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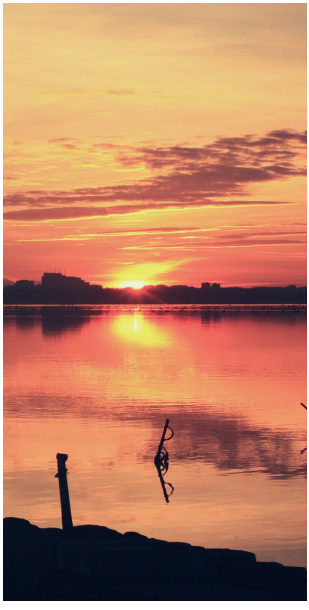
L'INNOVAZIONE NEL COMPARTO DELLE BONIFICHE E LE TRAIETTORIE DI SVILUPPO

LIBRO DEGLI ABSTRACT

A CURA DI VITO FELICE URICCHIO, SILVIA PAPARELLA E MARCO FALCONI

con le prefazioni delle Sottosegretarie al MiTE On. Ilaria Fontana, On. Vannia Gava e Gen. Giuseppe Vadalà



MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

Sistema Nazionale per la Protezione dell'Ambiente

ISPRA

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Libro degli abstract

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Direttore scientifico
Vito Felice Uricchio

Curatori
Vito Felice Uricchio, Silvia Paparella, Marco Falconi

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Indice

Microbial electrochemical Cr(VI) reduction in continuous flow system

Gabriele Beretta[1], Michela Sangalli[1], Elena Sezenna[1], Sabrina Saponaro[1], Anna Espinoza[2], Andrea Franzetti[2]

[1]Department of Civil and Environmental Engineering (DICA), Politecnico di Milano; [2]Department of Earth and Environmental Sciences (DISAT), Università di Milano-Bicocca.

Bioelectrochemical systems (BESs) are emerging technologies combining electrochemistry and biological methods. Consisting of biological reactors and two electrodes connected by an external circuit, they exploit the ability of certain bacteria to exchange electrons with solid substrates. These bacteria are called electroactive bacteria (EB). BESs applied to the remediation of contaminated soil have shown great efficacy to treat various pollutants: heterotrophic bacteria break down organic pollutants, including phenols, PAHs, and PCBs, into simple substrates which are oxidized by EB at the anode. The released electrons circulate to the cathode where other EB transfer them to a terminal electron acceptor (TEA), for example, oxygen or contaminants such as trichloroethylene and hexavalent chromium, that thus get reduced at the cathode. Bioelectrochemical technology is a versatile system that offers an adaptable platform for the removal of both organic pollutants and heavy metals from contaminated soils. The soil is a particularly complex and challenging environmental medium, as many factors, such as soil permeability, electrical conductivity, heterogeneous compositions, limited substrate mass transfer, and soil-contaminant interaction influence the pollutants' bioelectrochemical removal. To overcome these obstacles, different configurations of BESs have been proposed such as the single chamber, dual chamber, U-shape, and column type systems. In this study, a bioelectrochemical continuous flow (BECF) system with saturated Cr(VI)-contaminated soil has been set up to evaluate Cr(VI) reduction performance in comparison to an abiotic electrochemical system (AC) and an open circuit control (OC) to simulate natural attenuation mechanisms in aquifers.

During the first 20 days of operation, the systems were subjected to an initial concentration of 20 mg/l Cr(VI). A reduction in Cr(VI) concentration of more than 80% of the initial value was observed in all the systems. At the end of the test, the concentrations of dissolved chromium in the systems were 2.66 ± 0.13, 0.10 ± 0.01, 1.37 ± 0.07 mg/L in the AC system, the BECF system, and OCC, corresponding to Cr(VI) reductions of 86.7%, 99.5% 93.2% respectively. The trend in dissolved Cr(VI) concentration is similar in the various systems, but, differently than in both OCC and AC, in the BECF a reduction as high as 99.4% was observed on the ninth day of testing, demonstrating a faster removal rate than the controls. The average chromium removal rates in the 20 days of the test were found to be equal to 0.87, 1.00, and 0.93 mg l-1 d-1 respectively in the AC, the BECF, and the OCC.
Another test has been performed by increasing Cr (VI) dissolved concentration up to 50 mg/L, following a no-operation period for the columns of about 28 days. At the end of the test, the concentrations of dissolved chromium in the systems were 24.92 ± 1.25, 0.02 ± 0.01, 1.09 ± 0.05 mg/L, equal to removals of 26.3%, 99.9% 96.7% in the AC system, the BECF system, and the OCC. In BECF and OCC, despite in the first 70 days, the trends in chromium concentrations were similar with over 90% removal in both systems (93% in BECF and 91% in OCC), at longer times a divergence in the concentration trends was observed. Conversely, in the AC, Cr(VI) concentrations following a fast reduction to 20-25 mg/l remained pretty stable until the end of the experiment.
Bioelectrochemical chromium removal from saturated soil was performed in a continuous flow system. The tests have been benchmarked with controls tests and it was shown that the microbial electrochemical removal of Cr (VI) can occur, even without the addition of organic carbon and nutrients in a continuous system; the electroactive bacterial community development on the electrodes and closest to them allowed the treatment of hexavalent chromium highly contaminated soil and water. Furthermore, the tested lab-scale configuration could be considered for a future scale-up of the technology for in-situ soil remediation.

Email: gabriele.beretta@polimi.it