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IMPACT OF THE PRESENCE OF A NATURAL BIOFILM ON MOBILITY AND REACTIVITY TOWARDS TETRACHLOROETHYLENE (PCE) OF NZVI USED FOR NANOREMEDIATION

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ABSTRACT

Remediation techniques for toxic/persistant contaminants in groundwater are often technologically difficult. Nanoparticles (NP) like nZVI (Zero-Valent Iron) applicable as *in-situ* reduction or oxidation agents for groundwater treatment give promising results. This study aims to evaluate the mobility and the reactivity towards PCE, a frequent groundwater contaminant, of nZVI in the presence or absence of biofilm by column assays mimicking aquifer conditions.

Biofilms were grown on sand using environmental groundwater samples as inoculum in nitrate reducing conditions. For mobility assays, suspensions of nZVI were injected into the columns and the outlet Fe concentrations monitored. Biofilm-nZVI interactions were characterized using SEM/STEM observations of sand after the NP breakthrough. Biofilms were further characterized using molecular approaches. For reactivity experiments, three columns were used to study the impact of the presence of a biofilm and of nZVI on the dechlorination of PCE in the nZVI reactive zone.

The predicted travel distances of nZVI are found to be 1.5 to 25 m for a 10 m d^{-1} flow. The presence of biofilm in the column decreased the total porosity of column from around 30% to around 15%. Though the recoveries of nZVI at the column outlet in the presence or absence of biofilm were similar, the analysis of the sand suggested nZVI-biofilm interactions (correlation TOC vs Fe concentrations, presence of aggregates). These interactions are confirmed by the SEM/STEM observations. Concerning reactivity experiments, it appeared that the dechlorination of PCE was slightly higher in the absence of biofilm (65% of PCE transformed into Cl^- vs 60% in the presence of biofilm), but anaerobic corrosion, characterized by evaluating the formation of H2 within the porous media, was greatly diminished in the presence of biofilm, suggesting (i) interactions between nZVI and biofilm, and (ii) a better longevity of nZVI in the presence of biofilm, and thus a better reactivity towards contaminant over time.

It appears finally that reactive NP, even if they can represent a source of emerging contamination, are very useful for *in situ* groundwater treatment. However, the presence of biofilm in the porous media could modify the mobility and reactivity of nZVI and should be considered when designing a nanoremediation treatment.

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