National Conference on Science, Engineering and Technology (NCSET – 2016)
Volume: 4 Issue: 6
ISSN: 2321-8169
140 - 141

Simultaneous Electricity Generation and Sea Water Desalination by a Modified microbial fuel Cell

S. Rishi kumar and M. Praveen
Department of Electrical and Electronics Engineering, Velammal Engineering College Chennai-600066

Abstract:-Currently the world is facing two major challenges namely energy crises and severe shortage of fresh water. The global energy demand is increasing with exponential growth of population. Unsustainable supply of fossil fuels and the environmental concerns like air pollution and global warming associated with the use of fossil fuels are acting as major impetus for research into alternative renewable energy technologies. Another challenge Clean water for drinking is a scarce resource in many parts of the world. Many locations already desalinate water using either a reverse osmosis process or an electrodialysisprocess. Both methods require large amounts of energy. What is needed is a technology that generates electricity and also produces fresh water . In the present work we suggest a Modified microbial fuel cell that generates electricity and simultaneously desalinates water.

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I. Introduction

Microbial fuel cells have become a promising alternative for electricity generation, biomass cultivation and wastewater treatment.

They can harvest electricity from the energy available in organic wastewater [1]. In recent years there has been development of new bioelectrochemical systems (BES) that use bacteria to create renewable energy in the form of electricity, hydrogen, and methane [2-4]. For example, a microbial fuel cell (MFC) generates electricity using bacteria to degrade organic matter and produce a current. Microbial fuel cells are also believed to serve as a viable technological alternative to conventional Waste water treatment.It is estimated that in the next 20 years the average per capita supply of clean water will decrease by one- third [5].

Desalination is one option for producing potable water from brackish water and seawater in many parts of the world, but most water desalination technologies are energy and capital intensive [6]. The main desalination technologies currently used are reverse osmosis, electrodialysis, and distillation. Continual improvements in desalination processes, particularly in the past decade, have made these systems more reliable and have reduced capital costs, but high energy requirements remain a concern in many parts of the world [7]. Increasing attention is being placed on developing desalination processes powered by renewable energy, such as solar and wind driven electricity[8]. New membrane systems are also being developed that reduce the need for high water pressure through the use of forward osmosis [9]. All of these systems, however, require heat sources or electrical energy input. For example, reverse osmosis units require 3-5 kWh/m3 for water desalination [5]. Here we report about a modified microbial fuel cell which simultaneously remove both salts from the wastewater/sea water and produce additional energy.

II. Materials and Methods

Microbial Fuel Cell fabrication:

Conventional microbial fuel cells contain an anode, a cathode, proton exchange membrane and a resistor through which the electrons pass to the anode.

Bacteria need energy to survive, in the same way that humans need food to live. Bacteria get this energy in a two-step process. The first step requires the removal of electrons from some source of organic matter (oxidation), and the second step consists of giving those electrons to something that will accept them (reduction), such as oxygen or nitrate. If bacteria are grown under anaerobic conditions (without the presence of oxygen), they can transfer electrons to a carbon electrode (anode).The electrons then move across a wire under a load (resistor) to the cathode where they combine with protons and oxygen to form water. When these electrons flow from the anode to the cathode, they generate the current and voltage to make electricity.

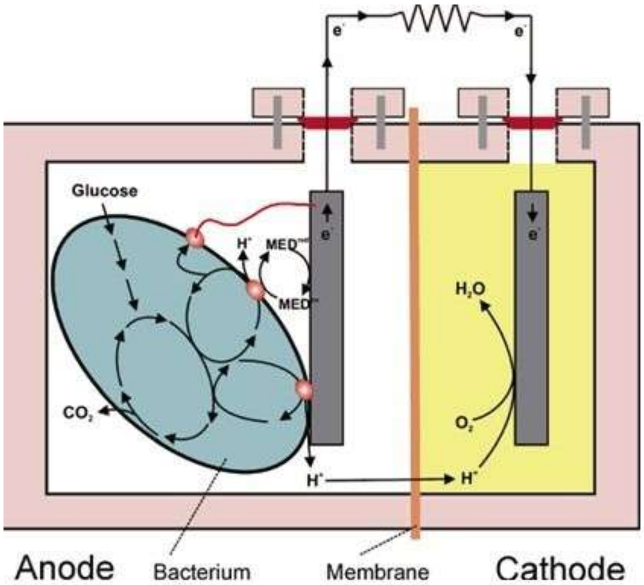

Figure 1 : Schematic diagram of a convertional microbial fuel cell

Modified Microbial Fuel Cells:

A typical microbial fuel cell consists of two chambers, one filled with wastewater or there nutrients and the other with water, each containing an electrode. Naturally occurring bacteria in the wastewater consume the organic material and produce electricity.

The new modified microbial fuel cell is designed by adding a third chamber between the two existing chambers and placing certain ion specific membranes -- membranes that allow either positive or negative ions through, but not both -- between the central chamber and the positive and negative electrodes. Salty water to be desalinated is placed in the central chamber.

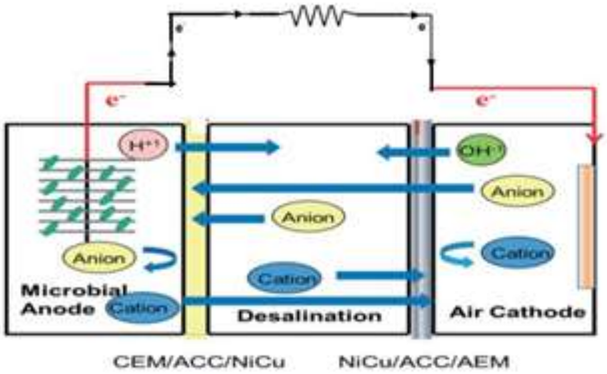

Figure 2 : Schematic diagram of modified microbial fuel cell

Seawater contains about 35 grams of salt per liter. Salt not only dissolves in water, it dissociates into positive and negative ions. When the bacteria in the cell consume the wastewater it releases charged ions -- protons -- into the water. These protons cannot pass the anion membrane, so negative ions move from the salty water into the wastewater chamber. At the other electrode protons are consumed, so positively charged ions move from the salty water to the other electrode chamber, desalinating the water in the middle chamber.

The desalination cell releases ions into the outer chambers that help to improve the efficiency of electricity generation compared to microbial fuel cells.

Challenges

"When we try to use microbial fuel cells to generate electricity, the conductivity of the wastewater is very low," "If we could add salt it would work better. Rather than just add in salt, however in places where brackish or salt water is already abundant, we could use the process to additionally desalinate salty water, clean the wastewater and dump it and the resulting salt back into the ocean."

Because the salt in the water helps the cell generate electricity, as the central chamber becomes less salty, the conductivity decreases and the desalination and electrical production decreases, which is why only 90 percent of the salt is removed. However, a 90 percent decrease in salt in seawater would produce water with 3.5 grams of salt per liter, Another problem with the current cell is that as protons are produced at one electrode and consumed at the other electrode, these chambers become more acidic and alkaline. Mixing water from the two chambers together when they are discharged would once again produce neutral, salty water, so the acidity and alkalinity are not an environmental problem assuming the leaned waste water is dumped into brackish water or seawater. However, the bacteria that run the cell might have a problem living in highly acidic environments.

For this experiment, the researchers periodically added a pH buffer avoiding the acid problem, but this problem will need to be considered if the system is to produce reasonable amounts of desalinized water.

III. Conclusion:

Though MFCs have shown remarkable increase in power outputs over the past few years, they could not be considered as energy supplying ways. Optimization and identification of sufficient sturdy materials and alternatives membranes for conventional systems are still required in order to overcome the short comings still present. More study in order to expand the applications of MFCs to desalination is our utmost need. In order to use MFC for desalination membrane configurations , long time operation stability, conductivity reductions of salt solution need to be investigated.

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