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Rational Surfactant Selection and Optimization of Surfactant Solution Parameters for Surfactant-Enhanced Soil Washing of Industrially Contaminated Soils in Korea

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ABSTRACT

Surfactant-enhanced soil washing (SESW) is emerging as successful and cost-efficient technology for removal of petroleum hydrocarbons from soil in Korea. The objectives of this study were to select potentially suitable surfactants that solubilize TEX (toluene, ethylbenzene, and xylene) present as a contaminant and to evaluate the optimal range of process parameters that can increase the removal efficiency in SESW and to present results obtained from full-scale SESW in field. Thirteen different surfactants were obtained from nine companies. Used experimental methods in surfactant selection were separatory funnel experiment and shaker table agitation / centrifugation experiment. The process parameters for SESW were surfactant solution concentration, surfactant solution pH, and temperature of surfactant solution.

In the surfactant pre-selection, five of the thirteen surfactants were judged to be less suitable on the basis of their properties (surfactant types, toxicity, HLB (Hydrophilic-Lipophilic Balance), CMC (Critical Micelle Concentration) and solubilization effectiveness). In the separatory funnel experiments, these eight different surfactants were reduced to four. The four suitable surfactants were DOSL (anionic), SDS (anionic), Brij 35 (nonionic), T-Maz 60 (nonionic). In the shaker table agitation / centrifugation experiments, these four different surfactants were reduced to one (T-Maz 60). The highest recovery (99 %) of the toluene was obtained using a nonionic surfactant (T-Maz 60) in the shaker table agitation / centrifugation

experiments. Used test methods may be very useful for rapidly selection of surfactants.

The batch tests showed that an optimum condition was achieved for surfactant solution concentration of 4 % (v/v), surfactant solution pH of 7.5, and surfactant solution temperature of 25 degrees Celsius. An optimal range was determined for each parameter under given washing conditions. The maximum removal of TEX (98 %) was obtained when optimal conditions were simultaneously met in full-scale SESW operations. The increased removal efficiencies by optimum conditions of TEX was about 25 % greater than that which could be obtained by SESW with non-optimum conditions. These results confirm the viability of SESW for treating contaminant soils. The optimum conditions of these parameters are expected to be in practical use in SESW and are essential for reducing cost in surfactant-assisted remediation.

Keywords: SESW, TEX, Selection of surfactants, Optimum condition, Maximum removal