INTERNATIONAL JOURNAL OF ENERGY RESEARCH
Int. J. Energy Res. 2008; 32:1228–1240
Published online 28 April 2008 in Wiley InterScience
(www.interscience.wiley.com). DOI: 10.1002/er.1419

Microbial fuel cells based on carbon veil electrodes: Stack configuration and scalability

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SUMMARY

The aim of this study was to compare the performance of three different sizes of microbial fuel cell (MFC) when operated under continuous flow conditions using acetate as the fuel substrate and show how small-scale multiple units may be best configured to optimize power output. Polarization curve experiments were carried out for individual MFCs of each size, and also for stacks of multiple small-scale MFCs, in series, parallel and series–parallel configurations. Of the three combinations, the series–parallel proved to be the more efficient one, stepping up both the voltage and current of the system, collectively. Optimum resistor loads determined for each MFC size during the polarization experiments were then used to determine the long-term mean power output. In terms of power density expressed as per unit of electrode surface area and as per unit of anode volume, the small-sized MFC was superior to both the medium- and large-scale MFCs by a factor of 1.5 and 3.5, respectively. Based on measured power output from 10 small units, a theoretical projection for 80 small units (giving the same equivalent anodic volume as one large 500mL unit) gave a projected output of $10Wm^{-3}$, which is approximately 50 times higher than the recorded output produced by the large MFC. The results from this study suggest that MFC scale-up may be better achieved by connecting multiple small-sized units together rather than increasing the size of an individual unit.

KEY WORDS: microbial fuel cells; scalability; stack configuration; maximum power transfer; internal resistance; fluidic conductance; continuous flow; mixed culture