Oil Reservoir & Environmental Technologies

In situ Permeable Barrier for BTEX Remediation

Direct-push groundwater circulation wells (DP-GCW) are a promising technology for remediation of groundwater contaminated with dissolved hydrocarbons and chlorinated solvents. In these wells, groundwater is withdrawn from the formation at the bottom of the well, aerated and vapor stripped, and injected back into the formation at or above the water table. Previous field studies have shown that: (a) GCWs can circulate significant volumes of groundwater; and (b) GCWs can effectively remove volatile compouonds and add oxygen.

A system of DP-GCWs has been developed and field tested for remediation of volatile organics such as benzene, toluene, ethylbenzene, and xylenes (BTEX). The GCWs were constructed with No. 20 slotted well screen (2.4 cm ID) and natural sand pack extending from 1.5 to 8.2 m below grade. Air is introduced ~ 7.5 m below grade via 0.6-cm tubing. Approximately 15% of the vertical length of the air supply tubing is wrapped in tangled mesh polypropylene geonet drainage fabric to provide surface area for biological growth and precipitation of oxidized iron. These materials were selected to allow rapid installation of the GCWs using 3.8-cm direct push Geoprobe® rods, greatly reducing well installation costs.

Laboratory testing of these sparged wells and computational fluid dynamics (CFD) modeling showed that these wells, although using only about 1 L/min of air, could circulate about 1 L/min of water through the surrounding aquifer. This flow was sufficient to capture all of a flowing contaminant if the wells are sufficiently close together, about 1 meter on center depending on the air flow rate supplied, in a line across the plume. The CFD work showed the details of this ability to capture, and also showed that unforeseen heterogeneities in the aquifer such as a gradient of permeability or a thin impermeable layer (such as a clay layer) did not prevent the system from working largely as intended.

The system was tested in a petroleum contaminated aquifer near Rocky Point, NC. The contaminant plume there is approximately 10 m deep, 50 m wide and contains up to 4 mg/L total BTEX and 75 mg/L dissolved iron. An extensive pilot test was first performed to estimate the zone of influence for a single well. At this site an air injection rate of 1.2 L/min resulted in a water flow rate of 1 to 2 L/min based on bromide dilution tests in the GCW. The GCW increased the dissolved oxygen concentration in the discharge water to between 6 and 8 mg/L and reduced contaminant concentrations to less than 20 µg/L total BTEX. Monitoring results from a 73-day pilot test were then used to define the zone of influence for a single DP-GCW and to design a full-scale barrier system.

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