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DOUBLE CHAMBER MICROBIAL FUEL CELL (DC-MFC) FOR GREEN ENERGY GENERATION FROM CANTEEN WASTEWATER AND A DC/DC BOOST CONVERTER

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ABSTARCT: The current experimental study is relied on the generation of electrical energy with the help of DC-MFC and then generated voltage can be boost through boost converter. In this study canteen drain water was considered as substrate, and then it was congregated from Vidya Vikas Institute of Engineering and Technology, Canteen Mysore. The maximum voltage and current for pure culture were 1035 mV, 4.9 mA, individually, by using Carbon rod taken as electrode. Tests were also carried by taking mixed culture for same canteen wastewater which produced a highest voltage and current of 2225mV and 8.1mA individually, using same electrode. An electrical converter was taken a little while back because of their advantages, such as the ability to store and boost the generated MFC voltage.

A DC/DC booster circuit was constructed and trial out along with microbial fuel cells (MFCs) to enhance the typical generated voltage (3-5V) to a highest voltage of 220 V DC.

Keywords: *Boost Converter; Double Chambered Microbial Fuel Cell (DC-MFC); mixed culture; Proton Exchange Membrane (PEM); Converter.*

I. INTRODUCTION

The important means for the production of current are Fossil fuels, which were deliberated as vital donors to societal complications. One possible substitute to discover is the utilization of MFCs, responsible for production of current with the help of micro-organisms. MFCs are type of Fuel Cells (FCs) that uses an energetic micro-organism as a biocatalyst in an anaerobic anode chamber for generation of bioelectricity. MFC employ microorganisms to produce current from biological energy obtained in middle of metabolic rate of organic substrates. MFC is a developing mechanics that uses bio-films as reactant to transform chemical energy in organic (and some inorganic) matter directly into electric energy [1, 2]. Using the MFC, transformation to hydrogen from energy is more as 8 times when contrasted to conventional hydrogen production mechanics using conventional fuel cell technology [3]. MFC has a distinct advantage in utilizing low grade bio-mass or even wastewater, to produce bio-electricity. In the past decade remarkable advances have been made. Certain analysis and the numerous publications have been increased in short while. Although MFCs have better prospective for substitution green energy generation, vital technical obstacles remaining for their practical placement.

The prime advantage of using renewable energy production sources are lead to not emitting environmental pollutant gases (such as SO2, NO2, CO2 and CO), high efficiency, and transportable parts are not existed [4]. A MFC converts biological energy, available in a bio-convertible substrate straightly into Electricity. To achieve this, microbes are used as a catalyst and to transform substrate into electrons and protons to penetrate through External Circuit and Proton Exchange Membrane (PEM) or salt bridge, respectively [5]. Decay of biological substrates by micro-organisms produced electrons (e-) and protons (H+) are present in the anode chamber that is moved to positive charge cathode penetrate in the circuit and membrane, individually. Biological substrates are used by microorganisms as their electric origin; result of the mentioned procedure is the liberation of high-energy negative charge which is moved to electron acceptors. In a DC-MFC, the voltage generation is enhanced by taking a mixed culture better than a pure culture under constant mean of performance [6].

In this study a low-voltage boost converter has been fabricated for voltage generated from a developed MFC. The fabricated converter has overcome the accompanying problems of oscillators [6]. A battery which is a DC supply, may be present, therefore the obtainable voltage is not satisfactory for the whole mechanism being provided. If considered, the motors taken for operating generic automobiles needs high voltages, like around 500V, which was enough for the battery to provide this voltage alone. If numerous batteries were taken, the additional weight and space taken up would not be that intelligent. Thus, fewer batteries is likely recommended to use to enhance the available DC voltage to the optimum level with the help ofboost converter. The other issues with batteries, whether it is large or small, is that their generated voltage is not constant accordingly with the available charge, and at some term the battery voltage becomes too minimum to provide the electricity to the circuit. However, if generated power can be enhanced back up to a optimum level again, by taking a boost converter, which can increase the life of the battery [7,8].

II. MATERIALS AND METHODS

MFC have been described as bio-reactors, that converts the energy placed in organic compounds found in drain water get converted into current by the action of catalytic activity of microbes under anaerobic conditions. Many investigators have been investigating on the production of current from drain water using dissimilar electrodes under various operating circumstances. The mentioned experimental test, certain tests were carried to liberate current from canteen kitchen wastewater by using carbon rod electrode in DC-MFC. The substances taken and procedure considered have been described in the given ways.

A. SUBSTANCES

Construction of MFC needs the utilization of substances that are used in the making of conventional fuel-cells. Therefore, it is crucial to note that, microorganism's plays important role in constituents of the MFC. The substances which are taken in the current MFC study have been described in the given ways.

The mentioned present theory says, Plastic bottles then used as Double Chamber reactors to carry out the tests. Carbon rod electrodes were used. In this study Canteen kitchen wastewater as pure and mixed culture is used as substrates, which were collected from Vidya Vikas Institute of Engineering and Technology (VVIET) Canteen Mysore, India. The Salt-bridge preparation is using; Sodium Chloride and Agar media were considered. Mediators such as, Curd (250ml) and Glucose was used for the test, to improve the electron movement. Sulphuric acid and hydrochloric acid chemicals were used for conduction of laboratory experiments.

B. METHODS

The drain water examination as well as the test methods for the production of current from canteen drainwater has been described in the given ways.

The DC-MFC reactors taken in this experimental test were constructed of plastic bottles. Certain tests were organized with a working capacity of 6 litres. Due to its durability and stability of plastic, good quality plastic bottles were used in double chamber-MFC reactors. In this experimental study, carbon rod electrodes were used with dimensions of the electrodes was (0.75cm (diameter) X 12cm (height)). All the electrodes were then placed in the double chamber-MFC reactor apart at 7 cm. To have regulation of the electrodes, electrodes were immersed in filtered water for about a day before carrying of the examination. The coating of substances, which guide as obstacle joining from two ways, which is repellent to precise pieces and materials is known as membrane. Anion, cation and ultra filtration membranes are considered as synthetic membranes. The mentioned membranes are highly-priced and are receptive to congestion and hence, agar-salt bridge was used as Proton Exchange Membrane (PEM).

Preparation of salt bridge was, by considering NaCl weighs 1.6 gm and agar weighs 2.5 gm with 25 ml of distilled water and permitted to heat for a time-period of 2 minutes with constant stirring. The heated liquid was then tipped into the void tube having height of 7 cm and 1.5 cm diameter. Then framework was later on kept to cool for about 2.5 hours, and the salt bridge was full prepared for usage. Experiment was conducted in room temperature ($29^{o}C$).

Microbes are sometimes taken in MFC to decompose the drain water in the lack of O2 and then the electrons are moved to the anode. The capability of many microbes holds to transfer of the electrons liberating from the metabolism of biological substances to the anode. The mentioned micro-organisms are constant and having good coulombic regulations. Shewanella putrefaciens [1], Geobacteraceae sulfurreducens [4] and Geobacter metallireducens [7] bacterial strains have show cased impactful development on the anode plates and transfer of electrons straightly to electrode around the membrane. Mentioned microbe is high in cost. The extension and preservation of these microbes are also crucial.

Therefore in the present study, culture prevailed from canteen kitchen wastewater normally containing determined anaerobic microbes. An absolute catalytic agent responsible enough to passes the cell membrane, capable to hold electrons from the electron bearer of the electron track chains, should holding a high electrode reaction rate, good solvent in non-biodegradable, harmless to microbes and is of low in price. In this experimental case, to balance pH of drain water between 7.0 and 7.7 Phosphate buffer and Potassium Permanganate were considered as catalysts. Laboratory scale curd and glucose were used to enhance the electron movement regulation.Glucose and curd has been account for the development of microbes found in the drain water. Analysis has been carried out for the wastewater collected from canteen for BOD, COD and pH concentrations.

Then a boost converter circuit was designed to boost voltage generated from MFC of 5V to 230V is as shown in fig 2. The circuit is having three regions. First region involves oscillator part i.e. R2 and C2 which are connected to the tapping of the transformer. Then in the filter region from R1 and C1, they convert DC into AC using saturation mode of transistors Q1 and Q2. When Q1 and Q2 are in saturation region, they form the switching circuit and when they are operating in active region, they form amplifying region. Hence the second region is to amplify the voltage. Then the third region involves conversion from 12V to 230V using tapping transformer.

C. EXPERIMENTAL PROCEDURE

Plastic bottles were used in Double Chambered MFC for organizing tests with a continuous density of 3L volume each. A 5 mm diameter penetration has been drilled in the centre of each reactor surface and 15 cm prolonged conductor has been injected through the penetrated area. Another pierced is injected on same parallel level, on surface of both reactors in front of each other, where a void tube of 7 cm prolonged is injected, which stand as a salt bridge. The test was carried with carbon rod electrodes. Agar Salt-bridge was considered as Proton Exchange Membrane (PEM), which was made by taking 1.46 gm of NaCl (Sodium Chloride) and 2.5 gm of agar was dissolved in 25ml of boiled water. Anaerobic sludge of 12 gm was mixed into the anodic section, which conducts to have a good electron movement to the cathode by lowering the drain water. Sample of wastewater was collected from VVIET canteen wastewater, Mysore. The tests have been conducted out in dissimilar stages for a time of 26-28 days.

For first 15-16 days no mediator was added in to substrate, after completion of 16th day 250ml curd and 10gm glucose were included to improve the development of microbes found in the drain water, so that it can increase the electron transfer efficiency. However, measurement of voltage and current has been noted at an time-period of 12 hours with changing in temperature (During day time 38^0C-40^0 C and during night time 30^0 C-32^0C). A 500 Ω external resistance of has been applied to the DC-MFC.

D. ANALYSIS

DC-MFC tests have been conducted out in distinct stages over a time of 26-28 days. Therefore, measurement of voltage and current has been recorded at a time of 12 hours. The influent and effluent COD, BOD applications and pH were regulated as per Regular methods for regulation of drain water. Test setup of double chambered-MFC is as shown in fig 1. And generated voltage form MFC can be boosted through fabricated boost converter is as described in fig 2 and fig 3.

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Fig 1: Double-Chambered Microbial Fuel Cell (DC-MFC) experimental setup

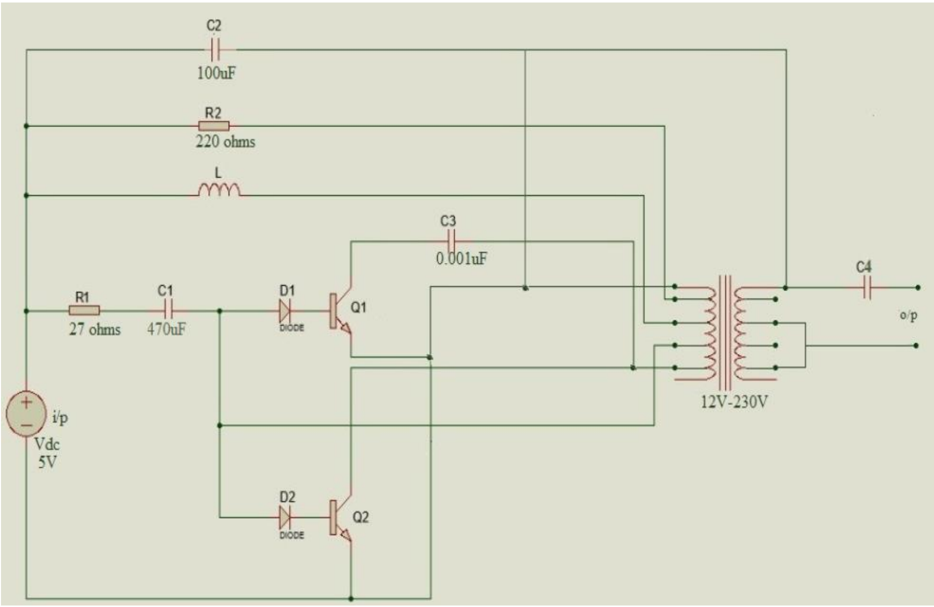

Fig 2: Boost converter circuit

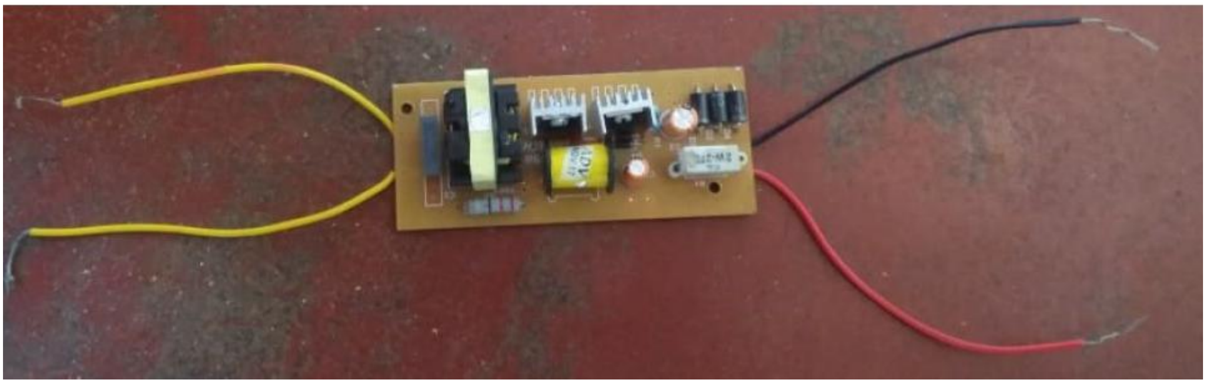

Fig 3: Proposed fabricated boost converter

III. RESULTS AND DISCUSSION

Impact of accumulation of distinct harvesting substances to the drain water on current production shows an important role. Hence, in present study experiments were conducted by adding 250 ml of curd with 10 gm of glucose as seeding material into the anodic chamber of DC-MFC reactor. In the degrading of Canteen wastewater, it was found that, canteen wastewater using Carbon rod electrodes with seeding material generated higher voltage (~2225 mV) compared to pure culture canteen wastewater(1035mV) without seeding material using same electrode is as shown in fig 4. After adding curd and glucose, this guide to increase liberating of high electrons. Thus, it was seen that, at the starting level of the test, voltage is high, and then falls and lastly lowered. Fig. 4-7 represents the ups and down of voltage, current, current density and power versus time for raw canteen wastewater and mixed canteen drain water in MFC reactor.

The fig 8 shows the voltage generated from the converter circuit for 5V, 0.05A at the lab condition using Regulated Power Supply (RPS). Because voltage generated from MFC was not stored in rechargeable battery so using Regulated Power Supply (RPS) showing results for boost converter. The voltage and current is set a as per the MFC generation.

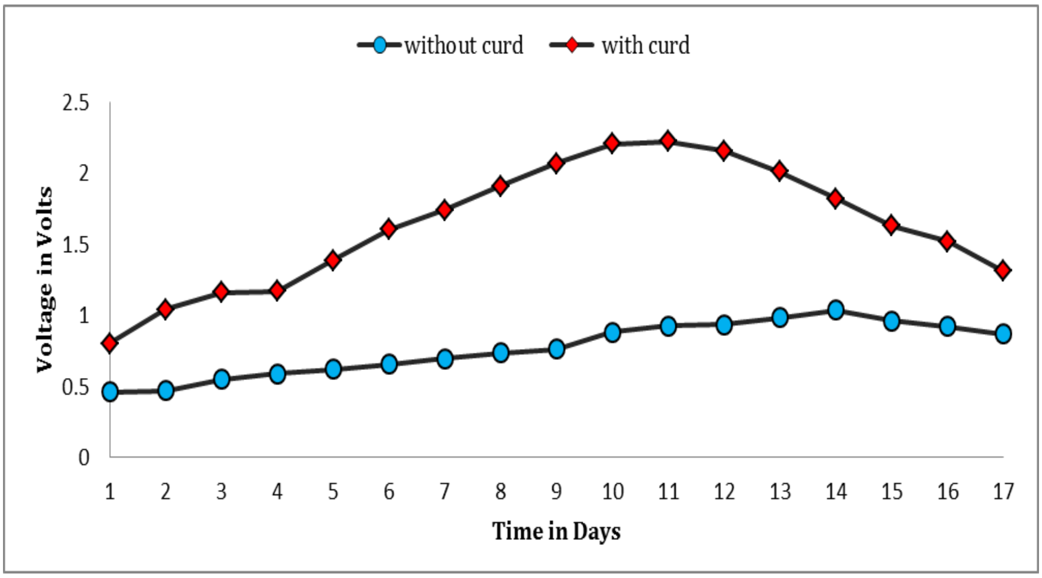

Fig 4: Variability in voltage v/s time in Double-Chambered -MFC

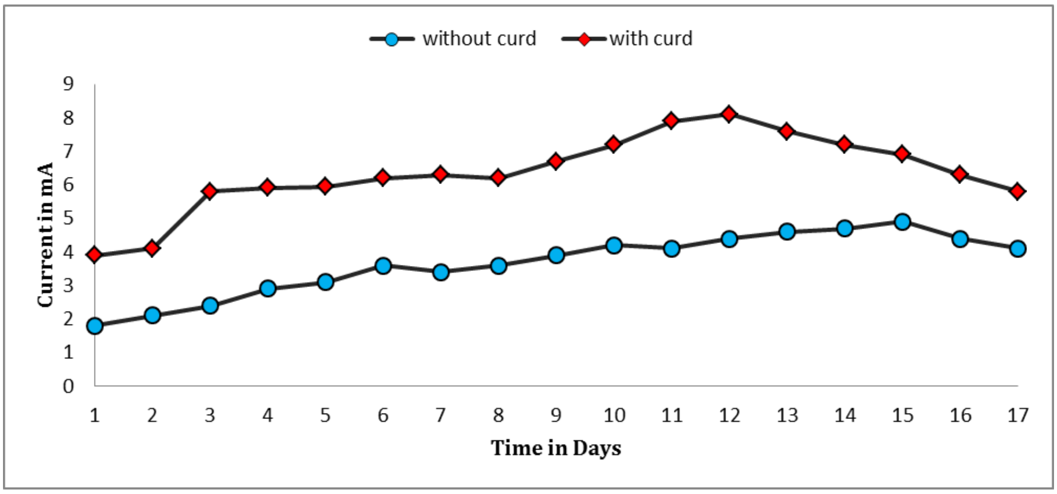

Fig 5: Variability in current v/s time in Double-Chambered DC-MFC

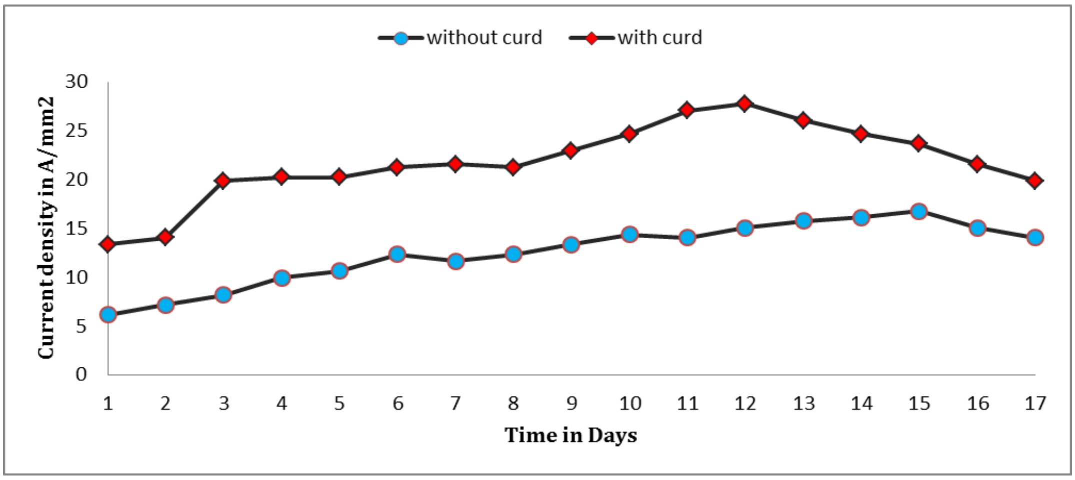

Fig 6: Variability in current density v/s time in Double-Chambered -MFC

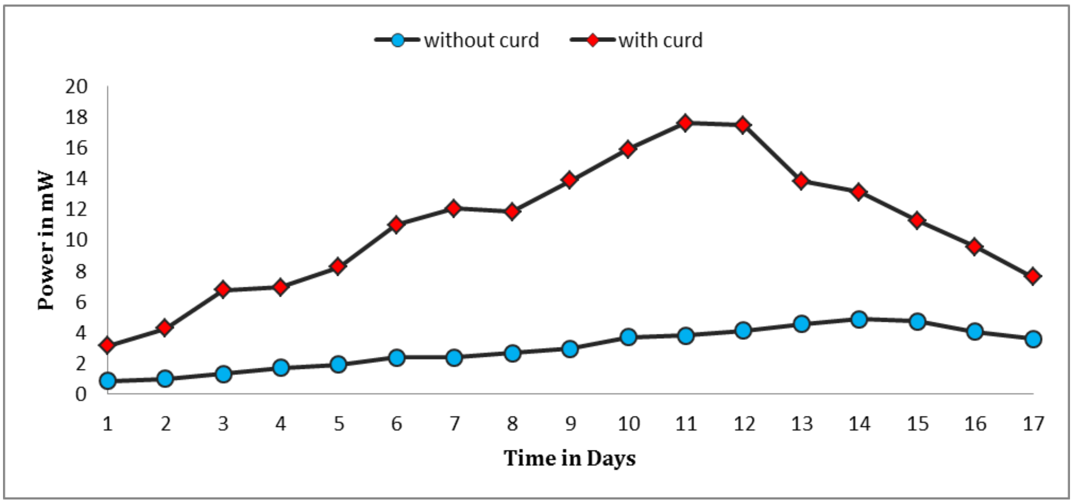

Fig 7: Variability in power v/s time in Double-Chambered MFC

Fig 8: Output of boost converter circuit

IV. CONCLUSION

The above study shows the application of a DC-MFC for production of power that supports the complete use of drain water of pure and mixed culture. The voltage and current values gained in double Chambered-MFC using mixed culture contain wastewater was 2225 mV and 8.1 mA, individually, that was measured to be high in level than the voltage and current values of 1035 mV and 4.9 mA, individually, gained with pure cultured canteen drain water with same carbon rod electrodes for both the substrate. Own starter double Chamber-DC boost converter for DC-MFC energy gathering is recommended. The recommended converter made up of cheap constructive cost, is capable enough to function with lowered input voltages and liberates a manageable output voltage.

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