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Electrical Tortuosity across Electrokinetically Remediated Soils

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Abstract : Electrokinetic remediation is one of the most influential and effective methods to decontaminate contaminated soils. Electroosmosis and electromigration are the processes of electrochemical extraction of contaminants from soils. The driving force that causes removing contaminants from soils (electroosmosis process or electromigration process) is voltage gradient. Therefore, the electric field distribution throughout the soil domain is extremely important to investigate and to determine the factors that help to establish a uniform electric field distribution in order to make the clean-up process work properly and efficiently. In this study, small-sized passive electrodes (made of graphite) were placed at predetermined locations within the soil specimen, and the voltage drop between these passive electrodes was measured in order to observe the electrical distribution throughout the tested soil specimens. The electrokinetic test was conducted on two types of soils; a sandy soil and a clayey soil. The electrical distribution throughout the soil domain was conducted with different tests properties; and the electrical field distribution was observed in three-dimensional pattern in order to establish the electrical distribution within the soil domain. The effects of density, applied voltages, and degree of saturation on the electrical distribution within the remediated soil were investigated. The distribution of the moisture content, concentration of the sodium ions, and the concentration of the calcium ions were determined and established in three-dimensional scheme. The study has shown that the electrical conductivity within soil domain depends on the moisture content and concentration of electrolytes present in the pore fluid. The distribution of the electrical field in the saturated soil was found not be affected by its density. The study has also shown that high voltage gradient leads to non-uniform electric field distribution within the electroremediated soil. Very importantly, it was found that even when the electric field distribution is uniform globally (i.e. between the passive electrodes), local non-uniformity could be established within the remediated soil mass. Cracks or air gaps formed due to temperature rise (because of electric flow in low conductivity regions) promotes electrical tortuosity. Thus, fracturing or cracking formed in the remediated soil mass causes disconnection of electric current and hence, no removal of contaminant occur within these areas.

Keywords : contaminant removal, electrical tortuousity, electromigration, electroosmosis, voltage distribution
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