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Soil Bioremediation Monitoring Systems Powered by Microbial Fuel Cells

Authors : András Fülöp, Lejla Heilmann, Zsolt Szabó, Ákos Koós

Abstract : Microbial fuel cells (MFCs) present a sustainable biotechnological solution to future energy demands. The aim of this study was to construct soil based, single cell, membrane-less MFC systems, operated without treatment to continuously power on-site monitoring and control systems during the soil bioremediation processes. Our Pseudomonas aeruginosa 541 isolate is an ideal choice for MFCs, because it is able to produce pyocyanin which behaves as electron-shuttle molecule, furthermore, it also has a significant antimicrobial effect. We tested several materials and structural configurations to obtain long term high power output. Comparing different configurations, a proton exchange membrane-less, 0.6 m long with 0.05 m diameter MFC tubes offered the best long-term performances. The long-term electricity production were tested from starch, yeast extract (YE), carboxymethyl cellulose (CMC) with humic acid (HA) as a mediator. In all cases, 3 kΩ external load have been used. The two best-operated systems were the Pseudomonas aeruginosa 541 containing MFCs with 1 % carboxymethyl cellulose and the MFCs with 1% yeast extract in the anode area and 35% hydrogel in the cathode chamber. The first had 3.3 ± 0.033 mW/m2 and the second had 4.1 ± 0.065 mW/m2 power density values. These systems have operated for 230 days without any treatment. The addition of 0.2 % HA and 1 % YE referred to the volume of the anode area resulted in 1.4 ± 0.035 mW/m2 power densities. The mixture of 1% starch with 0.2 % HA gave 1.82 ± 0.031 mW/m2. Using CMC as retard carbon source takes effect in the long-term bacterial survivor, thus enable the expression of the long term power output. The application of hydrogels in the cathode chamber significantly increased the performance of the MFC units due to their good water retention capacity.

Keywords : microbial fuel cell, bioremediation, Pseudomonas aeruginosa, biotechnological solution
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