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EFFECT OF NITRATE ON THE PENTACHLOROPHENOL DECHLORINATION WATER TREATMENT WITH ZERO VALENT IRON

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Pentachlorophenol (PCP) is a soil and groundwater contaminant and is listed as a priority pollutant by the USEPA due to its toxicity and persistence. Nitrate (NO_3^-) is a common groundwater contaminant arising from sources such as fertilizers, animal manure and septic tanks, which can pose health risks to animals and humans. Zero Valent Iron (ZVI) is a cost effective and readily available material, which can be used to treat water via PCP dechlorination as well as a reductive removal of NO_3^- from solutions. However, there is uncertainty regarding the effect of NO_3^- reduction on dechlorination of PCP by ZVI. This study used batch tests to investigate the effect of NO_3^- on PCP dechlorination using ZVI in the presence and absence of NO_3^- in solutions under anoxic conditions.

PCP dechlorination was assessed using gas chromatography-mass spectrometry and a ZB5-msi capillary column to quantify PCP as well as all dechlorination products formed. Concentrations of NO_3^- were determined using Ion Chromatography. Nitrate reduction by ZVI was accompanied by the accumulation of ammonia (NH_3-N) which was measured using the Salicylate Method, Nitrogen, Ammonia - Method 10031 and high range NH_3-N Test N Tube Reagent. Raman spectroscopy was used to identify the specific iron oxides formed on the ZVI surfaces.

In the absence of NO_3^-, PCP dechlorination increased over 25 days and resulted in the accumulation of tetrachlorophenols (TeCPs). The mass balance (*i.e.* PCP+TeCPs) accounted for ≈92% of the PCP initially added over the duration of the reaction. The presence of NO_3^- in the solution had a detrimental effect on PCP dechlorination. Nitrate competed with PCP for electrons and also led to a rapid formation of passive iron oxides (akaganeite, lepidocrocite, goethite) on the ZVI surface, which resulted in a significant decrease in PCP dechlorination. The PCP concentration decreased over time but there was no increase in dechlorination products resulting in a poor PCP mass balance (≈48% of the PCP added after 25 days).

Results show in the presence of NO_3^-, PCP removal from solution occurs mainly due to incorporation (sorption, co-precipitation and/or physical entrapment) of PCP with the iron oxides that form due to NO_3^- reduction with very little dechlorination evident. The rapid build-up of passive oxides resulted in decreased ZVI reactivity as well as incorporation of significantly higher amount of PCP and/or degradation products. Conversely, when only PCP was present in the solution, the predominant build-up of magnetite on the ZVI surface during the reaction further supports enhanced PCP dechlorination by ZVI (in the absence of NO_3^-).