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Bioelectricity generation by natural microflora of septic tank wastewater (STWW) and biodegradation of persistent petrogenic pollutants by basidiomycetes fungi: An integrated microbial fuel cell system

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Abstract

The microbial fuel cell is a unique advantageous technology for the scientific community with the simultaneous generation of green energy along with bioelectroremediation of persistent hazardous materials. In this work, a novel approach of integrated system with bioelectricity generation from septic tank wastewater by native microflora in the anode chamber, while Psathyrella candolleana with higher ligninolytic enzyme activity was employed at cathode chamber for the biodegradation of polycyclic aromatic hydrocarbons (PAHs). Six MFC systems designated as MFC1, MFC2, MFC3, MFC4, MFC5, and MFC6 were experimented with different conditions. MFC1 system using natural microflora of STWW (100%) at anode chamber and K3[Fe(CN)6] as cathode buffer showed a power density and current density of 110 ± 10 mW/m2 and 90 ± 10 mA/m2 respectively. In the other five MFC systems 100% STWW was used at the anode and basidiomycetes fungi in the presence or absence of individual PAHs (naphthalene, acenaphthene, fluorene, and anthracene) at the cathode. MFC2, MFC3, MFC4, MFC5, and MFC6 had showed power density of 132 ± 17 mW/m2, 138 ± 20 mW/m2, 139 ± 25 mW/m2, and 147 ± 10 mW/m2 respectively. MFC2, MFC3, MFC4, MFC5, and MFC6 had showed current density of 497 ± 17 mA/m2, 519 ± 10 mA/m2, 522 ± 21 mA/m2 and 525 ± 20 mA/m2 respectively. In all the MFC systems, the electrochemical activity of anode biofilm was evaluated by cyclic voltammetry analysis and biofilms on all the MFC systems electrode surface were visualized by confocal laser scanning microscope. Biodegradation of PAHs during MFC experimentations in the cathode chamber was estimated by UV-Vis spectrophotometer. Overall, MFC6 system achieved maximum power density production of 525 ± 20 mA/m2 with 77% of chemical oxygen demand removal and 54% of coulombic efficiency at the anode chamber and higher anthracene biodegradation (62 ± 1.13%) at the cathode chamber by the selected Psathyrella candolleana at 14th day. The present natural microflora - basidiomycetes fungal coupled MFC system offers excellent opening towards the simultaneous generation of green electricity and PAHs bioelectroremediation.