Mass Balance Confirmation of Bioventing Operations of Aerobically Degradable Hydrocarbons

Frank T. Barranco, Jr. (fbarranco@eaest.com) and Samantha Saalfield (ssaalfield@eaest.com) (EA Engineering, Science, and Technology, PBC, Hunt Valley, Maryland, USA)
Jason McNew (jmcnew@eaest.com) (EA Engineering, Science, and Technology, PBC, Abingdon, Maryland, USA)

Background/Objectives. Bioventing is an established and proven technology that is often employed at petroleum-impacted sites to readily biodegrade, under oxygenated conditions, contaminants that will undergo aerobic oxidation without addition of inorganic nutrients or other amendments. Rarely, however, is bioventing treatment performance evaluated by full mass balance of contaminant mass destruction, computed with pre-and post-treatment sampling of affected media, compared with mass destruction rate estimates, computed from respirometry results. Such a study was conducted at the Maryland Sand, Gravel, & Stone NPL Site, where bioventing treatment was conducted for a suppressed water table condition within an unconfined aquifer. Bioventing was performed at a location within this aquifer where soils, following a treatment phase of ex situ Low Temperature Thermal Desorption (LTTD), were backfilled and compacted. The bioventing zone of treatment also incorporated in situ soils underneath and on the periphery of LTTD-treated soils.

Approach/Activities. The bioventing system functioned to aerobically degrade residual hydrocarbon contaminant mass that remained in the unconfined aquifer and peripheral soils following completion of soil remediation activities (i.e., excavation, LTTD, and backfill of treated soils) by maintaining increased oxygen levels in the areas directly surrounding the LTTD-remediated source areas. The bioventing system introduced oxygen via regenerative blowers to the subsurface under positive pressure to enhance aerobic oxidation of aerobically degradable hydrocarbons. To facilitate aerobic unsaturated conditions, dewatering to depress the water table was maintained throughout the duration of the bioventing over five years. The types of chemical data on hydrocarbons collected over this timeframe (prior to, during, and following bioventing) included: 1) post-LTTD soil concentration, 2) proximal groundwater concentration, and 3) soil gas concentration, including respirometry results of oxygen and carbon dioxide. Following shutdown of the system, a rebound evaluation was conducted to confirm adherence with specific performance objectives and cleanup goals.

Results/Lessons Learned. Collection of a wide range of chemical data across media types and operational timeframes allowed for computation of a full mass balance of hydrocarbon destruction via biological aerobic oxidation during bioventing. Total hydrocarbon mass at the start of bioventing was calculated from post-LLTD soil concentration and the volume of backfilled soil. Soil-to-vapor equilibrium partitioning estimates with Henry's Constant were employed to compare computed hydrocarbon vapor estimates to respirometry results of oxygen degradation. Volatilization estimates over the timeframe of bioventing were computed to normalize data as a loss mechanism. Findings of the mass balance will be presented as means to illustrate the performance of the bioventing system as well as to validate the rate kinetics of observed aerobic respiration for the specific hydrocarbons of interest within this study.