World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:18, No:07, 2024

Establish Co-Culture System of Dehalococcoides and Sulfate-Reducing Bacteria to Generate Ferrous Sulfide for Reversing Sulfide-Inhibited Reductive Dechlorination

Authors : Po-Sheng Kuo, Che-Wei Lu, Ssu-Ching Chen

Abstract : Chlorinated ethenes (CEs) constitute a predominant contaminant in Taiwan's native polluted sites, particularly in groundwater inundated with sulfate salts that substantially impede remediation efforts. The reduction of sulfate by sulfate-reducing bacteria (SRB) impairs the dechlorination efficiency of Dehalococcoides by generating hydrogen sulfide (H_2S), resulting in incomplete chloride degradation and thereby leading to the failure of bioremediation. In order to elucidate interactions between sulfate reduction and dechlorination, this study aims to establish a co-culture system of Dehalococcoides and SRB, overcoming H_2S inhibition by employing the synthesis of ferrous sulfide (FeS), which is commonly utilized in chemical remediation due to its high reduction potential. Initially, the study demonstrates that the addition of ferrous chloride ($FeCl_2$) effectively removed H_2S production from SRB and enhanced the degradation of trichloroethylene to ethene. This process overcomes the inhibition caused by H_2S produced by SRB in high sulfate environments. Compared to different concentrations of ferrous dosages for the biogenic generation of FeS, the efficiency was optimized by adding $FeCl_2$ at an equal ratio to the concentration of sulfate in the environment. This was more effective in removing H_2S and crystal particles under 10 times smaller than those synthesized under excessive $FeCl_2$ dosages, addressing clogging issues in situ remediation. Finally, utilizing Taiwan's indigenous dechlorinating consortium in a simulated high sulfate-contaminated environment, the biodiversity of microbial species was analyzed to reveal a higher species richness within the FeS group, conducive to ecological stability. This study validates the potential of the co-culture system in generating biogenic FeS under sulfate and CEs co-contamination, removing sulfate-reducing products, and improving CE remediation through integrated chemical and biological remediations.

Keywords : biogenic ferrous sulfide, chlorinated ethenes, Dehalococcoides, sulfate-reducing bacteria, sulfide inhibition
Conference Title : ICEIAM 2024 : International Conference on Environmental, Industrial and Applied Microbiology
Conference Location : Tokyo, Japan
Conference Dates : July 22-23, 2024