C-Sparge Ozone for Rapid Removal of MTBE/Benzene

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A system called C-Sparging™ which uses ozone/air injected periodically in conjunction with a pulsing pump has been demonstrated to reduce MTBE from over 1000 ppb to less than 100 ppb in less than 40 days. The rate of decay was found to be a ten-fold reduction in monitoring wells located 3 to 7 meters from the injection point. Monitoring was performed weekly during and after treatment.

What is C-Sparging™?

The KVA process of C-Sparging™, in situ air stripping with micro-encapsulated ozone, combines three- unit operations offering a one-two-three punch to knockout MTBE. Firstly, fine bubbles with a high surface-to-volume ratio are injected into the saturated zone to extract dissolved MTBE from contaminated groundwater. Secondly, ozone contained within the bubble and thin film around the bubble reacts extremely rapidly to decompose the MTBE into simple products, alcohols, acetate and formate. Thirdly, the residual oxygen from the reaction encourages bioremediation which consumes the breakdown products and converts them to carbon dioxide (CO2) and water (H2O).

Ozone Microsparging is a Patented Technology for In Situ Treatment of Volatile Organic Compounds (VOCs) in Groundwater

The reaction detoxifies groundwater containing MTBE and BTEX compounds, specifically benzene, rapidly to groundwater standards without producing harmful byproducts. The reaction is produced with very low ozone concentrations-molar ratios-compared to VOC concentrations in groundwater. The technology combines the unit operations of air stripping and oxidative decomposition in a single process which can be catalytically accelerated. In the C-Sparge™ process, air and ozone are injected directly into groundwater through specially-designed spargers to create "microbubbles" that have very high surface area-to-volume ratio. The Henry's Constant which regulates the partitioning of MTBE from aqueous to gaseous state is about one-tenth that of benzene derivatives. However, the surface-to-volume ratio increase of over 30-fold compensates to promote rapid in situ stripping of MTBE. As the "microbubbles" rise within a saturated column of groundwater, they extract or "strip" the VOCs from aqueous to gas partitioning. Upon entering the microbubbles, MTBE and BTEX compounds react with ozone in the gaseous state or in the aqueous "thin layer" surrounding the bubble to decompose. MTBE is rapidly degraded with time. The rate of decay is similar to that previously reported by Karpel vel Leitner, et. al. (1994). In both bench-scale testing and field testing, ozone microbubbles appeared effective in reducing MTBE concentrations to beyond 90% of original levels (Kerfoot, 2000). The rate of removal has been sensitive to ozone concentration, pressure, and iron silicate content.

Site Specific System Set-up

A single C-Sparger® master unit with 6 Spargepoints® was installed upgradient of plume region. The unit can be installed with a dual-screened recirculation spargewell which has a lower Spargepoint® or with isolated Spargepoints®. The depth to groundwater was 2 to 3 meters. The general construction of a C-Sparge® consists of a 100 mm casing leading to a 1.5 meter screen with 0.5 meter above the water table, a blank casing which was bentonite-sealed in the annular space to prevent short-circuiting, and a lower 1.5 meter screen (10 slot). Alongside this was a 1.5 cm diameter tubing leading from the wellhead region to a 50 mm microporous Spargepoint® 46 cm long with a compression fitting situated below the lower double screen.

The predominant soil type was gravelly sands. Water table level occurred at 2 to 3 meters. The predominant contaminated region extended vertically from 1 to 3 meters deep. The Spargepoints® were installed at a depth of 10 meters.

Procedure Documents Quick Results

Initial results of the treatment were monitored by three indicators:

- VOC removal by groundwater sampling from monitoring wells and certified laboratory analysis.
- Dissolved oxygen (D.O.) field determinations on groundwater grab samples from monitoring wells.
- Oxidation-reduction potential (ORP) field determinations on groundwater grab samples.

Groundwater sampling showed an immediate rise in concentration of MTBE and benzene due to mixing followed by a progressive drop in concentration. The agitation of the groundwater and capillary pores by the fine bubbles often strips adsorbed fractions. The mixed concentrations are often a better measure of total mass for treatment than solely the aqueous fraction. The concentrations of MTBE from monitoring wells placed at 3 meters' and 4 meters' distance from the Spargepoint® rose to 1300 and 550 ppb before converging to less than 100 ppb for a removal efficiency of 99.9% and 99.8% respectively after 5 ‡ weeks of operation. Benzene rose to a high of 4300 ppb before dropping to below 700 ppb for 99.8% removal efficiency over 5 ‡ weeks.

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