Bioremediation and Biodegradation of Chlorinated Solvents in Soil and Groundwater using a Biobarrier System

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ABSTRACT

Many methods have been developed to remove chlorinated solvents from soil and groundwater. The methods range from aerobic and anaerobic biodegradation to methanotrophs, and to food-grade surfactants. Anaerobic and aerobic microorganisms can be used to breakdown chlorinated solvents in soil and groundwater. (Chu et al. 2004) Methanotrophs can be used to biodegrade certain chlorinated solvents such as chloroform and trichloroethylene (TCE). (Speital and Closmann 1991) Solubilization and mobilization in porous media using food grade surfactants to remove chlorinated solvents has also seen a positive affect. (Shiau et al. 2000) Case studies involving "Brownfields" have shown that removal of chlorinated solvents in contaminated groundwater sources using reactive iron walls for tetrachloroethylene (PCE) and aerobic biodegradation for TCE, dichloroethylene (DCE), and vinyl chloride (VC). A biobarrier system has been found to be one of the most effective ways to reduce chlorinated solvents such as the fore mentioned. The biobarrier system can be comprised of peat, among others, to remove chlorinated solvents under normal and varying redox conditions. A single layer biobarrier and a two-layer biobarrier are explained and the advantages of each are cost-effective, virtually maintenance free, and near 100% degraders of PCE and its intermediates into ethylene (ETH).

KEYWORDS

Bioremediation, Biodegradation, Chlorinated solvents, Aerobic, Biobarrier, Cometabolism, Reductive Dechlorination

INTRODUCTION

Chlorinated solvents are common contaminants of unsaturated and saturated soil, ground water, and landfill leachate. These one and two-carbon chlorinated solvents are an environmental concern because they are used widely and are mobile in the environment and many are considered carcinogens. Chlorinated compounds come from use as solvents, cleaners, and degreasers to name a few. Some chlorinated compounds cannot be removed with bioremediation. The ability to biodegrade these chlorinated solvents decreases within each class such as methanes, ethanes, and ethenes as the degree of chlorination increases. The trichlorinated chemicals are the most likely to be degraded by methanotophs. However, carbon tetrachloride and tetrachloroethylene (PCE) have found to be non-biodegradable. On the other hand, chloroform, trichloroethylene (TCE), and trichloroethane (TCA) which are resistant to biodegradation but are still biodegradable. The most biodegradable ethanes are 1,2-dichloroethylene (DCE) and 1,2-dichloroethane (DCA). (Speitel and Closmann 1991)0

TCE, DCE, and vinyl chloride (VC) can be rapidly oxidized to form nontoxic end products of chloride ions and carbon dioxide by oxygenase-expressing cultures. Some of these degradations are metabolic, yield carbon for cell growth, while others are cometabolic, and provide nothing for cell growth. (Chu et al. 2004)