EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

CONCEIVING WASTEWATER TREATMENT IN 2020 (Water_2020)

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Bioremediation of subsurface waters

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Objectives

Evaluation of bioelectrochemical systems (BES) as a new technological approach for bioremediation of arsenic-polluted groundwater. The aim of this study was to demonstrate, for the first time, the possibility to stimulate anaerobic oxidation of the highly mobile arsenite (As(III)) to the easy absorbing arsenate (As(V)) using a polarized graphite electrode as the sole electron acceptor.

Methodology

Two one-chamber BES (BES volume of 250mL) were assembled using a three- electrode arrangement (Figure 1). Two graphite rods connected to a titanium wire were used as working- and counter- electrode, respectively. An Ag/AgCl electrode (+0.197 V vs. SHE) was used as reference electrode. The cell was filled with 150mL of anaerobic synthetic medium that contained 15ppmAs-As(III). The head-space was continuously fluxed with N_2 gas to ensure anaerobic conditions. A biologic cell was inoculated with an aerobic arsenite-oxidizing bacterial mixed culture. The anaerobic bioelectrochemical oxidation of arsenite was tested by polarizing the working electrode at +0.497V vs. SHE (+0.300V vs. Ag/AgCl) over seven days cycles. The non-bioelectrochemical arsenite oxidation was tested by leaving the cell at open circuit (OCP) during seven days. The pure electrochemical As(III) oxidation was checked in an abiotic cell. As(III) and As(V) concentrations were followed daily. Each test was performed in duplicate

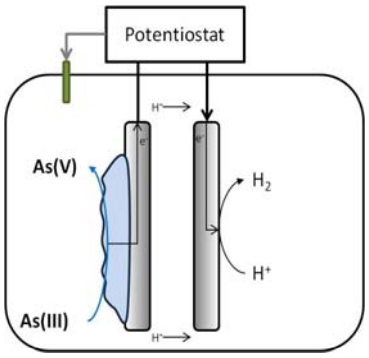

Figure 1. BES for arsenite oxidation.

Results

In the biologic cell with the electrode polarized at +0.497V vs. SHE, an arsenite oxidation rate of 420±38 μgAs·L^{-1}·day^{-1} and an arsenate production rate of 428±59 μgAs·L^{-1}·day^{-1} were observed (Figure 2). A coulombic efficiency of 40±11% could be deduced. When the BES was operated at open circuit voltage (OCP, no current was allowed to flow in the circuit) both arsenite oxidation rate and arsenate production rate decreased to 137±60 μgAs·L^{-1}·day^{-1} and 180±82 μgAs·L^{-1}·day^{-1}, respectively.

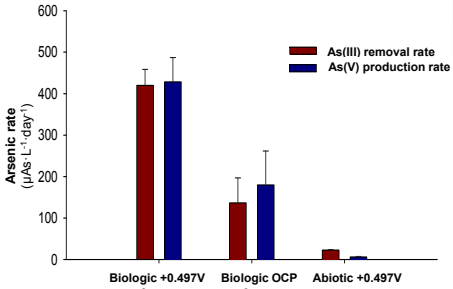

Figure 2. Arsenite oxidation performance.

The use of a polarized electrode enhanced arsenite oxidation rate by 137% (based on As(V) production). In the abiotic cell, an arsenite oxidation of 23±1 μgAs·L^{-1}·day^{-1} and an arsenate production of 6±1 μgAs·L^{-1}·day^{-1} were observed. It accounted for 5% of arsenite oxidation and 1% of arsenate production in the bioelectrochemical test. Thus, **the higher arsenite oxidation rate observed in the biologic cell was mainly related to an enhancement of biologic activity driven by electrode polarization.**

Highlights

Arsenite bio-oxidation using a polarized electrode as a final electron acceptor is demonstrated for the first time.

The results obtained in this project show that BES can be a promising technology for the bioremediation of arsenic in subsurface waters.

Results are already published: Pous, N.; Casentini, B.; Rossetti, S.; Fazi, S.; Puig, S.; Aulenta, F. (2015). *J. Hazard. Mater.* 283C, 617-622. DOI: 10.1016/j.jhazmat.2014.10.014.

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