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Biocatalysed sulphate removal in a BES cathode

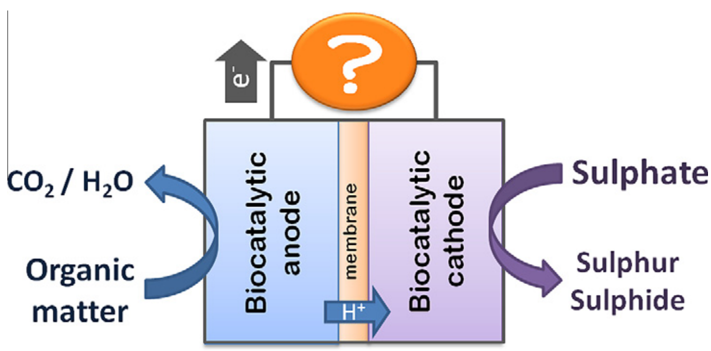
M. Coma, S. Puig *, N. Pous, M.D. Balaguer, J. Colprim

LEQUIA, Institute of the Environment, University of Girona, Campus Montilivi, E-17071 Girona, Catalonia, Spain

HIGHLIGHTS

- Sulphate was reduced in a biocathode separated from organic matter oxidation.
- Minimum energy is required to poise the cathode at −0.26 V *vs.* SHE for sulphate removal.
- Sulphide was the main product from sulphate reduction.
- Sulphide was entrapped in the cathode due to high pH from the reaction.

GRAPHICAL ABSTRACT



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ABSTRACT

Sulphate reduction in a biological cathode and physically separated from biological organic matter oxidation has been studied in this paper. The bioelectrochemical system was operated as microbial fuel cell (for bioelectricity production) to microbial electrolysis cell (with applied voltage). Sulphate reduction was not observed without applied voltage and only resulted when the cathodic potential was poised at −0.26 V *vs.* SHE, with a minimum energy requirement of 0.7 V, while maximum removal occurred at 1.4 V applied. The reduction of sulphate led to sulphide production, which was entrapped in the ionic form thanks to the high biocathode pH (i.e. pH of 10) obtained during the process.

1. Introduction

Sulphate (SO_4^{2-}) is one of the most abundant anions found in the environment. Despite large quantities of sulphate being released into the environment, little attention has been given to the mitigation of sulphate because of its relatively low direct environmental risk compared with other pollutants (Liamleam and Annachhatre, 2007). However, the European Groundwater Directive (2006/115/EC) and the American Environmental Protection Agency (EPA 822-R.03-007) do take into account sulphate in the list of pollutants to consider establishing threshold values, mostly from saline flows resulting from human activities. Wastewater containing sulphate is normally treated using physicochemical and biological methods. The use of biological treatment is restricted to anaerobic bioreactors, in which sulphate-reducing bacteria (SRB) couple the oxidation of organic matter (electron donor) to the reduction of sulphate (electron acceptor), producing hydrogen sulphide (Sarti and Zaiat, 2011). The inconveniences of this process mainly involve the competition of SRB with methanogenesis and the large amounts of organic matter required. Furthermore, sulphate-rich waste waters are usually deficient in electron donors (Liamleam and Annachhatre, 2007) and, regarding groundwater treatment, direct contact with organic matter should be avoided to maintain drinking water biostability (Puig et al., 2012).

* Corresponding author. Address: Laboratory of Chemical and Environmental Engineering (LEQUiA), Institute of the Environment, University of Girona, Campus Montilivi s/n, Facultat de Ciències, E-17071 Girona, Spain. Tel.: +34 972418182; fax: +34 972418150.

E-mail address: sebastia@lequia.udg.cat (S. Puig).

URL: http://lequia.udg.cat (S. Puig).

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