Integrated Thermal Remediation of NAPLs Sites Using Heating Network and Vapor Recycling

Xiaosong Chen (xiaosong@georemco.com), ***Allen Swift*** (allen.swift@georemco.com) ,
Robert D'Anjou (robert.danjou@georemco.com) ,***Shuhui Guan*** (shuhui.guan@georemco.com)
Chiheng Zhou (cheyney@georemco.com), **Carol Winell** (carol@georemco.com)
(GEO Inc, Orange, CA, USA)

Background/Objectives.

During the In-situ Thermal Remediation (ISTR) process, it is important to design the capacity of the vapor treatment system to be compatible with the heating process, especially for the NAPLs sites with highly volatile organic compounds. A former coking plant facility was polluted by BTEX and semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs), as well as coking-specific compounds in very high concentrations. The challenges of this site were: 1) to complete the remediation of a large volume in the short timeline of less than one year; 2) complex chemical composition and high concentrations (with NAPLs) due to decades of industrial activities; 3) the need for site accessibility during remedial operations as utility lines and some industrial facilities remained open.

Approach/Activities.

Gas Thermal Remediation (GTR™), a proven In Situ Thermal Remediation (ISTR) technology, was selected to meet the challenges at this site. A heating network using thermal conductivity heating (TCH) wells was applied to reach a target treatment temperature (TTT) of 350°C and remain at that temperature for 5 days. Since the target depth in many areas was 1m, a network of thermal blankets was installed at a depth of 0.7 m to heat this shallow TTZ. The thermal blankets significantly reduced the quantities of TCH wells required.

The vaporized chemicals are extracted from a pneumatic control network including Multiple Phase Extraction (MPE) wells and Soil Vapor Extraction (SVE) wells and flow through three levels of treatment processes. The primary level is cooling and condensation, which is designed to separate liquid from off-gas and remove the steam from the system to around 30-40°C. The secondary level of the treatment system applies different technologies at different zones. For medium-high contaminated zones, thermal oxidation decomposition and neutralization process is used. GTRO technology, simultaneous heating, and vapor oxidation system, are applied as the thermal oxidation process, followed by a quenching and scrubbing system. For highly contaminated zones, a system utilizing compression, cooling, and condensation methods (C3) process can treat any range of organic vapor concentrations or mixtures while realizing VOC removal efficiencies of 99% or greater. The C3 Technology platform can treat chlorinated VOCs without up-limit concentration while maintaining throughput volume and removal specifications. The last level of the treatment system is polishing with granular activated carbon (GAC) absorption before releasing the off-gas into the atmosphere. The GTRO, C3, and GAC equipment were connected with bypass valves. Later, when VOC concentrations reduce or reach near asymptotic levels, a calculated transition between the equipment benefits the outcome and the lifecycle cost of the project.

Results/Lessons Learned.

The subsurface soil was heated to 350°C in <90 days' operation duration. The application of condensation, reburn, and absorption processes was proven to be successful to treat the extracted vapor, meeting regulatory requirements prior to discharge. Results of final soil sampling indicated more than 99% of the removal of contaminants with all VOCs and SVOCs below remedial goals.