Stacking of Microbial Fuel Cells for Wastewater Treatment

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Energy and water supply are two of the biggest challenges facing humanity in the coming decades. The present efforts to develop strategies for the recovery or efficient usage of resources are, therefore, highly justified. Groundbreaking technology is needed to allow novel means of converting and conserving resources (Rabaey, 2009). Bio-electrochemical systems (BESs) have emerged as a promising and yet exciting technology. In a BES, bacteria interact with electrodes using electrons, which are either removed or supplied through an electric circuit. The most-described type of BES is the microbial fuel cell (MFC), in which power is generated from electron donors, such as organic compounds present in wastewater (Bennetto, 1990). MFC is considered to be a technology for sustainable bioenergy production, due to the ability of the system to generate electricity from wastewaters, while simultaneously treating them (Habermann and Pommer, 1991; Logan and Regan, 2006). Although over the last two decades the MFC technology has gained the scientists' interest the MFC technology is still far from its commercialization.

Under the view of the MFC technology to be practically implemented and integrated to the current wastewater treatment practices, during this work a prototype and relatively low cost smart stack was constructed. The stack consists of six multiple MFC units, based on the prototype design of the four-air cathode MFC configuration (4ACMFC) (Tremouli et al., 2016). In view of MFC commercialization, the cost of the stack was kept relatively low by replacing the expensive construction materials with cheap but effective ones. All the MFC units were inoculated using anaerobic sludge obtained from the Athens (Greece) Wastewater Treatment Plant. Glucose was used as carbon and energy source and 10% (v/v) of the anaerobic sludge was added to the anodic chambers. $NaH_2PO_4 \cdot 2H_2O$ and $Na_2HPO_4\ 2H_2O$ were added to the medium forming a Phosphate Buffer Solution (PBS, pH 7), while KCl was added to increase the solution conductivity. All cycles were conducted in batch mode. After the acclimation period, glucose was replaced by a food residue leachate. The results of the present study indicate that wastewater can be successfully treated using multiple MFC units which operate as a stack for maximizing the electricity production of the system.

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References

Bennetto, H.P., 1990. Electricity generation by microorganisms. Biotechnol. Educ. 1, 163–168. https://doi.org/10.2166/wst.2011.822

Habermann, W., Pommer, E.H., 1991. Biological fuel cells with sulphide storage capacity. Appl. Microbiol. Biotechnol. 35, 128–133. https://doi.org/10.1007/BF00180650

Logan, B.E., Regan, J.M., 2006. Electricity-producing bacterial communities in microbial fuel cells. Trends Microbiol. https://doi.org/10.1016/j.tim.2006.10.003

Rabaey, K., 2009. Bioelectrochemical Systems: From Extracellular Electron Transfer to Biotechnological Application. Water Intell. Online 8. https://doi.org/10.2166/9781780401621

Tremouli, A., Martinos, M., Bebelis, S., Lyberatos, G., 2016. Performance assessment of a four-air cathode single-chamber microbial fuel cell under conditions of synthetic and municipal wastewater treatments. J. Appl. Electrochem. 46, 515–525. https://doi.org/10.1007/s10800-016-0935-3