In Situ and On-Site Bioremediation of MTBE

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Background/Objectives. An industrial site close to Antwerp, Belgium, is contaminated with a variety of contaminants, including methyl-tert-butyl ether (MTBE), monochlorobenzene and other aliphatic and aromatic hydrocarbons. Most of the contamination is difficult to reach due to the infrastructure and the presence of storage tanks. A field test was conducted to investigate the feasibility of treating the different contaminants in-situ with aerobic bioremediation. Due to the mobile character of MTBE and the size of the plume, also a specific MTBE-bioreactor designed by VITO, was applied.

Approach/Activities. The field test consisted of two pilot tests, performed at the site in different areas at the site. Pilot 1 was conducted in an uncontaminated part of the site to test the radius of influence of the biosparging system. The system consisted of two air infiltration wells and nine monitoring wells. Pilot 2 was conducted in the contaminated part of the site to test the feasibility of stimulated aerobic biodegradation. The system consisted of four extraction wells, five infiltration wells, four monitoring wells and thirteen air infiltration wells. Groundwater was being circulated continuously. A soil vapor extraction system was installed in the vadose zone, mainly to prevent emissions due to the biosparging (i.e., volatilization). The MTBE bioreactor was fed from groundwater extraction well and the effluent was infiltrated in one of the infiltration wells. Besides the concentrations of the contaminants and methane, the dissolved oxygen concentration, redox potential and nitrogen and phosphorus were carefully monitored.

Results/Lessons Learned. Due to the high levels of methane that were present, the biosparging system was started up gradually for safety reasons. In the first months the concentration of most contaminants decreased significantly, however, the redox conditions improved only slowly. Additional tests indicated that the soil oxygen demand was extremely high therefore it was decided to install additional air infiltration wells after 9 months. The radius of influence of the air infiltration system appeared to be around 6 m.

The MTBE bioreactor had a removal efficiency up to 98%, however the flow was limited by the high oxygen demand of the groundwater and the rather low influent concentrations (±. 1000 µg/L). A part of the high COD/BOD was caused by a formerly unknown contaminant, that appeared to be a C9-acid. To confirm biological degradation at higher MTBE concentrations, the MTBE reactor was spiked continuously for a short period of time with influent concentrations of ± 4000 µg/L. Both MTBE and TBA were degraded with > 99% efficiency in the bioreactor to concentrations below detection limit.

The in situ MTBE removal efficiency was in the range of 56-76%, with maximum starting concentrations of 15,000 µg/l. It was however remarkable that in-situ MTBE degradation was significantly higher (93 %) closer to the infiltration well were the effluent from the MTBE reactor was infiltrated than in the wells further away, indicating the additional effect of bioaugmentation.

At the moment a full-scale remediation system is being designed and the lessons learned are implemented.