

OVERVIEW

Surface soils impacted by petroleum hydrocarbons or other compounds that are subject to biodegradation can be treated via various biological processes. When the contaminants are particularly recalcitrant or otherwise problematic then chemical oxidation using Provect-OX® can supplement the process to yield safe, rapid and effective treatment

- ◆ Provect-OX® Chemical Oxidation Technology: *in situ* chemical oxidation (ISCO) / enhanced bioremediation reagent that uses ferric iron (Fe III) as a safe and effective means of activating persulfate (US Patent No. 9,126,245).
- ◆ Provectus® Aerobic Bioremediation Reagent (ABR): proprietary formulation of hydrophilic carbon source + inorganic nutrients, vitamins, minerals and buffering agents to enhance biological processes.

There are a number of factors known to influence treatment efficacy, including soil type and texture, type of contaminants, presence of inorganic constituents, etc. However, some general strategies are presented below:

TPH Impacts	Remedial Approach	General Unit Price (USD/USTon)
>10% (>100,000 ppm) or heavily weathered TPH	Thermal / off-site disposal	\$250 to >\$500
5 to 10% (50,000 to 100,000 ppm)	On Site Combined Provect-OX Persulfate Pretreatment + bioremediation secondary Treatment	INDUSTRIAL (<1,000 ppm TPH) \$100 to \$125 RESIDENTIAL (<500 ppm TPH) \$125 to \$150
>0.1% to 5% (>1,000 to 50,000 ppm)	Provectus Aerobic Bioremediation via Land farming	INDUSTRIAL (<1000 ppm TPH) \$50 to \$75 RESIDENTIAL (<500 ppm TPH) \$75 to \$100

AEROBIC BIOREMEDIATION

TPH-impacted soil containing an average concentration of *ca.* >500 to 50,000 mg/kg refined petroleum hydrocarbons would be typically treated with 1% to 3% (soil dry weight basis) Provectus® Aerobic Bioremediation Reagent applied via multiple application events (**Table 1**). For example, 200 US tons (400,000 lb) of soil would initially receive *ca.* 1 US ton (0.5% soil dry weight) of reagent and the soils would be aggressively tilled twice per week using high efficiency mixing equipment. About 15 days after the initial treatment, an additional 0.5% reagent is added to the soil and the treatment is continued for 30 to 45 days, or until remedial goals are achieved. Soil moisture content must be maintained at *ca.* 65% of soil water holding capacity (WHC) and pH must be maintained near 7 throughout the process.

Table 1. General Overview of Provectus® Aerobic Bioremediation Reagent

Treatment	Activity
Day 1	Add 1 ton reagent to 200 tons soil; irrigate to 65% WHC; Till; Sample
Days 2 to 14	Till frequently monitor pH and WHC – amend as needed
Day 15	Till; Sample; Add 1 ton reagent to 200 tons soil; irrigate to 65% WHC; till
Days 16 to 44	Till; monitor pH and WHC – amend as needed
Day 45	Till; Sample

Project Example (source – ecosoluconies)

Challenge: 500 US Tons of TPH impacted soil at Refinery Site

Project: On Site Bioremediation to treat TPH impacted soils from >5,000 ppm to <500 ppm

Status: Completed October 2013 using Aerobic Technologies

Total material costs if Using Provectus Technologies: \$7,500 (5 tons of Provectus ABR @ \$1,500/ton), or \$15/ US ton of soil treated.



COMBINED ISCO + AEROBIC BIOREMEDIATION

Soil impacted by weathered, heavy hydrocarbons and/or large amounts of TPH can be pre-treated with Provect-OX® followed by aerobic bioremediation. As summarized below (**Table 2**), soils are first treated with ca. 0.5% to 1% (soil dry weight basis) Provect-OX®, or ca. 10% of the soil persulfate oxidant demand. The soils are then irrigated to ca. 90% WHC, aggressively mixed and allowed to incubate under static conditions for ca. 10 days. Soil moisture (65% WHC) and pH (6 to 8) are then be adjusted as required, and Provectus® Aerobic Bioremediation Reagent is applied at 0.5% (soil weight basis). The soils are then be managed as outlined above (Table 1).

Table 2. General Overview of Combined Pre-Treatment using Provect-OX® coupled with Provectus® Aerobic Bioremediation Reagent

Treatment	Activity
Day 1	Sample; Add 1 ton Provect-OX to 200 MT soil; and water to ca. 90% WHC;
Day 10	Till; Sample; Adjust pH and WHC to 60%; add 1 ton Provect ABR; till
Day 11 to 29	Till frequently; monitor pH and WHC – amend as needed
Day 30	Till; Sample; Adjust pH and WHC to 60%; add 1 ton Provect ABR; till
Day 31 to 44	Till; monitor pH and WHC – amend as needed
Day 45	Till; Sample

Project Example (source – ecosoluconies)

Challenge: 1,000 US tons of heavily TPH impacted soil at Refinery Site

Project: On Site Bioremediation to treat TPH impacted soils from >55,000 ppm to <1,000 ppm

Status: Completed October 2013 using combined ISCO/Aerobic Technologies

Total material costs if using Provectus Technologies: 50 tons Provect-OX @ \$3,500/ton = \$175,000 + 100 tons of Provectus ABR @ \$1,500/ton = \$150,000 totaling \$325,000, or \$32.50/ton soil treated.



CONTACT US FOR A COMPLIMENTARY SITE EVALUATION

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