Optimization Techniques for Aging SVE Systems

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Background/Objectives. Soil vapor extraction (SVE) systems are commonly used as a technique to remediate petroleum hydrocarbons in the subsurface. This technique relies on inducing a vacuum in the vadose zone to extract soil vapors containing liberated contaminants and degradation byproducts including carbon dioxide and methane, which are then thermally treated and vented to the atmosphere. These systems commonly reach a terminal end point in terms of contaminant reduction efficiency, which are observed through decline curves. These decline curves, however, tell only half of the story. Natural source zone depletion (NSZD) is known to be an effective means of mass reduction for free phase and residual hydrocarbons in the subsurface. The NSZD process is highly influenced by the operation of SVE systems due to the induced vacuum which enhances the pressure gradient from the atmosphere to the subsurface. This exchange increases oxygen concentrations in the subsurface which provides favorable conditions for microbial biodegradation of contaminants, thereby increasing NSZD rates. Looking at both vapor extraction and biodegradation processes, we aimed to optimize an SVE system to reverse the decline curve and speed up in situ biodegradation of residual hydrocarbons.

Approach/Activities. Optimization of an SVE system was performed for a year at a bulk oil storage terminal in California. Optimization focused on the two primary mechanisms of contaminant reduction: vapor removal and in situ biodegradation. The existing SVE system has an approximate capacity to treat 1,500 lb of hydrocarbons per day which has been overloaded for the lifetime of the system, therefore requiring air dilution and reducing efficiency. The first objective of optimization was to reduce the incoming contaminant mass from the system header to reach optimal removal rates and to better match the system capacity. The second objective was to enhance the subsurface exchange of atmospheric oxygen, especially in zones of oxygen depletion. Balancing these two areas of optimization was done by opening and closing individual SVE wellheads to enhance in-situ biodegradation.

Results/Lessons Learned. Optimization was an effective and inexpensive measure to increase natural biodegradation processes and enhance overall system operation. Results showed a significant increase in biodegradation of petroleum hydrocarbons (as measured by carbon dioxide via hand-held multi-gas meters). Unexpected results were found with respect to vapor contaminant reduction, which halfway through optimization shifted vapor composition from primarily volatile contaminants to methane. This shows that an aging SVE system can have another life and serve to enhance NSZD, even if endpoints for contaminant mass reduction through vapor extraction have been reached. This represents an opportunity to provide value and reduce the time to remedial endpoints of many petroleum-impacted sites with existing SVE systems, all with simple optimization techniques.