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Analysis of microbial fuel cells for the treatment of selected industrial wastewater effluents (domestic and brewery) and generation of electricity

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Abstract

The goal of this study was to evaluate the technical potential of Microbial Fuel Cells (MFCs) for harvesting bio-electricity from municipal and hospital wastewaters, as well as the effects of key parameters like biofilm growth rate, substrate dilution, and catalyst addition on COD removal efficiency and electricity generation in both open and closed circuit Microbial Fuel Cells. The study looked at MFC performance for organic matter removal from brewery and domestic wastewater as a function of biofilm growth rate at MFC start-up for open circuit and closed circuit in a double chamber MFC to investigate biofilm growth rate and its effect on MFC performance. In the second experiment, the impact of biofilm formation and optimum acclimation time in an MFC fed with both diluted and undiluted domestic and brewery wastewaters was investigated. The third and fourth experimental works synthesized and examined the electrocatalytic behavior of MnO_2/rGO as an oxygen reduction reaction catalyst in MFC applications for power generation in the treatment of selected industrial wastewaters. The analysis of the biofilm growth rate and biofilm growth constant revealed new information about substrate degradation pathways and microbial interactions. The addition of sludge to beer brewery wastewater reduces electron transfer ability at low external resistance, and external resistance was found to be highly proportional to anode colonization during biofilm production, as well as other MFC parameters such as current generation, microbial activity, biofilm growth rate, and power generated. The COD of the effluent was also evaluated as a function of external resistance, and it was discovered that as external resistance was increased, the COD of the effluent decreased, meaning that the substrate consumed by microorganisms increased. When the external resistance was increased, the MFC's remedial capacity was also increased. Finally, the results indicate that the low activity of the MnO_2/rGO catalyst in domestic wastewater fed MFCs may be attributed to catalyst toxicity, which reduces catalyst activity. Variations in bacterial yield or the presence of electron acceptors may also explain the lower performance of the catalyst coated cathode MFC in domestic wastewater fed MFCs. The MnO_2/rGO catalyst demonstrated higher ORR activity than plain cathode MFCs in brewery wastewater, making it more appropriate for brewery wastewater treatment rather than domestic wastewater treatment.