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Single Cell Biology

Editorial

Inspection of Exoelectrogen for Microbial Fuel Cells

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ABOUT THE STUDY

The Microbial Fuel Cell (MFC) technology is a biological modification of a fuel cell. The general reaction of break-down of chemical substrate release electrons and protons. In an MFC set up the reaction is allowed to complete in two different chambers [1]. The reaction is completed on two electrodes, anode and cathode placed in, anode chamber and cathode chamber respectively. The generated electrons travel from anode to cathode via an external connecting wire electrical circuit [2]. The passage of electron across the applied load resistor in the external connecting circuit helps to harvest the energy of electron in the desired form light, electricity, heat etc [3].

The potential difference between the two electrodes is maintained with the help of anolyte and catholyte. The microorganism grown in the anode chamber and presence of chemical catholyte in a double chamber MFC design or oxygen in the cathode chamber air cathode MFC design develop a potential difference between the two electrodes [4]. The proton produces during the breakdown of substrate also travels from anode chamber to cathode chamber but via a Proton Permeable Membrane (PEM). This PEM serves as an internal separator of the two chambers [5]. The commercialization of this technology can be a great boon to human race which is heading towards depletion of energy resources. The technical limitations are being studied by researchers worldwide.

Most likely electrode materials are chosen on the basis of their electrical conductivity and cost affectivity. Electrode in an MFC act as an electron collector, electron conductor and a physical support for the biochemical reactions but, it seldom takes part in the biochemical reactions happening inside the MFC chamber [6]. The metal-based electrode can be good choice but they are prone to oxidation-reduction reaction and further physiochemical reduction due to corrosion. The use of precious metals is avoided due to its costly nature. Graphite and carbon materials are relatively low cost, inert for biochemical reaction, conductor of electrons and especially biocompatible in nature. The commonly used electrodes in MFC reactors of different volume and design are made of graphite rods and carbon-based materials carbon paper, cloth, fibre, and felt [7].

The position and area of electrode affects the current generation capacity of the MFC reactor. The optimum distance between anode and cathode electrode and the ratio of area of the two electrodes can vary with respect to the design and size of the MFC reactor. An electrode is the base for biofilm formation. Electrode material has direct impact on the bacterial adhesion. Electrodes with more surface area favor more biofilm growth [8]. Modification in the conventional carbon-based electrode and use of material like graphite felt and graphite fiber brush increases the surface area of the electrode. An ideal electrode material should have good electrical conductivity, low resistance, strong biocompatibility, chemical stability; anti-corrosion, large surface area, mechanical strength and toughness as per requirement.

The microbial consortia are work force of the entire MFC system. The microbes that can give out electrons from their cell wall are termed as "Exoelectrogen". The history of such special kind of microbes goes back to the deep sea. The environment in the deep sea level is anaerobic and these microbes are originally known metal dissimilatory microbes [9]. These microbes give out electrons to metals present in the sea sediments. The electrons given out by microbes are utilized to reduce to metal ions and complete the Fe, Mn, and other metal cycles.

Complex nature of substrate supports the growth of mixed culture from natural inoculum during lab-scale experiments. The synergistic relationship between mixed cultures can always help in biodegradation of complex substrate with simultaneous power generation. The complex nature of anolyte gives rise to the formation of biofilm containing bacterial mixed culture. As a result, it is inevitable that different bacterial species perform different roles in the anode chamber [10]. While some species are responsible in the fermentation of the complex organic substrate to a simple form; few species may contribute in the oxidation of simple substrates to produce electrons; again, few will do the distance electron transport whereas few other species lead to the formation of biofilm and direct electron transfer on the electrode surface.

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