Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.10969

Electrokinetic remediation: A mixing and biogeochemical perspective

MASSIMO ROLLE[1,2] AND RICCARDO SPROCATI[1]

[1]Technical University of Denmark
[2]Technical University of Darmstadt
Presenting Author: masro@env.dtu.dk

Electrokinetic remediation is a promising technology that allows enhancing mass transfer rates in the delivery of reactants and/or in the mobilization of pollutants in contaminated soil and groundwater. The application of a low-intensity electric field in porous media results in effective transport mechanisms, such as electromigration and electroosmosis, which can be combined with chemical and biological reactions.

In this contribution we present the results of recent studies encompassing both laboratory investigation and field-scale modeling. In a series of multidimensional experiments, focusing on electromigration in saturated porous media, we demonstrate the controlling role of pore water chemistry on the delivery of different tracers and reactants [1,2]. The pore water composition strongly impacts the displacement, spreading and mixing of injected plumes of charged solutes moving by electrokinetics. Considering a strong oxidant reacting with a model organic compound, we also show that electrokinetic displacement leads to more reactive mixing and effective degradation compared to equivalent conditions in which transport occurred via advection and dispersion.

In a modeling study based on a pilot-scale application [3], we simulate electrokinetic transport combined with biodegradation of chlorinated ethenes in a shallow, low-permeability groundwater system. The model is based on a Nernst-Planck-Poisson formulation and allows describing the complex coupling between flow, transport, Coulombic interactions, pore water chemistry, degradation reactions and biomass dynamics. The results enable a detailed spatial and temporal description of enhanced amendment delivery and contaminant degradation in the field-scale domain. Quantitative metrics such as the relative area of delivery and the relative mass of contaminants in the system were proposed to analyze the performance of electrokinetic (bio)remediation.

[1] Sprocati et al. (2021), Environ. Sci. Technol. 55, 719-729; [2] Rolle et al. (2022), J. Contam. Hydrol. 244, 103933; [3] Sprocati et al. (2020), J. Hazard. Mater. 397, 122787.