Reductive Transformation of RDX in a Bench-Scale Simulated Aquifer

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The production and processing of military explosives has led to the contamination of soil and water by energetic compounds at more than 100 federal installations across the United States. Contaminants typically found at these sites include 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) and their transformation products. The use of in-situ biological degradation of these contaminants would provide significant cost savings over currently accepted treatment methods. Due to the mobility of RDX, it is the major contaminant of concern and the focus of this study.

A packed bed soil column study was conducted to examine the biologically mediated reductive transformation RDX using acetate as an electron donor/carbon source. The columns were inoculated with nitrate-reducing bacteria enriched from a municipal anaerobic digester sludge. Several experimental runs were conducted to examine conditions necessary to 1) poise the system for reductive RDX transformation, 2) assess varying electron donor / electron acceptor ratios, and 3) develop preliminary in situ transformation kinetics for the established RDX$\Rightarrow$ MNX $\Rightarrow$DNX $\Rightarrow$TNX transformation pathway. The results of various in-situ conditions evaluated were analyzed to ellucidate biotransformation parameters pertinent to cost effective field-scale application.

Significant results include RDX concentration reduction from 8 ppm to 56 ppb (99.3% removal), with a first-order reaction coefficient of 3.0 hr^{-1}. A build-up of MNX and DNX was not detected. Current results show a build up of TNX followed by much slower TNX degradtion to unidentified transformation products indicating potential rate limiting step for full scale implementation. Current first-order reaction coefficient for TNX is 0.017 d^{-1}. Additional studies are underway to examine effects of various electron donors on microbial community composition and biomass, and whole organisms toxicity of unidentified transformation products.