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94. Utilization of Bio fuel Cell Technology for Power Generation in Pakistan

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Abstract

"This research centers around the possible prospects for the utilization of biofuel cell technology in Pakistan for electrical generation. We have speculated the possibility of employing the microbial fuel cells all over the rice fields in Punjab by sowing its anodes with their roots and keeping floating cathodes over the water surface of rice paddies, the rhizodeposits (carbohydrates) or organic matter as substrate in the roots of these plants react with microorganisms coated on anode which produce electrons, protons and CO2, Joining anode with cathode by a wire, electrons reach cathode to combine with oxygen. These electrons can be turned into huge electricity by a useful chemical reaction. Secondly we estimated the use of these cells along the coastal sediments of Karachi that are rich in metals which can be used to fuel these cells and make 1000s of Megawatts."

Keywords: *"Biofuel; cell; anodes; react; electricity"*

1. Introduction

It goes without saying that at present Power is the need of hour all over the world, but when it comes to Pakistan; our country is in dire need of it. Pakistan, despite being a country rich in coal reserves, natural gas reserves, renewable energy utilization prospects, nothing has substantially ever been done to tap into all the above resources for power generation. For the entire power deficit, no heed is paid to using green energy for energy acquisition. Pakistan being a country rich in agricultural products has a host of prospects for electricity to be got out of its agricultural lands as well apart from conventional renewable energy sources. This research work is based on an estimated analysis for the possible utilization for microbial fuel cell application on the rice fields at large and on the marine sediments along the coastal areas of Karachi, for power generation. These estimations are figured out keeping in view different researches in Europe and different countries on microbial fuel cell utilization along rice plants and marine sediments.

2. Microbial Fuel Cell

A microbial fuel cell is a simple cell like a battery having a positively-charged and a negatively charged electrode. In this cell cathode acts as an electron sink and anode as an electron acceptor. This process taps into the biological action of micro-organisms present everywhere I.e. in water, in soil etc. The micro-organisms perform degradation of organic as well as inorganic compounds for their survival. These degradations are of two types aerobic degradation and anaerobic degradation, 1st one involves oxygen while the second one doesn't respectively. In anaerobic degradation the micro-organisms consume the substrate that may be an organic or inorganic compound, in the absence of oxygen and consequently carry out oxidation on the compounds to result in electrons protons and carbon dioxide, while speaking about organic substrates. These freed electrons gravitate towards an anode, which takes them up and transport the electrons across to the cathode by means of a wire as shown ion "Fig. 1". Thereby this process gives rise to an electrical current and between cathode and anode there can be connected as well as wattmeter in series with the load and a voltmeter in parallel with the load. On the cathode electrons

combine with oxygen so a reduction reaction takes place. This phenomenon of electricity generation can be turned into several advantages out of which only a few are assessed in this research.

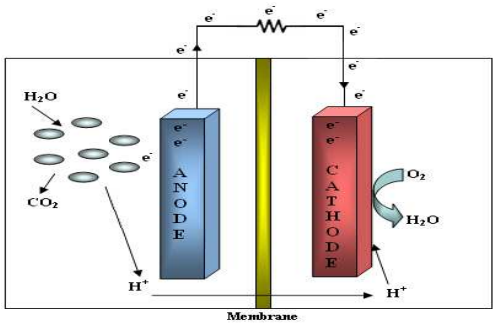

Fig. 1. Illustration of Microbial fuel cell structure

3. Application of Microbial fuel cell on Rice Plants

Although microbial fuel cell has a wide area of applicability yet we analyze its application with respect to rice plants, as its applicability is possible only in wetlands. The plant's leaves are exposed to sun all the day. These leaves form carbohydrates out of carbon dioxide. These carbohydrates trickle down the roots of the plants which are exerted as small low molecular weight compounds by the roots. These carbohydrates are consumed by micro-organisms in the absence of oxygen which gives rise to electrons, protons and carbondioxide. The electrons are gravitated towards an anode sown together with the roots which takes up the electrons and transport them across to cathode, by means of a wire joining both electrodes. At cathode there takes place a reduction reaction when oxygen soaks up the flow of electrons from the anode, and water results as shown in the "Fig. 2".

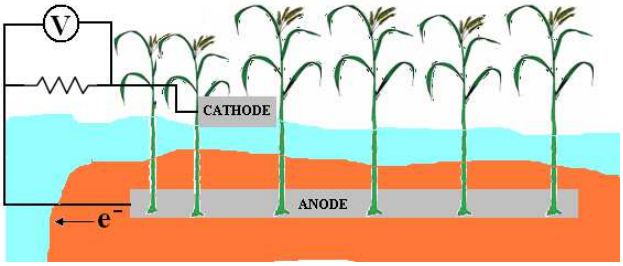

Fig. 2. Illustration of Microbial fuel cell with rice fields

It's been noticed by several researchers in Europe that the power produced is directly subject to the area of anode sown with the roots. To speed up these redox reactions its suggestible to use electrochemically active bacteria that may act as catalysts these are Shewanella Puterfaciens [9], Aeromonas Hydrophila [17].

4. Energy Conversion Cycle

To understand this entire phenomenon one must need to comprehend the ins and outs of this whole generation process. The input of generation cycle is the solar energy which is harnessed by the leaves by being exposed to the sun all day long. This solar energy is converted into organic compounds which are a sort of chemical energy and at last this chemical energy deposited into the roots is turned into electrical energy by the interference of bacteria present in the soil by anaerobic degradation of this chemical substrate. In the wake of this process we come to acquire electricity at the output. It's a three stage conversion process which is elaborated in "Fig. 3".

Fig. 3. Energy Conversion Cycle

5. Expected Output Power Generation In Pakistan

Having scrutinized the European researches on the implementation of microbial fuel cell on rice fields we can also assess very well its applicability in Pakistan. As Pakistan has a very rich agricultural land so it has a great potential for such a green energy's utilization along its lands. Pakistan has rice fields on an area as much as 2.5 million hectares which is almost 20% of the total area of food crops in Pakistan [2]. That's the reason why Pakistan has been a large exporter of rice too. When we assess for a while the implementation of microbial fuel cell along all these rice fields we are taken aback to speculate the power production that we can reap out of these fields on top of rice. Researchers in Europe came to a conclusion that by the application of these fuel cells on rice plants, at maximum long about 289 to 300W/hectare power could be produced.

Rice Fields Area in Pakistan = 2.5 million hectare

Electrical output power with MFC $\cong$ 300Watts/hectare

Expected Electrical output power = $300 \times (2.5 \times 10^6)$

Expected Electrical output power = 750 Mega Watts

If we assess the implementation of microbial fuel cells along our field in an area of 2.5 million hectare then we can get 750MW of power in total, on these fields in khareef seasons. This is indeed an enormous amount of power that can work wonders on our annual generation capacity. It's suggested that graphite-coated electrodes be used for construction of both electrodes. In "Fig. 4". A comprehensive arrangement can be seen for the deployment of these fuel cells in rice fields.

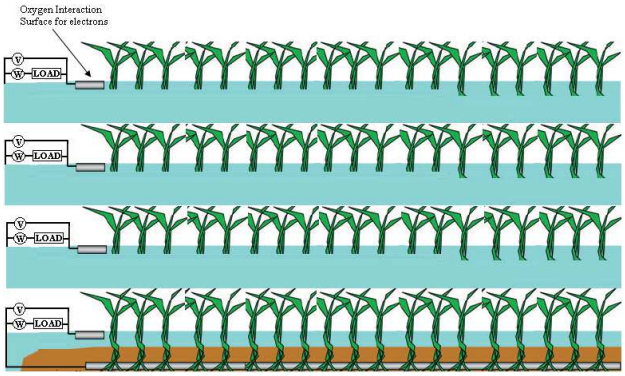

Fig. 4. Arrangement of Microbial fuel cell in rice fields

6. Implementation of Microbial fuel cells along Marine Sediments

Apart from the implementation of microbial fuel cell on rice fields, they can be used along the marine sediments. Our coastal sediments along the coastal belt are too rich in metallic reserves [15]. The sediments inside the sea have a great deal of hidden reserves of organic and inorganic compounds that keep on undergoing degradation at the hands of bacteria present in the soil. So this degradation of inorganic and organic compounds can also be tapped into for electrical generation by penetrating the anode into the sediments and keeping the cathode on the water surface for reduction reactions. In these cases special catalysts may be used on cathode surface to speed up the redox reactions. In these implementations a platinum anode and a stainless steel cathode is suggested to be used along with appropriate catalysts, for avoiding possible corrosions, which comes to a big expense as well, as the platinum is too expensive to be used.

7. Merits

This research may yield a great deal of benefits at present because of the current power scarcity. Its utilization may shore up the annual power generation capacity. Agricultural sector may be promoted by being integrated with power sector. With an estimated generation of around 750MW, Power dearth could be eliminated to a great extent. An energy that doesn't consume any fuel to generate electricity.

8. Conclusion

This research is based on a speculation of microbial fuel cell utilization in Pakistan. At this point in time

Pakistan is short of power to meet its demands so in such a situation piecing together the power from even small sources may help us get over the power dearth to a great extent. That's how implementation of microbial fuel cell on the rice fields as well as on the marine sediments may meet our current power demands and may help us overcome the rising shortage of power day by day. In Europe billions of pounds are invested into such projects. In Pakistan a minute investment into this energy can get us so many advantages that it cannot be imagined.

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