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Flat-plate microbial fuel cell operation using different ion-exchange and size-selective separators

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Increasing population of the globe increases the demand for clean water on one hand and the generation of wastewater on the other hand. Current wastewater treatment systems consume lots of energy to remove the organic matter that has been shown to be potential source of energy [1]. Microbial fuel cell (MFC) technology offers a way to recover some of the energy stored in wastewater in the form of electrical current or useful chemicals' production. Flat-plate microbial fuel cell (FPMFC) design, adopted from hydrogen fuel cells [2], is a promising configuration for large scale applications offering the possibility of stacking a large number of MFCs, and reduced energy consumption by using passive air-cathodes. Despite the potential for large scale applications, flat-plate design has not gained proper attention in the microbial fuel cell research. A possible reason for this could be the anaerobic anode inhibition by the oxygen crossover from the cathode due to the close spacing of the electrodes [3]. This issue, however, could potentially be addressed by using appropriate separators providing suitable proton conduction while maintaining low oxygen crossover. The effects of electrode spacing in the flat-plate design as well as the 3D anode electrode compression are also not well studied.

In this work, five size-selective and ion-exchange separators were selected based on a systematic pre-evaluation study (Fig. 1). The selected separators (Nafion®117, SciMat®, Hyflon®, glass fibre filter, and nylon mesh 20) were then tested in a previously designed novel FPMFC configuration generating electricity and removing ethanol from wastewater simultaneously [4]. Three air-cathode FPMFCs with different anode chamber depth (2mm, 4mm, and 8mm) were designed in order to examine the effect of electrode spacing on the performance of FPMFCs using different separators. Graphite felt anodes were used to provide high surface area for the biocatalyst growth as well as to study the effect of 3D anode compression on the FPMFC performance. The performance of the FPMFCs was analyzed by studying the polarization curves, impedance results, coulombic and COD removal efficiencies.

This work provides an in-depth understanding of the performance FPMFCs using different separators by first, systematically selecting them, and second, testing them in the FPMFC configuration.

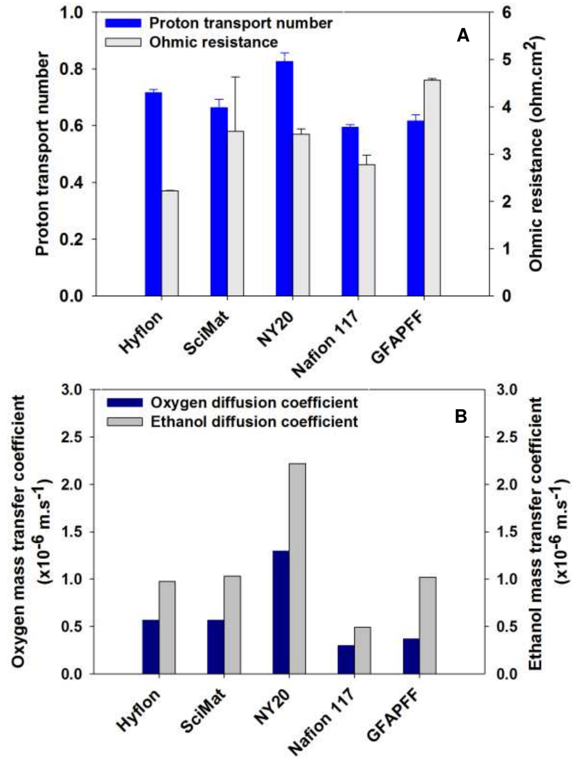

Figure 1 Selected separators for the FPMFC testing; A) Proton transport number vs. Ohmic resistance, B) Oxygen vs. Ethanol mass transfer coefficients

References

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