, we are intended to perceive the effect of MnO_2 on the parameters and performance of bio-battery.

II. Material and Method

For the analysis of nonconventional energy, we have used anode made by graphite electrode plate (4 sq. cm, thickness 0.2 cm) and a cathode made by zinc plate and cow's urine samples were collected from Sadguru Sewa Sadan (Dairy) Chitrakoot Satna (M.P.). Graphite plate (4 sq. cm, thickness 0.2 cm) was purchased from Graphite India Ltd. Kolkata, whereas zinc plate (4 sq. cm, thickness 0.1 cm) was purchased from the local market of Satna. Manganese dioxide was purchased from Qualigens fine chemicals, Bombay. For each experiment, fresh electrode prepared. All experiments have been carried out at room temperature 25±2 °C.

A small plastic pot has been taken which contains 10 ml cow's urine with MnO_2 in different concentration, and the electrodes are anode and cathode electrode plate respectively, which act as a battery cell as shown in Fig. 2. The connecting wires are connected to anode and cathode terminals outside of this lid. After that, the voltage and current at a specific time measured using digital multi-meter (RISH Multi 14S) and DPM (Agronic34A6). This was open to simulate aerobic condition. 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. Further, connection of the wires must be good enough to get the desired output. Similarly, several experiments are performed with MnO_2 in different concentration.

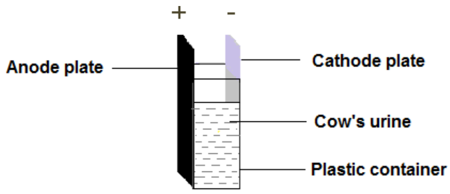

Fig. 2 Schematic representation of a single bio-voltaic cell

III. Results and Discussion

Consistency of the cathodic mix up: Effect of mixing different amount of MnO_2 has been obtained. The results for cow's urine are presented in Table I.

TABLE I
EFFECT OF VARYING CONCENTRATION OF MnO_2 (BY WEIGHT) OF PERFORMANCE WITH COW URINE, SEPARATION: 1 CM. SIZE: C-ZN PLATE (4 SQ. CM.)

MnO_2 % (by weight)	OCV ±100 mV	SCC ±500 µA	P_{MAX} ±100 (mW)	Current corresponding to P_{max} (µA)	Internal Resistance (kΩ)
00	950	5000	695	1312	0.31 – 0.71
10	1100	5400	812	1400	0.36 – 0.51
15	1050	5700	819	1490	0.31 – 1.18
20	1010	6000	900	1500	0.06 – 0.46
25	1080	6600	914	1524	0.31– 0.62
30	1070	6800	950	1900	0.3 – 0.6
35	1120	6900	1210	2200	0.2– 0.58
40	1090	7100	1377	1830	0.1 – 0.2
45	1080	6900	1248	1784	0.14 – 0.32
50	1060	6600	1054	2640	0.25 – 1.33

The results show that the variation in open circuit voltage (OCV) of cow urine battery is almost constant for the entire ratio studied, while the short circuit current (SCC) value varied significantly. With increase in MnO_2 concentration the SCC density of cow's urine battery is increased. Attaining a maximum value is at 35-40% percentage amount of MnO_2. This indicates that, at this composition, the internal resistance of cow's urine battery attains a minimum value using 40% amount of MnO_2 shows the OCV value of 1090± 100 mV and SCC values of 6.9 to 7.1 mA. The resistance of cow's urine battery corresponding to P_{max} is progressively lowered to increase in concentration of $MnO_2$and reaches to an optimum for 35-45%. After this optimum amount of MnO_2, internal resistance further increases and hence 40% has been taken as the optimum concentration of MnO_2 by weight for the fabrication of cow's urine battery.

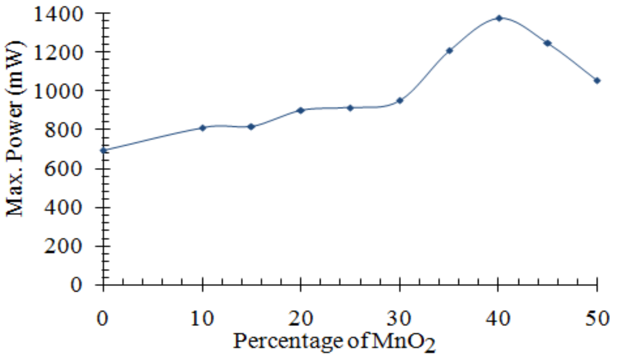

Fig. 3 Maximum power of varying percentage of MnO_2 (by weight) effect of performance with cow's urine

Comparative study of characteristics of cow's urine battery and customized cow's urine battery: The cow's urine using 40% amount at MnO_2 (by weight) powder was used for further studies. The current-voltage (I-V) characteristic of cow's urine battery and customized cow's urine battery is depicted in Fig. 4. A very interesting feature of the curves has been observed regarding the nature of the slope. Result shows almost a linear fall in the customized cow's urine battery voltage with an increase in current. Slope angle of the curve is somewhat lower than of former cow's urine battery. This result indicates that battery electrode is capable of being discharged at high current drain with low polarization. Polarization effects are more pronounced below from the cow's urine battery.

The current-power (I-P) characteristic of cow's urine battery and customized cow's urine battery is shown in Fig. 5, and it reveals that customized cow's urine battery gave expanded maxima. The maximum power of the battery is 1377 mW, which shows that the cow's urine battery and customized cow's urine battery may be used in different loads, at constant power. In general, it was observed that, the power of customized cow's urine battery is increased by two to three folds.

A discharge characteristic of cow's urine battery and customized cow's urine battery across load 100 kΩ is shown in Fig. 6. The voltage drop rate is insignificant when a higher load was used. Usually the cut off voltage is suggested at the knee of the discharge curve (i.e. one third of the OCV) [19]. In the present study, the cut-off voltage is taken one third of the OCV. It can be noticed that cow's urine battery and the customized cow's urine battery can work continuously for 145 hours and 300 hours of discharge within a voltage range of 0.362 V and 0.726 V. Thus, the customized cow's urine battery gives higher cell voltage and longer duration of discharge at moderately flat potential –plateau.

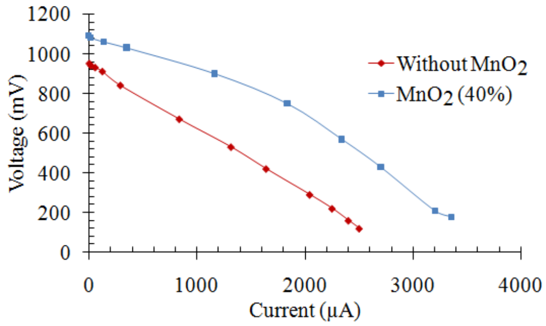

Fig. 4 Current-Voltage (I-V) characteristics of cow's urine battery and customized cow's urine battery

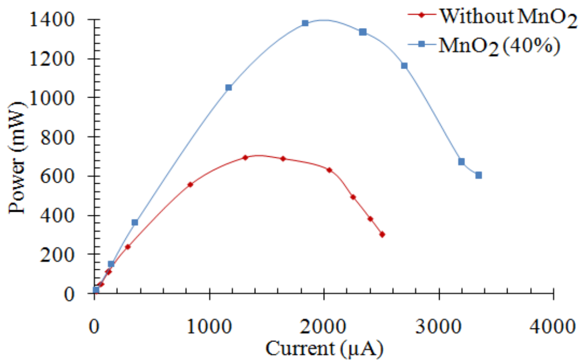

Fig. 5 Current-Power (I-P) characteristics of cow's urine battery and customized cow's urine battery

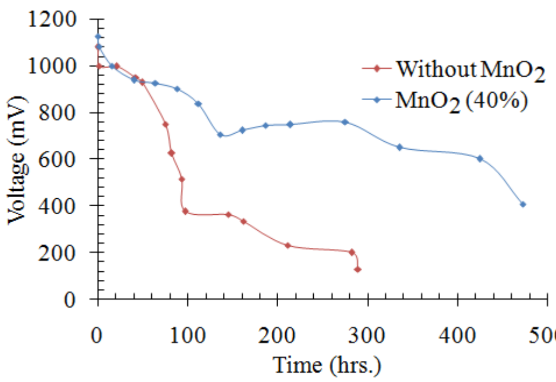

Fig. 6 Discharge characteristics of cow's urine battery and customized cow's urine battery

IV. Conclusion

The improved battery is found to have good performance characteristics. The cell voltage is more constant than conventional battery and is higher than that of the latter. Generally, it was found about 1.00 to 1.120 V. The cell voltage is also higher than that of conventional battery at high current drainage. The power of this battery also increases in comparison with conventional battery. Detailed investigation of the characteristics shows that these improved batteries are quite suitable to energize 1377 mW power consuming gadgets. Thus, the performance of bio-battery may be improved by using depolarizer, and MnO_2 is best suitable for this.

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