Kossge International Symposium on Soil & Groundwater Environment
October 27-28, 2005 Mayfield Hotel, Seoul, Korea

In Situ Electrokinetic Remediation FOR THE REMOVAL OF Contaminants from Soil and Groundwater

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ABSTRACT

This paper presents a study on an in situ electrokinetic remediation coupled with permeable reactive barrier filled with reactive material for remediation of groundwater contaminated with heavy metal and organic substance. A series of field experiments including variable conditions such as concentration of contaminants, magnitude of applied electrical current, operating duration, and applications of reactive materials were performed with the contaminated groundwater. Investigated are volume of water flow through soil specimen, and the concentration changes of soil specimen, and the concentration changes of groundwater inflow and outflow. The efficiency of heavy metal and organic substance removal by the proposed method was evaluated under various operating conditions. The field test setup used in this study was made to combine the electrokinetic processor with permeable reactive barrier processor. The elecrokinetic with permeable reactive barrier processor consists of four parts: anode electrode, cathode electrode, electric power supplier, and permeable reactive material. TCE and Cd were used as a surrogate contaminant to demonstrate the groundwater and soil contaminated by heavy metal and organic substance. The tests were conducted for two conditions: electrokinetic remediation test (EK) and electrokinetic with permeable reactive barrier test (EK+PRB). In the tests, the clay soil specimens were thoroughly mixed with TCE of 300ppm and Cd of 300ppm. The test specimen was then subjected to electric power at 2.0V/cm from electrokinetic test setup.

It shows big difference in recovery (total amount of contaminant after /before test) by the coupled effect of electrokinetic and permeable reactive barrier. In the case of soil contaminated with TCE, the recovery in effluent appeared 85% for electrokinetic test but the recovery in effluent appeared 20% for electrokinetic with permeable reactive barrier test. In

the case of soil contaminated with Cd, the recovery in effluent appeared 90% for electrokinetic test but the recovery in effluent appeared 70% for electrokinetic with permeable reactive barrier test. The recovery difference of EK test and EK+PRB test is 65% in TCE case and the recovery difference of EK test and EK+PRB test is 20% in Cd case This result shows that the reduction rate of TCE migrated from soil specimen by the reaction of reactive material with atomizing slag in anode container is higher than the reduction rate of Cd. The figure presents the concentration of TCE and chloride ion in effluent water. The concentration of TCE is higher in the case of EK test than that in the case of EK+PRB, otherwise the concentration of chloride is lower in the case of EK test than that in the case of EK+PRB due to reduction of TCE by the reaction between TCE and reactive material. The figure presents the concentration of Cd in effluent water. The concentration of Cd is higher in the case of EK test than that in the case of EK+PRB. The removal rate of Cd in soil specimen is slightly higher than that of TCE due to electro osmosis and additional electro migration effect of positive charge contaminant, but the recovery rate of Cd in effluent is lower than that of TCE due to high reduction of TCE by the reaction of reactive material. From this research, the coupled technology of electrokinetic with permeable reactive barrier will be very effective to remove the contaminant in the subsurface without extraction of the contaminant from subsurface to the ground due to adsorption and reduction of contaminant in the permeable reactive barrier.

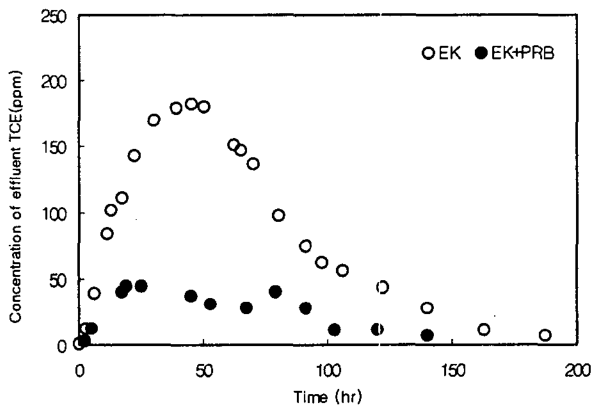

Figure 1. Concentration of TCE in effluent solution

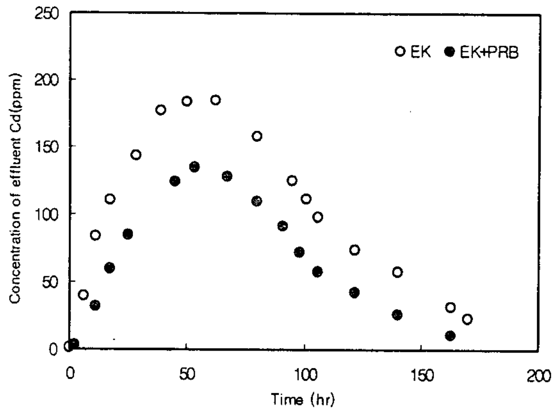

Figure 2. Concentration of Cd in effluent solution