Journal Article – Volume 367, Journal of Environmental Management 2020, Pages 1 - 12

Towards environmentally-friendly solutions for real textile-dyeing wastewater with energy recovery: Effluent recirculation and Rubia plant-derived purpurin electron mediator in microbial fuel cell

Abstract

Escalating global water pollution exacerbated by textile-dyeing wastewater (TDW) poses significant environmental and health concerns due to the insufficient treatment methods being utilized. Thus, it is imperative to implement more effective treatment solutions to address such issues. In this research, different environmentally-friendly strategies involving effluent recirculation (ER) and Rubia cordifolia plant-derived purpurin electron mediator (EM) were introduced to enhance the treatment of real TDW and bioelectricity generation performance of an anti-gravity flow microbial fuel cell (AGF-MFC). The results revealed that optimum performance was achieved with a combination of hydraulic retention time (HRT) of 48 h with a recirculation ratio of 1, where the reduction efficiency of biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), ammonium (NH_4^+), nitrate (NO_3^-), sulphate (SO_4^{2-}), ammonia nitrogen (NH_3–N), colour and turbidity were 82.17 %, 82.15 %, 85.10 %, 80.52 %, 75.91 %, 59.52 %, 71.02 % and 93.10 %, respectively. In terms of bioelectricity generation performance, AGF-MFC showed a maximum output voltage and power density of 404.72 mV and 65.16 mW/m^2, respectively. Moreover, the results also signified that higher treatment performance of TDW was obtained with natural purpurin from Rubia cordifolia plant than synthetic purpurin as EM. The reduced reactivity of highly stable synthetic purpurin EM for mediating the electron transfer was a contributing factor to the outperformance of plant-derived purpurin. Additionally, detailed electron-mediating mechanisms of purpurin were proposed to unravel the underlying electron transfer pathway involved in AGF-MFC. This research offers insight into the development of more sustainable solutions for managing TDW, and consequently reducing environmental pollution.

Keywords

Bioelectricity generation; Electron mediator; Hydraulic retention time; Microbial fuel cell; Real wastewater