Synergistic effect of electrotrophic perchlorate reducing microorganisms and chemically modified electrodes for enhancing bioelectrochemical perchlorate removal


Abstract

Perchlorate has been described as an emerging pollutant that compromises water sources and human health. In this study, a new electrotrophic perchlorate reducing microorganism (EPRM) isolated from the Atacama Desert, Dechloromonas sp. CS-1, was evaluated for perchlorate removal in water in a bioelectrochemical reactor (BER) with a chemically modified electrode. BERs were operated for 17 days under batch mode conditions with an applied potential of −500 mV vs. Ag/AgCl. Surface analysis (i.e., SEM, XPS, FT-IR, RAMAN spectroscopy) on the modified electrode demonstrated heterogeneous transformation of the carbon fibers with the incorporation of nitrogen functional groups and the oxidation of the carbonaceous material. The BERs with the modified electrode and the presence of the EAM reached high cathodic efficiency (90.79 ± 9.157%) and removal rate (0.34 ± 0.007 mol m−3 day) compared with both control conditions. The observed catalytic enhancement of CS-1 was confirmed by a reduction in the charge transfer resistance obtained by electrochemical impedance spectroscopy (EIS). Finally, an electrochemical kinetic study revealed an eight-electron perchlorate bioreduction reaction at −638.33 ± 24.132 mV vs. Ag/AgCl. Therefore, our results show the synergistic effect of EPRM and chemically modified electrodes on perchlorate removal in a BER.

Keywords

Bioelectrochemical reactors; Perchlorate; Dechloromonas; Biocathode; Modified electrode