Marine Photosynthetic Microbial Fuel Cell for Enhanced Renewable Power Generation

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The use of microbial fuel cells (MFCs) that generates energy from biodegradable substances by means of microorganisms, has several applications, including wastewater treatment, operation of remote sensing devices, and bioremediation. In terms of energy generation, the ocean is a vastly underutilized yet potentially abundant resource. Because of the rapid ionic movements and superior electrical conductivity of sea water, it is a suitable medium for operating bio-electrochemical devices. The anode compartment's mixed consortium of marine microorganisms can perform robust extracellular electron transfer and has to be fed an external substrate like glucose. In conventional MFCs the cathode has to be coated with an expensive noble metal to efficiently catalyze the oxygen reduction reaction (ORR) and it requires active aeration. Biofilm-forming marine photosynthetic microorganisms (MPM) serve as electron donors and replace the typical cathode catalyst in this marine photosynthetic MFC (mpMFC). This study examined the use of seawater as a conducting medium in a two-chambered MFC to enhance power production in conjunction with a marine photosynthetic bio-cathode as an alternative to the abiotic chemical cathode. Using a modified BG11 medium, MPMs were effectively transferred into the cathode compartment. After a significant quantity of biomass had formed, it was prepared for use as an exo-electrogens-nourishing extracellular feeding substrate. The effectiveness of marine MFC (mMFC) was evaluated in three phases: before adding MPMs to the cathode compartment, after adding MPMs into the cathode compartment, and while feeding ready-to-use substrate. Power current plots and polarization curves were used to evaluate the efficiency of MFC. In mMFC, maximum power density (Pd_{max}) was 147.84 mW/m^2 and maximum current density (J_{max}) was 1311.82 mA/m^2. In mpMFC, Pd_{max} was 104.48 mW/m^2 and J_{max} was 1107.27 mA/m^2. The Pd_{max} in mMFC is increased by 178.2% and in mpMFC by 161.4%, while the J_{max} is increased by 96.6% and 120.65% respectively. Exo-electrogens were proven to exist by observing a color change in anode samples cultivated in modified chromogenic medium. We conclude that this mpMFC that is fully driven by sea water along with a biocathode is a promising technology for the sustainable production of electricity.

Keywords: Marine MFC, Photosynthetic Biocathode, Renewable Energy