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Review article

A critical review of ceramic microbial fuel cell: Economics, long-term operation, scale-up, performances and challenges

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ABSTRACT

Microbial fuel cell (MFC) is a sustainable and renewable technology for applications in power engineering and wastewater treatment. In double chamber MFC, the anode and cathode are separated by a selective membrane, which reduces oxygen transfer, substrate losses and keeps the anode chamber anaerobic. The high price of commercially available membranes, proton exchange membrane (PEM) has accelerated research into substitute materials for use as separators in MFC. Various research identifies low-cost clay-based ceramic materials as one of the most promising substitutes for commercial membranes. These low-cost materials are a viable option for spiked systems due to their low cost, functional long-term robustness, and natural availability. These eco-friendly materials' ability to easily change their microstructure by mixing various compounds into the ceramic raw clay is another benefit of employing them as membranes. The MFC ceramic also ensures stable power output for up to nineteen months in terms of long-term performance reported by previous studies demonstrated a performance of up to 1.56 mW (22.3 W m^{-3}) over a one-year period. The 3-module cascade achieved up to 75 mW (13.9 W m^{-3}) of power, indicating 20 % power loss on day 446, the stack module with 22 MFCs obtained up to 21.4 mW (11.9 W m^{-3}). In the pilot-scale and industrial applications of MFC, the emphasis should not only be on the greatest energy harvesting or recovery but also on the large-scale MFC prototype's economic viability. This review discusses the use of ceramics in MFC for low-cost ceramics, with long-term performance, upscaled, stacked, pilot plant and the challenges of their use in MFC.

1. Introduction

Microbial fuel cell (MFC) is a sustainable and renewable technology for applications in power engineering and wastewater treatment [1,2]. With the ability to transmit electrons to solid electron acceptors, electroactive bacteria (EAB) in biofilms can use MFC to capture energy from a variety of environmental activities. The MFC system that generates energy from organic contaminants, can be used to power a variety of electronic devices with different energy requirements [3,4]. The substrate, which can range from simple compounds such as water to more complex substrates such as wastewater, is one of the key elements influencing the production of power in MFC [5]. The use of MFC to remove contaminants from waste streams has garnered a lot of interest because conventional treatment methods, such as the activated sludge process, are thought to be particularly energy- intensive. Industrial waste from the brewing industry [6], food waste from the swine industry [7], and domestic wastewater or clean urine are among the most popular feedstocks for MFCs [8,9]. The anode and cathode compartments are often physically separated in dual-chamber MFCs by a selective membrane or porous separator, which lowers substrate losses and maintains

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