Bio-electrochemical power generation in petrochemical wastewater fed microbial fuel cell

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ABSTRACT

The petrochemical wastewater (PCW) from acrylic acid plants possesses a very high chemical oxygen demand (COD) due to the presence of acrylic acid along with other organic acids. The treatment of PCW by conventional aerobic and anaerobic methods is energy intensive. Therefore, the treatment of PCW with concurrent power generation by employing microbial fuel cell (MFC) could be a potential alternative to solve the energy and environmental issues. This study demonstrates the potentiality of PCW from acrylic acid plant with an initial COD of 45,000 mg L^{-1} generating maximum power density of 850 mW m^{-2} at a current density of 1500 mA m^{-2} using acclimatized anaerobic sludge (AS) as biocatalyst. The predominant microbes present in acclimatized AS were identified using Biolog GEN III analysis, which include the electrogenic genera namely *Pseudomonas* spp. and *Bacillus* spp. along with methanogenic archea *Methanobacterium* spp. The mechanism of electron transfer was elucidated by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) which clearly demonstrated the natural metabolite-based electron transfer across the electrode/biofilm/solution interface. The abundance of the electron shuttle metabolites was increased with the microbial growth in the bulk solution as well as in the biofilm leading to a high power generation. The COD removal efficiency and the coulombic efficiency (CE) were found to be 40% and 21%, respectively after 11 days of operation using initial COD of 45,000 mg L^{-1}. The low COD removal efficiency could drastically be increased to 82% when the initial COD of PCW was 5000 mg L^{-1} generating a power density of 150 mW m^{-2}. The current work proves the feasibility of the MFC for the treatment of acrylic acid plant PCW using acclimatized anaerobic sludge (AS) as a biocatalyst.

KEYWORDS
DC-MFC; Electron shuttle; Biofilm; Coulombic efficiency; COD removal efficiency

ACKNOWLEDGEMENTS
We are thankful to Universiti Malaysia Pahang (www.ump.edu.my) for providing research grant (RDU180355)