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Project Number
38452

Project Title
Treatment of Contaminated Groundwater with a Bioinspired Complex-Nanoparticle Hybrid Catalyst System

Abstract

Objectives/Goals
Growing scarcity of high-quality drinking water supplies across the globe heightens the need for innovative and sustainable technologies for drinking water decontamination and water-waste reuse. Perchlorate, a chemically inert but toxic oxyanion, has been widely detected in groundwater supplies and agricultural products in Southern California as a result of source water contamination from improper disposal of explosive materials, use of contaminated fertilizers, and natural atmospheric processes. Other known contaminants in groundwater, such as NDMA and TCE that are connected with health concerns, have further accentuated the demand for developing effective technologies to remove ClO4- and related recalcitrant contaminants from groundwater.

Methods/Materials
Two separate experiments were conducted to compare the catalytic treatment of ClO4- in two different water matrices: DI water artificially spiked with ClO4- and raw groundwater. Briefly, 100 mg of Pd/C and 0.25 mg of NH4ReO4 stock solution were mixed together in a solution of 50 mL of DI water/50 mL of groundwater in a 50-mL round bottom flask capped with a rubber stopper. Collected aliquots of suspension were immediately filtered and analyzed (using ion chromatography) for residual ClO4- concentration at specific time intervals after initiating the batch reaction. A total of three trials were conducted for each water matrix.

Results
The catalyst system successfully completed ClO4- reduction in both the DI water and groundwater matrix. In the DI water matrix, the catalyst reduced ClO4- to 1.02% of the original concentration in 60 minutes. In the groundwater matrix, the catalyst reduced ClO4- to 1.74% of the original concentration in 120 minutes. The experiments also revealed that the catalyst reduces ClO4- more thoroughly in DI water than it does in groundwater. In DI water, 99.9% of the perchlorate was reduced while only 98.3% of the perchlorate was reduced in the groundwater matrix.

Conclusions/Discussion
The results disproved our hypothesis. The catalyst system showed a slower rate of reaction in the groundwater matrix relative to the DI water matrix. This may be due to the fact that the groundwater matrix contains numerous contaminants in addition to perchlorate which may also react with the catalyst. However, demonstrating the catalyst#s success provides an alternative method that is more efficient in treating contaminated groundwater.

Summary Statement
The project demonstrates the success of a new catalyst system in treating perchlorate contamination in groundwater more efficiently.

Help Received
Kamron Saremi taught how local water treatment facilities use different methods to treat contaminated groundwater, and their limitations. Dr. Jinyong Liu taught the fundamentals of the catalysts systems and also supervised the experiment at UCR.