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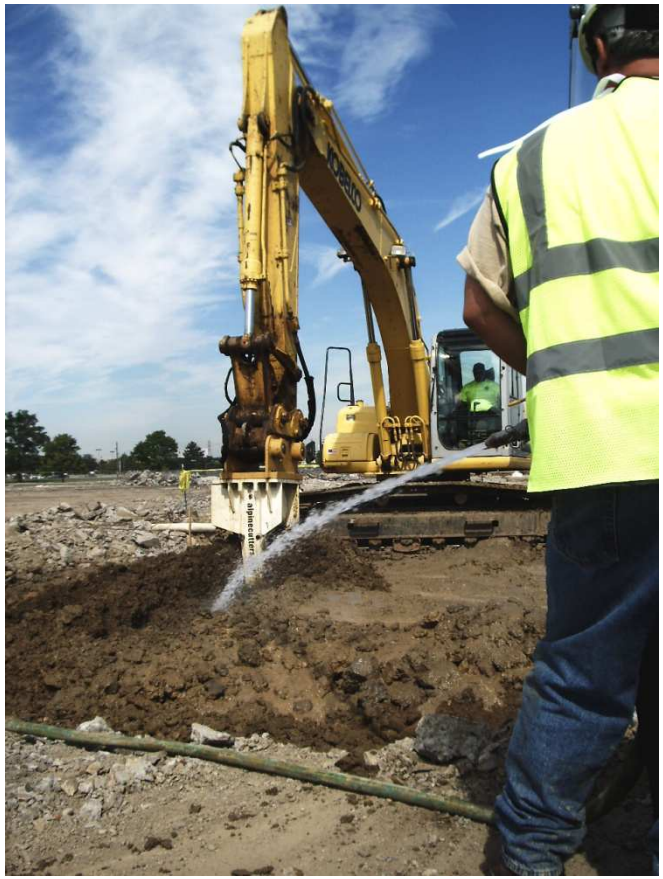
Use of Chemical Oxidation Mixing Procedure to Address TCE Contamination at a Former Industrial Facility

Outline

- Introduction
- What is the treatment process?
- Where this process works.
- How this process works.
- Why this process is viable.
- When to utilize this process.
- Case Studies
- Conclusion

What is the Treatment Process?

- On Site Treatment/ Mixing
- Treatment/Mixing within the Area of Contamination ("in-situ")
- Chemical Oxidation
- Spray Application in lifts with excavators and mixer attachments



What is the Treatment Process?

Oxidation is a chemical process in which electrons are transferred from an atom, ion or compound. The in-situ chemical oxidation process is designed to destroy organic contaminants. Oxidants most frequently used in chemical oxidation include hydrogen peroxide (H_2O_2), potassium permanganate ($KMnO_4$), sodium permanganate ($NaMnO_4$) and sodium persulfate ($Na_2O_8S_2$).

Rapid Treatment Time

- Ability to treat contaminants present at high concentrations
- Effective on a diverse group of contaminants

Where this Process Works

This chemical oxidation treatment process is best applied to sites with:

- Contaminated soil 0-20 feet below ground surface (bgs)
- Levels of VOC contamination above hazardous waste standards

Where this Process Works

Innovative Environmental Technologies, Inc.

Not enough time

The on site treatment process typically takes 1-2 weeks to achieve the necessary contaminant reductions. The alternative (off site disposal as hazardous waste) typically requires 1-2 weeks to secure an EPA id# and waste approvals. And daily acceptance limits typically apply to off site disposal of hazardous waste.

Not enough money

On site treatment is simply the most effective way to meet budgetary goals when dealing with relatively high levels of VOC soil contamination.

Not enough space

On site treatment takes place within the area of contamination, hence no stockpiling is necessary. On site treatment requires no more space than typical dig and haul operations.

How this Process Works

In-Situ Chemical Oxidation (ISCO)

- Sodium Persulfate oxidation with activators
- Sodium and Potassium Permanganate

How this Process Works

- Spray application of chemicals
- Mechanical mixing with excavators and attachments
- Allow 1-4 weeks (typically 1-2 weeks) for treatment via chemical oxidation
- Conduct composite sampling and confirmatory analysis per US EPA guidelines
- After analysis confirms soil treatment has been successful, the soil can be loaded out for non-hazardous disposal or possibly can remain on site depending on site specifics

How this Process Works

Why this process is viable

Concern: How can you conduct treatment of Hazardous Waste without a permit?

- Contaminated soil becomes a hazardous waste when it is removed from the "area of contamination" **if** it has contamination levels above hazardous waste standards when it is removed.
- If levels of contamination are reduced in-situ prior to removal/waste generation, then the soil can be sent for disposal as non-hazardous waste or can be reused on site (depending on site specifics and cleanup standards).

Why this process is viable

Concern: What about air emissions, hazardous vapors and odor control?

- Air emissions are no more of an issue with on site (in-situ) treatment than they are with a dig and haul.
- Hazardous vapors (similar to a dig and haul) are monitored for health and safety purposes and appropriate levels of personal protective equipment (PPE) are employed.
- Hazardous vapors and odors are effectively mitigated by using vapor suppressing foam in conjunction with excavation and mixing operations.

Why this Process is Viable

When to Utilize this Process

- To achieve soil cleanup and site remediation within a short time frame.
- To significantly reduce costs versus removal/disposal of contaminated soil as hazardous waste.
- When traditional in-situ remediation systems/processes are too slow, too costly or cannot guarantee cleanup goals will be met.
- To minimize or eliminate hazardous waste generation and related regulatory burdens.

When to Utilize this Process

Reduced Liability

-No Liability associated with transportation/disposal of hazardous waste

-No PRP liability associated with disposal in landfill (if soil remains on site)

Effective Delivery

-Uniform delivery of remedial compounds (especially in unsaturated zones)

-Production rates comparable to dig and haul

-No RCRA TSD permits required as remediation is completed within the area of contamination (in-situ)

-Wide variety of compounds treated (chlorinated, PAH's, etc.)

-Ability to treat soils at very shallow depths not conducive to other methods of in-situ treatments

-Well suited for highly concentrated LNAPL and DNAPL source zones

Cost Savings

-Savings typically 4-10 times less expensive than dig and haul depending on type and level of contamination

-Timeframe typically 1 week to 1 month to meet treatment goals

Case Study - Former Automotive Manufacturing Facility

Contaminants of Concern:

- Trichloroethylene (TCE)
- cis-1, 2-dichloroethylene (c-DCE)
- Vinyl chloride (VC)
- Mixed Petroleum Compounds

Results:

- Treated 20,000 tons of silty clay soil
- Concentrations of CVOC's up to 2000 ppm
- Treated 0-20' bgs in 6' lifts.
- Average timeframe was 2 weeks to meet site cleanup standards and TCLP treatment standard for TCE of <0.5 ppm
- All treated soils were replaced on project site

Case Study - Former Electronics Manufacturing Facility

Contaminants of Concern:

- Tetrachloroethylene (PCE)
- Trichloroethylene (TCE)
- cis-1, 2-dichloroethylene (c-DCE)
- Vinyl chloride (VC)
- Mixed Petroleum Compounds

Results:

- Treated over 2,000 tons of clayey silt soil
- Concentrations of CVOC's up to 500 ppm
- Treated 4-12' bgs.
- Average timeframe was 1 week to meet TCLP treatment standard for TCE of <0.5 ppm
- All treated soils were disposed as non-hazardous waste

Conclusion

On Site (In-Situ) Soil Treatment can achieve remediation goals for VOC contaminated unsaturated soils.

- Timely (fast acting)
- Reduce Costs
- Minimize Waste

ISGS Options

- In-Situ Geochemical Stabilization (ISGS) remedial process entails the use of modified permanganate solutions for the purposes of mass removal and flux reduction (i.e., NAPL stabilization).

- The introduction of the permanganate solution results to the migration of the oxidant through the treatment area and consequently to geochemical reactions that destroy the targeted contaminants that are present in the dissolved phase.

- As the oxidant migrates through the treatment area, various (bio)geochemical reactions destroy the targeted compounds present in the dissolved phase. This causes a “hardening” or "chemical weathering” of the NAPL as it steadily loses its more labile components.

ISGS Options

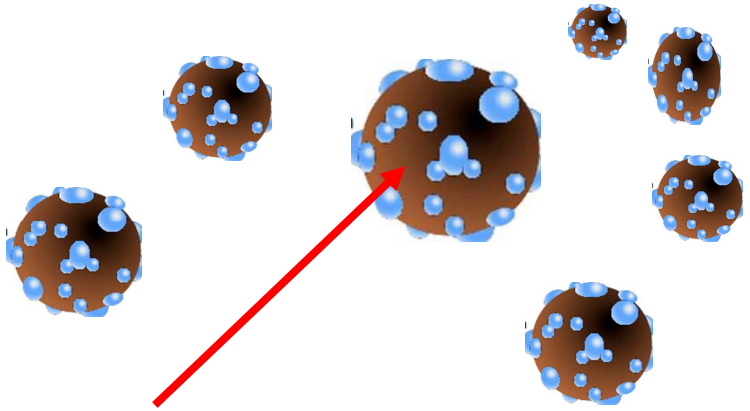
- A net increase in viscosity of the organic material is observed, which yields a more stable, recalcitrant residual mass.

- Both the insoluble manganese dioxide precipitate, that results from permanganate oxidation, and other mineral species included in the ISGS formulation accumulate along with the NAPL interface, resulting in the physically coating of the NAPL and thereby reducing the flux of dissolved-phase constituents of interest into the groundwater.

- Unlike the typical application of In Situ Chemical Oxidation reagents, ISGS is used to encapsulate NAPL, with chemical oxidation of COIs being a secondary affect. Thus, the overall oxidant dosing is often substantially less than ISCO applications, resulting in rapid, highly effective treatment at a much lower cost.

ISGS Options

Provect-GS™ Next Generation



OrganoClay – Condensation Nuclei

Modified formulation of previous reagents integrates Organoclay to:

- **Help Address Dissolved Phase COI**
- **Promote Pore Space "Plugging"**
- **Initiate Crystal Formation / Encapsulation outside of DNAPL Area**
- **Increase Longevity**
- **Improve Reliability**
- **Help with Overall Acceptance of Immobilization Premise**

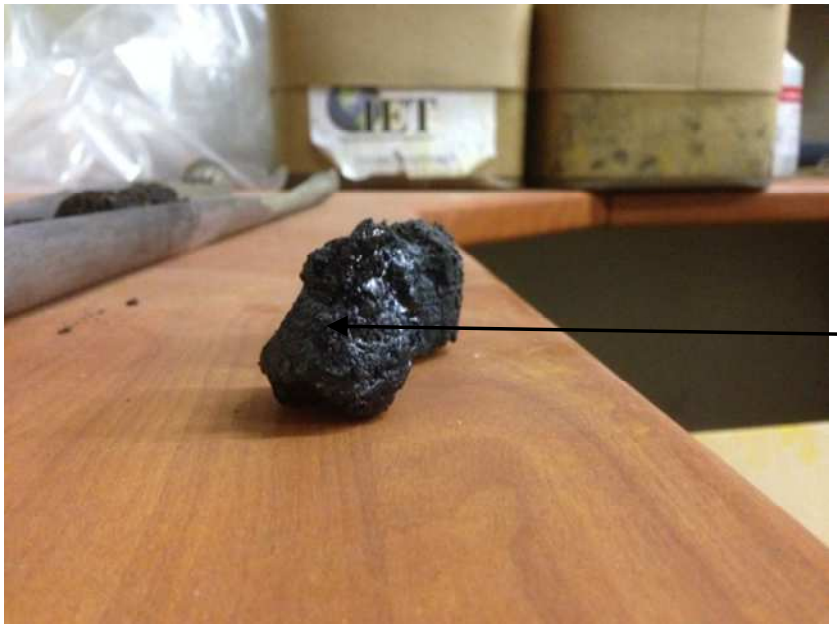
ISGS Options

- Buffered, catalyzed solutions of $NaMnO_4$ + Additives + Organoclay
  - ✓ Hydrophobic – does react with water
  - ✓ Oil adsorption cap. >0.5 lb oil/lb OC
  - ✓ Non competitive adsorption
  - ✓ Non-toxic
- Integrates physicochemical LTS to improve reliability, predictability and longevity
- Enhanced geochemical reactions and NAPL encrustation
- Rapid reactions (days)
- Long term stability (est. >150 years)

ISGS Options

Additional On Site Soil Treatment Options

- Treatment of NAPL contaminated soil with In-Situ Geochemical Stabilization (ISGS)



Questions