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AN ANALYSIS OF MICROBIAL FUEL CELL (MFC) PERFORMANCE FOR BIO-ENERGY PRODUCTION

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ABSTRACT

Microbial Fuel Cells (MFCs) are an emerging and promising technology for bio-energy production, harnessing the metabolic processes of microorganisms to convert organic waste into electrical energy. In an MFC, bacteria break down organic substrates present in wastewater or biomass, generating electrons and protons. The electrons are transferred through an external circuit to produce electricity, while the protons migrate through a proton exchange membrane to combine with oxygen, forming water at the cathode. The efficiency of MFCs depends on several factors, including the type of microorganisms used, the substrate concentration, electrode materials, and reactor design. Using bioengineered or electrogenic bacteria can enhance electron transfer rates, thus improving energy yields. Furthermore, optimizing the anode and cathode materials, such as using carbon-based or metal catalysts, can significantly boost performance. The dual benefits of wastewater treatment and energy recovery make MFCs particularly attractive for sustainable energy solutions. However, challenges such as low power density, high internal resistance, and the cost of materials currently limit their widespread application. Advances in nanomaterials, membrane technologies, and microbial community engineering are being explored to address these hurdles. With further development, MFCs hold potential as an eco-friendly and cost-effective solution for decentralized energy production, particularly in regions lacking conventional power infrastructure.