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LOW-COST PROTON EXCHANGE MEMBRANES FOR MICROBIAL FUEL CELLS USING CLAY AND ACTIVATED CARBON

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The proton exchange membrane (PEM) is a significant component that affects the performance of the microbial fuel cell (MFC). Electro-neutrality between the two chambers is very important in MFCs, and it is performed by PEM, which transfers the protons across the membrane. A Nafion membrane is widely used as PEM in MFC for exchanging protons, but it is costly. Therefore, further research on low-cost PEM, which is high in porosity and mechanical strength, is vital. In this study, a PEM was made using natural clay and activated carbon derived from coconut shells (ACCS) and was compared with the results obtained for the Nafion membranes in other studies. In both MFCs, the volume of the anode and cathode chamber was 250 ml, and a phosphate buffer solution (50 mmol dm^{-3}) was added to the cathode while wastewater was added to the anode chamber. In this study, lake sediment was used as the source of electrochemically active bacteria in the anode chamber of MFC. Open circuit voltage and short circuit current density of clay and ACCS membrane were observed as 270 mV and 920.0 mA m^{-2}, respectively. The maximum power density obtained from the MFC using clay and ACCS (43.3 mW m^{-2}) was lower than the MFC with Nafion as PEM (202±6 mW m^{-2}). However, calculations showed that the cost per square meter for PEM developed from clay and ACCS (5,600 LKR) was much lower than the Nafion membrane (4.0 million LKR). Furthermore, a performance comparison of MFCs revealed that the cost per watt for clay and ACCS membrane was 0.13 million LKR, while that of Nafion was about 19.8 million LKR. Hence, low-cost clay and ACCS membranes were found to have the potential to replace Nafion membranes in MFCs for their field-scale applications. Therefore, MFC prepared using clay and ACCS can be used as a low-cost and clean energy source to generate bioelectricity.

Keywords: Activated carbon derived from coconut shell (ACCS), Bioelectricity generation, Cost per watt, Natural clay, Proton exchange membrane (PEM)