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Feasibility of sulfidated zero-valent iron activated persulfate in in situ treatment of soils contaminated with organics.

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Sulfidated microscale zero-valent iron (S-mZVI) and persulfate system was evaluated for treating a soil contaminated with phenol in situ. In order to enhance the reactivity and stability of mZVI, S-mZVI was synthesized using a mechanochemical ball milling process. X-ray powder diffraction and X-ray photoelectron spectrometry successfully confirmed the presence of sulfide species on the surface of S-mZVI. An optimum molar ratio of sulfur to Fe(0) that was associated with the greatest persulfate activation performance appeared to exist around 0.12. Complete removal of phenol within 30 min was observed at the molar ratio of persulfate to S-mZVI of 2 to 1 in the soil slurry experiments that were designed to provide conditions similar to those observed during in situ soil remediation. Phenol removal was favored in the acidic condition over neural or alkaline condition. Phenol removal was hampered when the fine soil (silty clay) was subject to S-mZVI/persulfate. A high concentration of soil organic matter was mainly responsible for this lower reactivity due to the increased persulfate demand. Finally, a 3-L scaled-up reactor was used to test the feasibility of S-mZVI/persulfate system in treating soils contaminated with phenol in an in situ soil mixing scenario that simulated auger mixing at the soil to water ratio of 1:1. Complete removal of phenol was also obtained in this experiment with the higher doses of S-mZVI and persulfate as compared with the doses used in the previous soil slurry experiments. The scaled-up reactor revealed that initial soil mixing duration and mixing intensity would be critical operating variables in the execution of the field work.