Biosparging Success in Confined Aquifers Using Chimneys as Subsurface Bioreactors at a BTEX Site in Gillette, Wyoming

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Background/Objectives. Biosparging is a proven approach for aromatic and aliphatic hydrocarbons, but if the treatment is to occur in a confined aquifer, provisions are needed to draw the injected air away from the zone of treatment. Without this, confined sparging can simply transfer COCs to another zone, air can become trapped and thereby impede groundwater flow, and pressurized air can cause geysering of air and water in nearby monitoring wells. An approach using columns of pea gravel chimneys was successful at providing air pathways through the confining layer at this site, and were discovered to be successful at degrading the sparged vapors, such that the vapor collection system legally operated without air treatment after six months.

Approach/Activities. To provide channels that would allow the sparged air to travel through the finer-grained sediments and prevent the air from becoming trapped, 38 hollow-stem auger borings were dug, and backfilled with pea gravel from 4 to 50 feet. A 2-inch PVC well screen was placed from 4 to 14 feet, and connected to a vapor header running in eight trenches that also carried the pressurized air lines for 12 sparge wells. The chimneys were about 10 to 15 feet apart; the sparge wells about 25 feet apart. The system started up in January 2016, and has been operating since.

Results/Lessons Learned. In the deepest part of the site, where the soils were coarse enough for treatment by conventional sparging, concentrations dropped quickly and remain low. We also learned that deep sparge flows should stay below 5 cfm, to avoid sending air laterally to wells outside the treatment zone. Wells screened in the shallow saturated zone initially showed evidence of being quickly affected by sparging, including a sharp drop in concentrations and a rise in DO and ORP. After this initial result, these wells reverted to more anaerobic conditions, believed to be caused by biological clogging at small sand seams where these intercepted the chimneys. Chimney monitoring at the system manifold showed the removal of hydrocarbons and oxygen initially; after 3 weeks chimneys began to show carbon dioxide at 2% to 5% (after dilution from perimeter chimney vents). The total mass treated by extraction (based on PID) and by in situ dilution (inferred from carbon dioxide readings) showed that in situ treatment accounted for 83% of the remediation. Ten shallow sparge wells were recently added and shallow treatment has accelerated.