Fenton Reaction as a Tool for In-Situ Contaminant Remediation – Laboratory Analysis on Fit for Purpose

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Numerous studies have demonstrated Fentons oxidation in batch aqueous systems in the absence of porous media representing traditional Fenton's chemistry of low pH, low oxidant concentration and soluble iron (Fe^{2+}) catalyst. Extrapolation of results from batch aqueous systems can deliver misconstrued data for dynamic field conditions. Considering that, the specific objectives are to study the 1) transformation and utilization of Fenton catalyst ($Fe+H_2O_2$) under different flow conditions 2) feasibility of Fenton reaction for in situ phenol degradation under various geochemical configurations 3) influence of Fe catalyst distribution and H_2O_2 location and 4) degradation efficiency and sustainability of the system by increasing the residence time without the addition of fresh Fe catalyst. All these are first of its kind representing the application of Fenton reagent in subsurface treatment system. In addition, mineralogical studies were conducted at various depths of the columns using AT-FTIR and XRD in order to identify the accumulation of reaction products.

The catalyst emplaced in porous media to effectively degrade phenol at circum-neutral pH is successfully demonstrated using continuous aqueous column studies. Different column configurations varying in ZVI distribution, location of H_2O_2 and extended retention time investigated to implement sustainable Fenton's oxidation in actual fields is first of its kind. Fe particles contributed 61-84% interaction between Fe^{2+} ions and H_2O_2, promoted good radical generation and sustained continuous corrosion, invigorated effective Fe^{2+}-Fe^{3+} cycling, retained active iron surface area and circumvented precipitation and secondary sludge production. Additional sand-only columns proved that Fenton's oxidation in in situ porous media can be improvised by 14% to 34% without incumbent addition of Fe particles but only offering extended reaction time. Variation in flow rate and initial phenol concentration followed exponential transformation in phenol removal and active stage. The study addresses the major factors hindering the sustainability of Fenton's process in practical applications and provides a new dimension in reactive material selection and its limited usage.