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Effects of precipitation on the low-frequency electrical properties of zero valent iron: implications for monitoring PRBs

Jaeyoung Choi (1), Won-Hyun Ji (2), Jung-Seok Yang (1), Jeong-Gi Um (3), Ik Woo (4), Ju-Young Lee (1), and Young-Tae Park (1)

(1) Korea Institute of Science and Technology (KIST), Gangneung Institute, Gangneung, South Korea (fiam3620@hotmail.com), (2) Institute of Mine Reclamation Technology, Seoul, South Korea, (3) Pukyung National University, Pusan, South Korea , (4) Kunsan National University, Kunsan, South Korea

The relatively recent development of permeable reactive barrier (PRB) has provided a potentially viable alternative to established pump-and-treat systems for remediation of chlorinated solvent contaminated groundwater. Non-invasive methods for the assessment and monitoring of PRB have been required for evaluating long-term PRB performance and allowing effective management decisions regarding in situ site cleanup. The presence of metal in the subsurface results in the following additional charge transfer mechanisms (a) electronic conduction in the metal (b) polarization of charges at the interface between a metal and the pore-filling electrolyte. Both these mechanisms profoundly modify the measured electrical properties of the subsurface and support the utilization of electrical measurements for investigating PRB. Low frequency (0.1-1000 Hz) electrical properties are sensitive to the surface chemistry of metals in subsurface environment. In this range, electrical properties are controlled by ionic conduction through the electrolyte, surface electronic or ionic conduction, as well as diffusion mechanisms that occur at the mineral surface-pore fluid interface. Oxidation-reduction reactions may transfer electrons between mineral and fluid. The magnitude of polarization is directly related to the amount of metallic mineral surface available for charge transfer. The frequency dependence of the low frequency electrical response is indicative of the nature of electrochemical reactions occurring at the grain-fluid interface. Numerous experimental studies confirm that the frequency at which imaginary conductivity peaks inversely correlates with the grain size of the metallic particles. It is thus possible that the numerous complex surface chemical reactions involved in chlorinated solvent degradation may have distinct frequency dependent electrical signatures. In addition to the polarization term, the conduction term may also contain valuable information on PRB performance.