Analytical Element Method and Soil Gas Measurements Applied to Biovent System Compositional and Rate Performance

Andrew Kirkman (bp North America)
Jorge Montoy (Sovereign Consulting)
M Del Ciello (Sovereign Consulting)

Bioventing of a hydrocarbon source area was undertaken at a former refinery initially in a 0.15 acre area and then expanded to multiple acres. As improved understanding of microbiological degradation of source zones is evolving, improved methods to monitoring remedial performance are needed. Natural source zone depletion has been monitored using soil gas and temperature-based methods.

Approach/Activities. Here we employed temperature and soil gas to bioventing. Upon identifying that temperature lagged soil gas in indicating subsurface conditions, soil gas became the focus. Initially respiration testing was conducted by shutting off the system and measuring oxygen depletion over time. However, more continuous monitoring was desired and an alternative approach was employed that used soil gas concentrations at vapor points during operation while incorporating the travel time of biovent air to those points.

Calculation of air travel time was needed for multiple vapor monitoring points where air was injected at multiple biovent wells. A Python model using analytical element method was developed to calculate the travel time under various flow regimes that required unique solutions depending on the biovent wells operating and the flow rates at each biovent well, along with the location of a given vapor monitoring point. Results were compared to helium distribution field test.

Soil gas data were collected on a routine basis during system operation. Ratios of oxygen depletion to carbon dioxide generated were evaluated for comparison to stoichiometry for methane oxidation, benzene oxidation and alkanes; each compound results in a unique ratio of oxygen utilized to carbon dioxide produced. Further research indicated that this methodology has been used by soil scientists to identify methane leakage versus organic material degradation around developed oil fields.

Results/Lessons Learned. The respiration rate calculated during operations while incorporating flow rates and travel times to monitoring points, combined with using oxygen and carbon dioxide ratios to identify the class of compound being degraded resulted in an improved understanding of remedy performance. The methodology was automated utilizing routing monitoring data and decreased overall labor required in the field and system down time. This information is being used to support identification of transition point to passive bioventing or NSZD as well as optimize system flows to areas requiring more oxygen.