Augmentation of microbial fuel cell and photocatalytic polishing technique for the treatment of hazardous dimethyl phthalate containing wastewater

Sarmin Sumaya [a] , Tarek Mostafa [a] , Roopan Selvaraj Mohana [b] , Cheng, Chin Kui [c] , Rahman Khan Md Maksudur [a]

[a] Department of Chemical Engineering, College of Engineering, Universiti Malaysia Pahang, Kuantan, 26300, Pahang, Malaysia

[b] Chemistry of Heterocycles & Natural Product Research Laboratory, Department of Chemistry, School of Advanced Science, Vellore Institute of Technology, Vellore, 632 014, Tamilnadu, India

[c] Department of Chemical Engineering, College of Engineering, Khalifa University, P.O. Box 127788, Abu Dhabi, United Arab Emirates

ABSTRACT

In the present paper, the potentiality of integrating microbial fuel cells (MFCs) with a photocatalytic reactor to maximize the wastewater treatment efficiency with concurrent power generation was explored. Dimethyl phthalate (DMP) and acetic acid (AA) were the employed substrate and the co-substrate, respectively, using Pseudomonas aeruginosa as a biocatalyst. MFCs operated by single substrate showed the maximum power generation of 0.75–3.84 W m−3 whereas an addition of AA as the co-substrate yielded 3–12 fold higher power generation. Pseudomonas aeruginosa produced phenazine-1-carboxylic acid in DMP-fed MFC as the metabolite whereas AA along with DMP yielded pyocyanin which reduced the charge transfer resistance. Chemical oxygen demand (COD) removal efficiency in the MFCs was circa 62% after 11 days of operation. Thereafter, it further increased albeit with a drastic reduction in power generation. Subsequently, the MFC anolyte was treated in a photocatalytic reactor under visible light irradiation and catalyzed by CuO-gC3N4. The performance of photocatalytic reactor was evaluated, with COD and total organic carbon (TOC) removal efficiency of 88% and 86% after 200 min of light irradiation. The present work suggests that the MFC can be integrated with photocatalysis as a sustainable wastewater treatment method with concurrent power generation.

KEYWORDS

Dimethyl phthalate; Microbial fuel cell; Photocatalytic technique; COD removal efficiency; High power generation

ACKNOWLEDGMENTS

We are grateful to Universiti Malaysia Pahang (www.ump.edu.my) for providing research grant (RDU180355) and PGRS1903133. The manuscript was written through contributions of all authors. All authors have given their approval to the final version of this manuscript.