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Maximizing Wastewater Treatment Efficiency by Coupling a Periodic Anaerobic Baffled Reactor (PABR) with a Microbial Fuel Cell (MFC)

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Abstract

Microbial fuel cell (MFC) technology has been extensively researched to maximize both the efficiency of wastewater treatment as well as the simultaneous power output. MFCs have been coupled with other wastewater treatment methods such as anaerobic digestion or dark fermentation to maximize the treatment efficiency and the energy recovery. Additionally, the quest for cost – efficient materials has led to the use of ceramic-based cathode assemblies as effective anode – cathode separators (Winfield et al., 2016). In this work the MFC technology has been incorporated in a two-stage system, in order to refine the characteristics of the effluent from a high-rate anaerobic digester (the periodic anaerobic baffled reactor, PABR) (Skiadas I.V. & Lyberatos G., 1998), while maximizing the energy recovery from the already treated effluent. The PABR has been fed with a condensate originating from the vapors of dried household food waste (HFW). The MFC cathode set – up consisted of four air cathode mullite electrodes coated internally with a MnO_2 catalytic paste. As MFC anode, graphite granules (250 g) were used for biofilm growth with a graphite rod embedded in them for current collection. The PABR effluent characteristics were a low COD concentration (250 – 550 mgCOD/L), neutral pH (7.9±0.1) and low conductivity (3±0.7 mS/cm). The MFC was fed with the PABR effluent (150 mL) without any pretreatment. Six operation cycles were performed, producing repeatable current output peaks (1.8 – 2 mA). Moreover, the COD removal efficiency ranged from 67% to 93% and the pH presented a small decrease from 7.9 to 7.5. Polarization experiments were conducted on the MFC, measuring a maximum power output of 5.4 W/m^3 and an internal resistance of 78 Ω. The highest electricity yield was measured at the first operation cycle (40 mJ/gCOD/L), along with the highest coulombic efficiency (43%), indicating the effect of residual salts from the phosphate buffer in the graphite granule bed. During the consecutive operation cycles with PABR effluent the

MFC performance deteriorated, resulting in 15% coulombic efficiency and 14 mJ/gCOD/L electricity yield. However, the maximum power output of each cycle presented an increase from 0.9 W/m^3 at the 1st operation cycle to 5.4 W/m^3 at the last. This work demonstrated the MFC ability to utilize a treated effluent for maximum energy recovery, while refining its characteristics.

Keywords: PABR, MFC, condensate, Bioelectrochemistry

References

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