

Bioremediation of Groundwater Contaminants in India by Extremophiles

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ABSTRACT

Bioremediation is an emerging and sustainable approach for the treatment of environmental contaminants, including PFAS (Per- and Polyfluoroalkyl Substances) and TCE (Trichloroethylene), in contaminated soil, water, and groundwater in the major cities in India. For this purpose, specific bacteria can degrade TCE through a process known as anaerobic reductive dechlorination, where microbes reduce the chlorine atoms in TCE, breaking it down into less harmful compounds. Common bacteria involved in this process include *Dehalococcoides* and *Geobacter* species, which are known to be effective in breaking down these pollutants particularly in industrial zones and areas with contaminated groundwater. While bioremediation of TCE is more amenable to these microbes and are successfully applied in some parts of the world like Japan; PFAS removal is still under research and is facing challenges due to the chemical's persistence. To address this issue, extremophiles represent a promising frontier for PFAS bioremediation. *Dehalobacterium* and *Dehalococcoides* spp. can survive under extreme conditions such as high salinity, high pressure, or low temperatures. While extremophiles could offer innovative solutions in lab settings, scaling up their use for real-world applications (large groundwater treatment projects or contaminated industrial sites) presents challenges in terms of ensuring sufficient microbe size and their functional enzymes. Thus, advances in synthetic biology and genetic engineering could help optimize extremophiles for large-scale PFAS remediation efforts.

Keywords: Bioremediation, Trichloroethylene, PFAS, *Dehalobacterium* spp, *Dehalococcoides* spp.

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