Microbial Fuel Cells- A New Approach for Energy Source

Shradha Sharma

Abstract:- As a fuel cell company (among other things), we perk up when anything with the words “fuel cell” passes by our desks. If you're the same, you've probably seen the term “microbial fuel cell” in recent technology news headlines, especially tied to the eye-catching word “urine”. Today we're going to talk about microbial fuel cells (MFCs), how they work, and how they are similar and different from conventional fuel cells. You might be surprised to learn how much technology is shared between them, and how they might even work together in the future for more available clean energy.

Introduction

Recently, great attentions have been paid to microbial fuel cells (MFCs) due to their mild operating conditions and using variety of biodegradable substrates as fuel. The traditional MFC consisted of anode and cathode compartments but there are single chamber MFCs. Microorganisms actively catabolize substrate, and bioelectricities are generated. MFCs could be utilized as power generator in small devices such as biosensor. Besides the advantages of this technology, it still faces practical barriers such as low power and current density.(1,2)

MFC is a bioreactor that converts chemical energy present in the organic or inorganic compound substrates to electrical energy through catalytic reactions of microorganisms. Many substrates involve in generating electricity including carbohydrates, proteins, volatile acids, cellulose and wastewaters used as feed in MFC studies. MFC has a wide range of applications, including serving as household electrical generators and powering items such as small portable electronic devices boats, automobiles, electronics in space and self-feeding robots. The construction and analysis of MFCs requires knowledge at both scientific and engineering fields, ranging from microbiology and electrochemistry to materials and environmental engineering. We conclude that for further development of MFC technology a greater focus on the understanding of its components, microbial processes, factors of limitations and designs of the construction the in MFC systems is mandatory, in order to be simplified and large scale system developed; so that it will be cost-effective and to increase electricity production

Discussion

Dxtensive studies have corroborated new insights into MFC, which show that a wide array of carbon sources including wastes can be employed using a variety of microbes. Consequently, microbial transformation of wastes using novel bioremediation strategies such as MFC for energy generation is considered as an efficient and environmentally benign approach.

Just like with traditional fuel cells, there are many variations on microbial fuel cells, so we'll focus on the most widely established MFC in terms of research and use, known simply as the mediator-free microbial fuel cell. It shares a lot in common with a standard hydrogen fuel cell in terms of setup, with an anode and cathode chamber and a proton exchange membrane between the two.(3,4) The process moves along these steps:

1. The microbial (normally a bacteria) consumes (oxidizes) fuel that passes into the anode, liberating electrons which it transfers into an electrode wire linking the anode with the cathode.
2. Hydrogen proton charges pass from the anode to the cathode via the proton exchange membrane.
3. The cathode chamber contains oxygen or an oxidizing agent, and the hydrogen combines with the oxygen in electron charges for form water and completes the circuit, producing power.

The researchers actually created a consortium of bacteria that produces electricity because each bacterium does its portion of the job. Using synthetic biological approaches, including DNA cloning, the researchers created a bacterium like those in the depths of the Black Sea, but one they can grow in the laboratory. This bacterium uses methane and produces acetate, electrons and the energy enzyme that grabs electrons. The researchers also added a mixture of bacteria found in sludge from an anaerobic digester—the last step in waste treatment. This sludge contains bacteria that produce compounds that can transport electrons to an electrode, but these bacteria needed to be acclimated to methane to survive in the fuel cell. They report the results of their work today (May 17) in Nature Communications.(5,6)

"We need electron shuttles in this process," said Wood. "Bacteria in sludge act as those shuttles."

Once electrons reach an electrode, the flow of electrons produces electricity. To increase the amountof electricity produced, the researchers used a naturally occurring bacterial genus—Geobacter, which consumes the acetate created by the synthetic bacteria that captures methane to produce electrons.

To show that an electron shuttle was necessary, the researchers ran the fuel cell with only the synthetic bacteria and Geobacter. The fuel cell produced no electricity. They added humic acids—a non-living electron shuttle—and the fuel cells worked. Bacteria from the sludge are better shuttles than humic acids because they are self-sustaining. The researchers have filed provisional patents on this process.(7,8)

Results

As petroleum source is depleted, energy crisis encouraged researchers in the world to consider for alternative sources of energy. Moreover, using of fossil fuels may cause environmental pollution. Clean fuels, significantly fuel cells and biofuels, as new sources of energy without any pollution are suitable replacements of traditional fossil fuels. MFCs are individual kinds of FCs which use active biocatalysts such as microorganisms or enzymes to generate energy. MFCs are one of the newest technologies to produce energy from different sources of substrates. Because of the promise of sustainable energy generation from different substrates such as organic wastes, research has been intensified in this field in the last few years. MFCs have different applications based on generated power. The generated power in MFC is still too low and researchers are working to improve it for commercial application.(9,10)

Faculty,

St. Anselum School, Phulera

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