"Hybrid Electricity Generation Using Cow Urine and Microbial Fuel Cell (MFC) Based Buck Convertor"

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Abstract—Day by day the electricity demand is on increasing. To provide the electricity demand for the customer we have to find different resources to generate the electricity. Up to the 2022 electrical power target include achieving 175 GW of energy from solar power, 60 GW from wind power, 10 GW from biomass and 5 GW from small hydro power. Every year, about 55 million tonnes of municipal solid waste and 38 billion litres of sewage are generated in the urban areas of India. In addition, large quantities of solid and liquid wastes are generated by industries. Waste generation in India is expected to increase rapidly in the future. As more people migrate to urban areas and as incomes increase, consumption levels are likely to rise, as are rates of waste generation. It is estimated that the amount of waste generated in India will increase at a per capita rate of approximately 1-1.33% annually. This paper introduces the new hybrid renewable source of energy that is cow urine power Powered Battery and microbial fuel cell has been designed and proposed for sensor, LED display applications and to compensate the demand at urban village sites to electrify the villages which are under darkness by means of LED. In this hybrid source we are going to used cow urine as well as organic matter which is obtained from mud, soil, waste water treatment plant has been utilised as a source of energy extraction. The natural cow urine and Inorganic or organic Bactria has been used as an electrolyte in the design. The proposed hybrid system consists of series parallel combination of cow Urine and MFC cell. The electrodes have been dipped in to hybrid system and potential across the electrodes has been measured. The selection of materials for electrodes, amount of urine per cell, requirement of soil content number

Of urine powered cells in each row and number of rows to be connected in parallel are some of the important aspects urine power battery and MFC battery. The single cell urine power battery, having Cu-Al electrode combination can generate voltage of 0.56 V using cow urine. In addition to this we are going to used microbial fuel cell (MFC) uses bacteria as a catalyst to oxidize organic and inorganic matter and generate current and voltage by using aluminium mesh electrode as anode and cathode. the hybrid output of both urine powered battery and MFC cell is fed to load by using buck regulator LTC-3388 because the load regulation of both cells is very poor. Analysis and simulation of buck regulator is done on LT-spice.

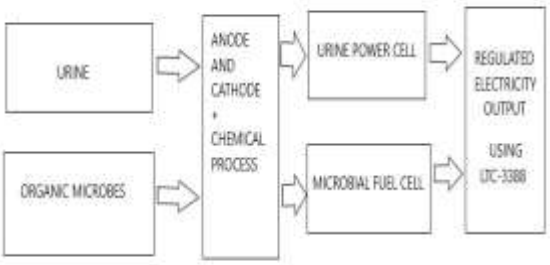
1. INTRODUCTION

The energy scenario as per Central Electricity Authority (CEA) and ministry of power, has installed capacity in (MW) 334146.91 MW up to February 2017 and out of which 62846.90 MW of energy is generated from renewable sources. Still in some hilly areas and in urban areas energy crisis problem is found in which only 1370 villages to be electrified out of 18,452 un-electrified villages. The research in the field of energy harvesting has been primarily focused on decreasing the dependency on non-renewable energy resources and utilizing abundant ambient energy for generating and extracting electrical energy. The research has been going on from the last few decades to utilize ambient energy, present in our surroundings to generate electricity. The researchers across the world have been finding the methods to utilize the organic and inorganic waste to generate electricity like MFC and waste cow urine. The energy shortage and environmental pollution have brought forth global crisis and have seriously impacted human survival and development. We are going to develop a hybrid source of energy that is urine power and MFC battery which we will get in to village side.

2. DESIGN LAYOUT AND MODULE DESCRIPTION

2.1. Urine Power Battery

In the system, a Urine Powered Battery has been designed to drive low power sensors and LED. The overall system has been comprised of five modules - Urine Powered Battery, MFC cell, step down DC/DC convertor LTC3388-3, load LED. The block diagram of proposed system is shown in fig. 1. The detailed description and function of various modules has been discussed below. A Urine Powered Battery (UPB) The first and foremost block of the proposed system is UPB. The urine is used as an electrolyte in the cells. It is composed of mixed combination of number of small single chamber Urine Powered Cells. The single chamber Urine Powered Cell comprises of anode and cathode electrodes dipped in a single chamber containing urine. There are numerous parameters that affect the performance of single chamber UPC. The essential UPC design parameters are material of electrodes, size and area of electrodes and amount of urine per cell. The idea is to design a cheap system employing neat cow urine as a source of energy to drive sensor and LED. The setup of single small urine powered cell is identical to Galvanic electrochemical cell. The containers for UPC's have been formed from plastic bottles or plastic cup. The used plastic bottles are normally dumped as scrap. Thus, this also helps in effective utilization of waste plastic bottles.it has been observed that Cu-Zn and Cu-Al, combinations are best in terms of output voltage and reliability using human as well as cow urine . These materials have been preferred because they are easily available and have low cost. The fig.2 depicts the voltage measured across single chamber UPC having Cu-Al and Cu-Zn electrode combination,respectively.Theperformance of single chamber UPC having Cu-Al electrode combination has been analysed over time and observed that the cell performs satisfactorily for maximum of 24 hours capable of maintaining voltage of 0.6 V to 0.5 V after which it degrades over time. The Cu-Al electrode combination has been used in the proposed system because of higher output voltage.



In the proposed system different electrodes combination are used to analyse various parameter like rate of reaction, electrode resistance, Micro-bial cell performance, various mud. The current rating and voltage ration can be increased by connecting,

Fig 1: Block diagram of proposed system

Number of UPC's which has been connected in series and parallel in order to obtain the required sufficient rated voltage and current to drive the system. The number of cells connected in series and parallel are capable to generate 5 V. Voltage measurement across single chamber UPC having Cu-Zn electrode combination (0.6V).

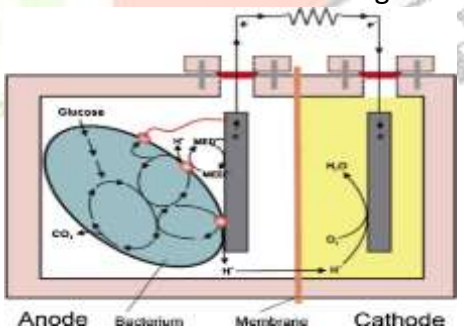


Fig 2: UPB with Cu and Al electrode

3. Working Principle

An anode is an electrode through which electric current flows into a polarized electrical device. The direction of electric current is, by convention, opposite to the direction of electron flow. In other words, the electrons flow from the anode into, for example, an electrical circuit. A commonly used mnemonic is ACID (Anode Current into Device). A

$\Delta Gr = \Delta Gr\ 0 + R\ T\ \ln(\Pi)$

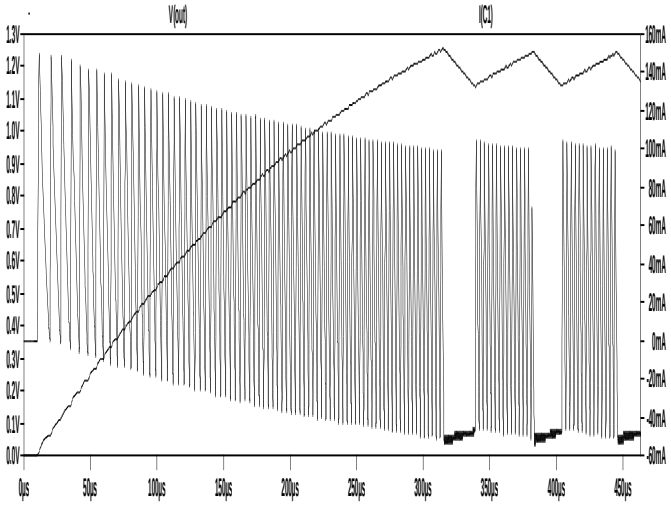
cathode is an electrode through which electric current flows out of a polarized electrical device. The direction of electric current is, by convention, opposite to the direction of electron flow thus, electrons are considered to flow toward the cathode electrode while current flows away from it. This convention is sometimes remembered using the mnemonic CCD (cathode current departs). The chemical reactions in this source cause a build-up of electrons at the anode. This results in an electrical difference between the anode and the cathode. We can think of this difference as an unstable build-up of the electrons. The electron wants to rearrange them to get rid of this difference. But they do this in a certain way. Electrons repel each other and try to go to a place with fewer electrons. In this system, the only place to go is to the cathode. But, the electrolyte keeps the electrons from going straight from the anode to the cathode within the battery. When the circuit is closed wire, electrons will be able to get to the cathode. This is one way of describing how electrical potential causes electrons to flow through the circuit. However, these electrochemical processes change the chemicals in anode and cathode to make them stop supplying electrons. So there is a limited amount of power available in output. When we recharge a battery, we change the direction of the flow of electrons using another power source, such as solar panels.

3.Microbial Fuel cell.

Electricity is generated in an MFC only if the overall reaction is thermodynamically favourable. The reaction can be evaluated in terms of Gibbs free energy expressed in

Units of Joules (J), which is a measure of the maximal work that can be derived from the reaction calculated as ,

where ΔGr (J) is the Gibbs free energy for the specific conditions, ΔGr 0 (J) is the Gibbs free energy under standard conditions usually defined as 298.15 K, 1 bar pressure, and 1 M concentration for all species is the universal gas constant, T (K) is the absolute temperature, and Π (unit less) is the reaction quotient calculated as the activities of the products divided by those of the reactants. The standard reaction Gibbs free energy is calculated



from tabulated energies of formation for organic compounds in water, available from many sources. For MFC calculations, it is more convenient to evaluate the reaction in terms of the overall cell electromotive force EMF (V), defined as the potential difference between cathode and anode given by Q is the charge transferred in the reaction, expressed in Coulomb (C), which is determined by the number of electrons exchanged in the reaction, n is the number of electrons per reaction mol, and F is Faraday's constant (9.64853 × 104 C/mol). all reactions are evaluated at standard condition.

4. Simulation and Result

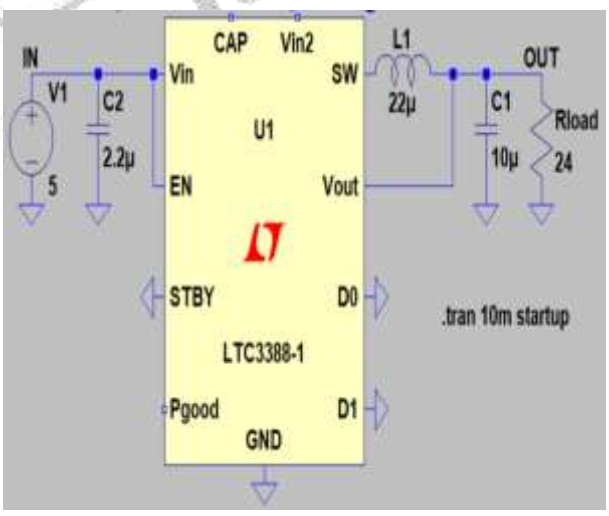
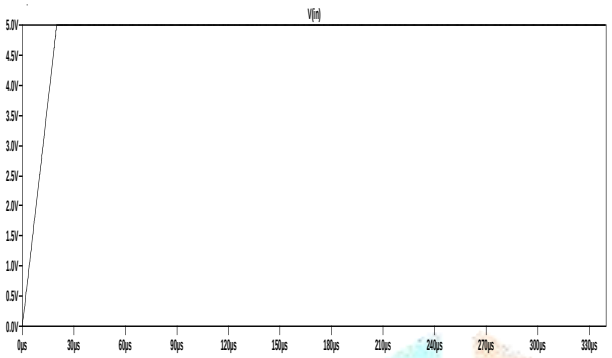


Fig 4: LT-spice Circuit of LTC-3388

The major limitation of sources in the field of energy harvesting is poor load regulation and low output current.to make the load regulation good we are going to used LTC-3388 buck regulator. The simulation is done on LT-spice

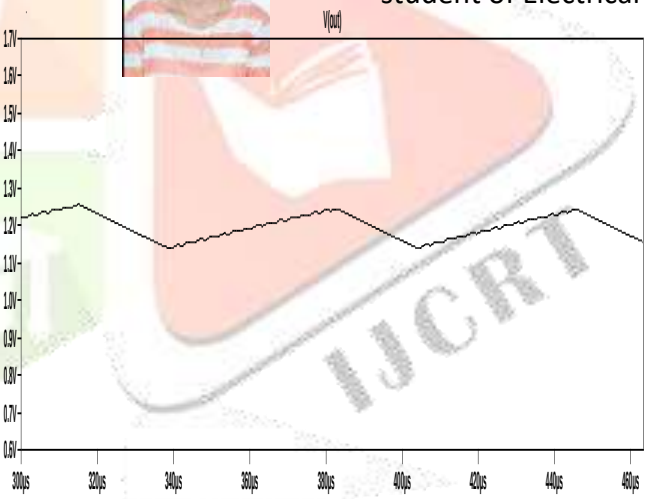
Fig 5:



Input voltage vs. Time

Fig 6: Inductor and Capacitor Current

Fig 7: Regulated Output Voltage



7. Future scope

In future we are going to collect lots of amount of urine from human wastage, cow urine from farm to make complete system of electricity generation. Such kind low output electricity is useful various low power requirement sensors, led displays, in village areas, railways indicators and rural electrification at low cost. The application of MFC includes BOD, Hydrogen Generation, Biosensor application, power supplies.

8. References

1.http://cea.nic.in/
2.web.mit.edu/pweigele/www/.../Logan%202006%20Environ%20Sci%20Technol.
3.https://www.researchgate.net/publication/282317605_Generation_of_Electricity_Using_Cow_Urine.
4.http://ieeexplo.ieeere.org/document/7380736/?reload=true.
6. http://powermin.nic.in/.

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