Free-Hydrocarbon Plume Modeling: A Tool for Predicting Remediation Effectiveness in Vulnerable Shallow Aquifers

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ABSTRACT

Light non-aqueous phase liquids (LNAPL) represent one of the most serious problems in aquifers contaminated with petroleum hydrocarbon liquids (HC). LNAPL plume characterization and its potential recovery from the subsurface take special interest in vulnerable zones, where shallow groundwater levels are located beneath oil-industry facilities, like coastal regions of the Gulf of Mexico. We study the application of several remediation alternatives to recover an LNAPL plume, having as a case study a contaminated site affected by a diesel spill leaked from a HC pipeline, located at the western part of the Trans-Mexican Volcanic Belt. Local hydrogeological settings are similar to those presented in coastal areas: unconfined shallow aquifers formed by permeable materials in porous media. In order to investigate the feasibility of several technologies, the API/Charbeneau recovery modeling was performed, based on the geological properties and hydrogeological conditions of the aquifer with a multiphase transport approach in the vadose zone. Skimmer wells, bioslurping, dual-phase extraction, and trench recovery technologies were simulated. Results showed remarkable improvement of free-product recovery when simultaneous extra-phase (groundwater and/or air) was extracted from simulated wells in addition to the LNAPL lens. This methodology can be applied to other polluted aquifers with similar conditions in order to improve the management of contaminated sites in oil-industrial areas.

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