REDOX TECH, LLC

"Providing Innovative In Situ Soil and Groundwater Treatment"

A CASE STUDY FOR THE APPLICATION OF POTASSIUM PERMANGANATE BY SOIL BLENDING METHODS TO REMEDIATE TRICHLOROETHENE IN SOIL

Project Location
Yorkville, IL

Contaminants
Trichloroethene

Product Used
Potassium Permanganate ($KMnO_4$) Oxidant

Scope and Media
Oxidant Application to Contaminated Soil Using a Soil Blender

Results
TCE↓ 88%
Achieved target soil cleanup goal in six weeks.

Redox Tech, LLC utilized *in situ* soil blending to apply potassium permanganate ($KMnO_4$) into contaminated vadose zone soil in Yorkville, IL. The goal was to use chemical oxidation with permanganate to decrease TCE concentrations within the source area to below the soil leaching saturation limit of 1,300 ppm. Chemical oxidants had previously been applied to the soils by another contractor using conventional backhoes and excavators; however, these application methods were unable to achieve the target soil cleanup goals due to incomplete mixing (Figure 1). The Redox Tech soil blending method provided more efficient and uniform soil mixing that enhanced contact of the chemical oxidant with the contaminants and resulted in a successful cleanup.

SITE BACKGROUND

Unsaturated soils above the water table that were targeted for treatment included 75 cubic yards of a silty clay unit encompassing an area of 500 square feet and extending from depth of 4 to 8 feet below ground surface. Historical pre-treatment soil sampling showed TCE concentrations exceeding 10,000 mg/kg in this soil stratum. While the initial oxidant application using backhoes and excavation had limited success, TCE concentrations greater than 7,000 mg/kg remained in the soil following the first attempt at treatment.

To estimate the permanganate required to treat the remaining 75 cubic yards of impacted soil, Redox Tech used a conservative estimated TCE mass of 7,000 mg/kg and a stoichiometric loading of 2,335 pounds of permanganate. To allow for potential natural oxidant demand of the soils and other contaminants, a supplemental permanganate dose of 1 g/kg (i.e. 335 pounds) was used.

METHODS

Soil blending field services were initiated by Redox Tech in April 2009. To access the target treatment zone, the upper four feet of soil was removed using an excavator and stockpiled onto an adjacent treatment area. The KMnO4 was delivered to the site in a dry crystal powder and was spread across the top of the exposed treatment zone at a depth of four feet. Water was used to dissolve the KMnO4 while it was being mixed in-situ with the deeper contaminated soil using the soil blender. Blending continued until a consistent mixture of oxidant was obtained

throughout the contaminated soil zone. After mixing was complete, the upper four feet of clean soil was replaced into the excavated area.

The soil blender is a 28-inch diameter mixing drum with specially designed teeth that is mounted on a large excavator with a modified diesel engine and hydraulic power system. The mixer drum is capable of blending dry soil as well as sludge material to depths of 18 feet below ground surface. Utilizing a hydraulic pressure of 5,000 pounds per square inch, the mixing drum is rotated at speeds up to 100 revolutions per minute with a torque of 300 pounds per foot. This rugged durability allows the mixing drum to penetrate all soil types, even with the presence of backfill debris such as bricks, boulders and rebar.

Because chemical oxidation requires direct contact with the target contaminants, its effectiveness is often limited by the ability to evenly distribute the chemical amendments throughout the soil medium. The blending process mechanically breaks up the soil matrix, allowing the rotary teeth to blend the reagent(s) and the soil into a relatively homogeneous mixture for more effective treatment.

RESULTS

Pre-treatment soil samples were collected in February 2009 as part of the design phase. Post-treatment soil samples were collected in May 2009, approximately six weeks after the permanganate was blended into the soil. Figure 1 presents a graphical representation of results for soil samples CS-6, CS-7 and GP-2-CS. Results indicate that TCE concentrations in soil were reduced by 54% to 88% as a result of the chemical oxidant blending program. The final TCE concentrations in soil were below the corrective action target cleanup level and the soil remediation objective was achieved.

Figure 1.TCE Results in Soil