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Multi-Criteria Optimal Management Strategy for in-situ Bioremediation of LNAPL Contaminated Aquifer Using Particle Swarm Optimization

Authors : Deepak Kumar, Jahangeer, Brijesh Kumar Yadav, Shashi Mathur

Abstract : In-situ remediation is a technique which can remediate either surface or groundwater at the site of contamination. In the present study, simulation optimization approach has been used to develop management strategy for remediating LNAPL (Light Non-Aqueous Phase Liquid) contaminated aquifers. Benzene, toluene, ethyl benzene and xylene are the main component of LNAPL contaminant. Collectively, these contaminants are known as BTEX. In in-situ bioremediation process, a set of injection and extraction wells are installed. Injection wells supply oxygen and other nutrient which convert BTEX into carbon dioxide and water with the help of indigenous soil bacteria. On the other hand, extraction wells check the movement of plume along downstream. In this study, optimal design of the system has been done using PSO (Particle Swarm Optimization) algorithm. A comprehensive management strategy for pumping of injection and extraction wells has been done to attain a maximum allowable concentration of 5 ppm and 4.5 ppm. The management strategy comprises determination of pumping rates, the total pumping volume and the total running cost incurred for each potential injection and extraction well. The results indicate a high pumping rate for injection wells during the initial management period since it facilitates the availability of oxygen and other nutrients necessary for biodegradation, however it is low during the third year on account of sufficient oxygen availability. This is because the contaminant is assumed to have biodegraded by the end of the third year when the concentration drops to a permissible level.

Keywords : groundwater, in-situ bioremediation, light non-aqueous phase liquid, BTEX, particle swarm optimization
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