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# Mathematical Modeling and Sensitivity Analysis on Cadmium Transport in Kaolinite under Direct Current Electric Field

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**Abstract**

Soil pollution is a challenging concern for environmentalists. Different remediation methods have been proposed to remediate polluted soils. Most of the existing methods cannot purify low permeable soils. Electrokinetic remediation (EKR) is an effective method which can remediate fine-grained soils. Understanding the physicochemical phenomena of the EKR is necessary to achieve efficient experimental framework. Therefore, the present study aims to introduce a theoretical and mathematical model for the EKR process. In the present model, different transport phenomena including ion migration, electroosmotic flow, and diffusion were considered. In addition, Chemical reactions such as adsorption/desorption, precipitation/dissolution, water autoionization reaction, and electrolysis reaction were considered. For modeling purpose, a set of partial differential and algebraic equations were used to model the remediation process. The implicit finite difference numerical model showed a good capability of simulating the EKR process. The sensitivity analysis on the retardation and tortuosity factors represented that the retardation factor had a considerable effect on the pH and cadmium concentration profiles. Although tortuosity factor did not have a significant impact on the pH profile, it had a non-negligible effect on the cadmium concentration profile.

*Keywords:* Numerical Model; Finite Difference; Chemical Reaction; Electrokinetic; Cadmium; Sensitivity Analysis.

## 1. Introduction

Soil pollution is one of the most important concerns for environmentalists. Contaminants such as heavy metals, organic matters, and radionuclides threat soils and sediments. Various methods including bioremediation, thermal remediation, soil vapor extraction, soil washing, soil flushing, electrokinetic remediation (EKR) have been introduced to purify contaminated lands [1]. Among them, EKR has shown to be a practical method to remedy low permeable soils (e.g., clays and silts) [2–6]. In the EKR process, application of low direct current (DC) into the soil medium leads to contaminants transportation by different transport phenomena such as electro-migration, electroosmotic flow, and electrophoresis. Electro-migration is the transport of ions and charged complexes under an electric field which is the main mechanism for transportation of heavy metals. Electroosmotic flow is the movement of pore water through a porous medium of soils as a subsequence of the electric field, and it is the main factor for removing neutral contaminants (e.g., organic matter) [7]. Electrophoresis is the movement of charged colloidal size particles and bound contaminants under an electric field [8] and becomes significant in the EKR when surfactants are used to enhance the EKR process, or when the technique is employed in the remediation of slurries [9].

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