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Evaluation of electrode configuration and mode of DC power for improvement of electrokinetic soil remediation

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Electrokinetic soil remediation is also called electrokinetic soil processing, electroreclamation, and electrochemical decontamination. The electrokinetic technique needs a low-level direct current of the order of mA/cm2 between electrodes to remove contaminants. The electrokinetic technique is one of the most promising remediation processes, and offers high efficiency and time effectiveness in the decontamination of low-permeability soils contaminated with heavy metals, radionuclides, or organic compounds. The significance of this technique is attributed to its low operational cost and potential applicability to a wide range of contaminant types, and these benefits have resulted in the initiation of numerous studies into its use for waste remediation.
Electrode configuration is crucial for cost-effectiveness and overall efficacy of the elelectrokinetic processing, particularly in its field implementation. We investigated the effectiveness of various electrode arrays which can be grouped into one-dimensional (1-D) and two-dimensional (2-D) ones. Normally, the DC electricity of full wave has been used to remove contaminants from soils using elelectrokinetic processing. However, application of half-wave DC power can be also taken into account to improve efficacy of the processing, because it generates pulse power and accelerates the migration of contaminants within soils. We empirically evaluated the effect of type of DC electricity on the overall performance of the electrokinetic soil processing.
The 1-D configuration with 5 electrode pairs showed the least total electric power, but that consumed in only the soil cell was less in the 2-D arrays than in 1-D ones. Particularly, most of the electric power is likely to be consumed in the electrode compartments, and the electric resistance in the electrode parts should be reduced to save the electric energy cost in the whole processing. In terms of removal efficiencies of 5 heavy metal contaminants, overall efficiency was higher in the 2-D arrays than in the 1-D ones, and it is caused by the fact that the migration of heavy metals is enhanced towards cathode in the 2-D configuration because the current density increases in that direction due to nonlinear electric fields. Comparing removal efficiencies between Cu and Pb, the half-wave DC seems to be more effective in removing Pb, whereas Cu was more efficiently removed by the full-wave DC than by the half-wave DC power. This difference is likely to be caused by the two coupled reasons: difference in chemical fractionations of two heavy metals and difference in features between two kinds of DC electricity. The results suggest that the types of DC electric power as well as combination between them should be evaluated to improve overall efficacy and economy of whole electrokinetic processing for soil remediation.