

REGENESIS RegenOx® PetroCleanze™

RELEASES SORBED HYDROCARBON MASS FOR MORE EFFECTIVE ENHANCED RECOVERY AND CHEMICAL OXIDATION

PRODUCT APPLICATION INSTRUCTIONS

RegenOx® PetroCleanze™ is a customized formulation of the widely used RegenOx chemical oxidant. This formulation is designed to enhance desorption of petroleum hydrocarbons from the soil matrix into groundwater.

RegenOx PetroCleanze is a two part product: 1) the standard RegenOx Part A Oxidizer-Complex (a white granular material) and 2) PetroCleanze (a dark liquid) that serves as the activator. When combined these 2 parts form RegenOx PetroCleanze.

Material Handling and Safety

A Material Safety Data Sheet is provided with each shipment. This document should be read and reviewed prior to application.

RegenOx PetroCleanze Part A oxidizer complex is a Class 5.1 oxidizer. This material should be stored in a dry place. Please refer to the MSDS for special handling and safety information. RegenOx PetroCleanze Part A is packaged and delivered in either bags or pails; PetroCleanze is a liquid and is packaged and delivered in 5 gallon buckets. Typically, RegenOx Part A Oxidizer-Complex will be delivered in a 55 pound bag or 30 pound pail, PetroCleanze will be delivered in a 5 gallon pail and weigh 30 pounds.

RegenOx PetroCleanze is a corrosive. Please refer to the MSDS for special handling and safety information. RegenOx PetroCleanze should be stored in a dry place. It is common for PetroCleanze to settle during shipping, a quick pre-mix stir* using a hand held drill equipped with a paint mixer attachment will rapidly re-homogenize the material. The alkaline nature of PetroCleanze makes it necessary for field personnel to use appropriate personal protection equipment (PPE) including eye protection. Gloves should be worn during handling. Personnel who operate field equipment during the installation process should have appropriate training, supervision, experience, proper PPE and should review the MSDS prior to site operations.

*PetroCleanze buckets are designed to meet USDOT/UN class 8 shipping requirements and to allow easy remixing of the material. Prior to unsealing the bung opening, the buckets can be tipped onto its side and "rolled" 3-4 revolutions. This will re-mix PetroCleanze inside the sealed bucket without the need for a drill and paint mixer attachment.

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The remainder of this document is divided into two sections. Section I details use and application of RegenOx PetroCleanze for desorbing contaminant mass bound to soil; Section II details the application of RegenOx PetroCleanze for enhanced recovery of contaminants using an existing pump and treat system (P&T).

Please refer to the associated documents for details on physical properties, product features, and benefits.

I. Application: Desorption of Soil Contaminant Mass

The use of RegenOx PetroCleanze is typically part of an overall site remediation strategy for removal of elevated hydrocarbon (HC) mass sorbed to the soil matrix prior to implementation of other soil and groundwater mass removal measures e.g. use of RegenOx and/or ORC-A™ based enhanced bioremediation.

Application of RegenOx PetroCleanze should be designed to facilitate desorption and removal of sorbed HC mass from the soil matrix in the most highly impacted sections of the site. As part of this designed desorption a capture mechanism should also be in place to remove the desorbed HC mass. This HC mass may be in the form of Separate Phase Hydrocarbon (SPH) or a HC and water emulsion. Removal of desorbed HC mass should be recovered through use of dedicated extraction wells or application/extraction wells using a “push-pull” approach. Removal of the desorbed mass generated will allow for a more efficient use of the subsequently applied reagents.

For optimal contaminant mass removal efficiency, Regenesi s recommends RegenOx PetroCleanze be used in conjunction with one of the following physical and/or mechanical extraction systems and which is capable of removing the resulting SPH and/or HC and water emulsions. Some of the more common physical/mechanical fluid removal systems are:

- Dual Phase Extraction
- Pump & Treat
- Dedicated Push-Pull Wells
- Episodic Multiphase Extraction (Vacuum Truck)

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Removal Method	Applicability	Technical Requirements
Dual-Phase Extraction System	Previously Installed System nearing end of design life; revitalizes useful life of the system, by releasing sorbed mass locked onto soil matrix	Engineered System; Total Fluids Recovery Handling Capability; Fluids and Vapor Treatment System; Fluid and Vapor Discharge Permits
Pump & Treat System	Previously Installed System nearing end of design life; revitalizes useful life of the system, by releasing sorbed mass locked onto soil matrix	Engineered System Fluid Recovery Handling Capability Fluid and Vapor Discharge Permits
Push-Pull Treatment System	Dedicated well(s) for injection and/or extraction; application via the push phase, extraction is via the pull phase; existing monitoring wells <i>may</i> be incorporated into <i>pull-phase</i> only. Application via direct-push methods is an option; PetroCleanze is applied in select high mass location; via application using DPI or wells oriented around a central extraction well. The pull phase is via DPI, extraction dedicated well(s) or select injection wells	Engineered or Semi-Engineered System Total Fluids Recovery Handling Capability Fluids and Vapor Treatment Fluid and Vapor Discharge Permits
Episodic Multi-Phase Extraction	No infrastructure necessary; Best for Open excavations where few wells remain useful; skimming SPH and PH emulsion from the excavation's surface or excavation sumps	
	Vacuum Hose Only No infrastructure necessary Best for Open excavations where few wells remain useful Skimming SPH and PH emulsion recovery from the excavation's surface or excavation sumps	Non-engineered system; Extracts what is readily removable; Disposal of total fluids recovered at a permitted facility
	Well Stinger For sites where existing wells become useful SPH recovery wells; Recover as much SPH and HC emulsion as is reasonable	Disposal of total fluids recovered at a permitted facility

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Targeting Contaminated Soil Mass

Surface Soil Applications: RegenOx PetroCleanze requires direct contact with petroleum HC mass in order to facilitate desorption. Thus, in order to allow contact of RegenOx PetroCleanze with contaminated soil and maximize desorption, adequate soil mixing and moisture levels should be provided as well as control and management of the desorbed HC mass.

Subsurface Soil Applications: Subsurface application of the RegenOx PetroCleanze should target the most highly contaminated sections in the subsurface and/or aquifer section (horizontally and vertically). This is critical in order to ensure direct contact between RegenOx PetroCleanze and the contaminant mass. It is very important to implement an adequate recovery system that optimizes the capture and removal of the desorbed contaminants. For details on recommended capture and removal methods see the list and table in Section I above. For details on use of RegenOx PetroCleanze to enhance removal of contaminant mass using P&T methods please see the discussion in Section II below.

Application Approaches

Depending on site conditions and application approach, RegenOx PetroCleanze components can be applied separately or in combination. For best results RegenOx Part A and PetroCleanze should be applied at a 1:1 ratio (see the ratio guidance below). When applied separately PetroCleanze component should be applied first and followed with RegenOx Part A Oxidant-Complex.

Application Rates

Application rates for the PetroCleanze component will vary depending upon contaminant mass and setting. PetroCleanze application rates can range up to 5 pounds per cubic yard (3 kg/m³) of saturated soil. This is roughly equivalent to 15 pounds per vertical foot (22.3 kg/m) as delivered by direct push injection (DPI) using a 10 foot (3 meter) center spacing.

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Typical Weight Ranges for standard RegenOx Part A: PetroCleanze components as applied per vertical foot:

Contaminant Range	Ratio Part A to PetroCleanze	Weight to Weight (Lb)	Weight to Weight (Kg)
TPH>10,000ppm	1:1	15:15	6.8:6.8
Medium	1:1	10:10	4.5:4.5
TPH<1,000ppm	1:1	5:5	2.3:2.3

Water Requirements

As with standard RegenOx, RegenOx PetroCleanze should be applied at a solution weight of between 3-5%. Use the following Equation to estimate the necessary water requirements for the desired solution application %:

$$\text{Gallons of Water Required} = \frac{\text{RegenOx Part A (lbs.)}}{\left(\frac{8.34 \text{ lbs}}{\text{gallon}}\right)(\% \text{ RegenOx Solids Solution})} [1 - (\% \text{ RegenOx Part A Solution})]$$

The estimation of water volume requirements using the above equation can be simplified to the following equation and using the conversion factors provided:

$$\text{RegenOx Part A (lbs.)} \times \text{desired solution \% factor} = \text{Water Required (gals)}$$

- 3% : 3.87
- 4% : 2.87
- 5% : 2.27

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Typical Water Volumes Necessary to create RegenOx Part A Solutions %

Part A (lbs)	Desired Solution %	Solution Factor	Water Volume (gals)
30	5	2.27	68
20	5	2.27	45
10	5	2.27	23
30	4	2.87	86
20	4	2.87	57
10	4	2.87	29
30	3	3.87	116
20	3	3.87	77
10	3	3.87	39

NOTE: water volume may vary slightly due to significant digit rounding

Mixing

Prior to application, the PetroCleanze component should be homogenized (see the discussion above on re-mixing).

When applied separately, the PetroCleanze component should be diluted and applied with water at a wt:wt solution that typically ranges from 3% to 8%. NOTE: The dilution rate for PetroCleanze is often site and application specific. The dilution rate used for your project should be discussed with your Technical Sales or Technical Services Representative.

When applied together the methodology of dilution and final mixing of PetroCleanze component with RegenOx Part A component remains the same as with the standard RegenOx material. For detailed instructions on mixing standard RegenOx please use the following link:

<http://www.regenesis.com/contaminated-site-remediation-products/chemical-oxidation/regenOx/application.aspx>

Surfacing

From time to time during subsurface injections of RegenOx PetroCleanze a small quantity of the material may reach the surface. If you observe surfacing in the work area, stop application immediately and remove and dispose of the surfaced material as appropriate. It is highly recommended that prior to

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injection, the application area be equipped with appropriate barrier material to prevent any RegenOx PetroCleanze that may surface from entering a storm drain or other surface water feature.

II. Application to Enhance P&T Systems

RegenOx PetroCleanze has also been used to extend the useful life and efficiency of pump and treat (P&T) systems that may have reached asymptotic levels. As discussed above the use of RegenOx PetroCleanze will enhance petroleum HC mass desorption from soil and so removal of this formerly sorbed mass becomes available for removal by the P&T System.

The following are recommended considerations for defining the area of RegenOx PetroCleanze application to enhance recovery using existing P&T systems.

- HC concentration in GW ≥ 10 mg/L
- The distance or residence time between the soil HC mass and the extraction well should be ≤ 30 feet or ≤ 45 days, whichever is greater
- Areas with suspected or confirmed sorbed HC mass that are within the time and distance recommendations above.

Upon defining the area of application, RegenOx PetroCleanze should be mixed and applied using the general guidance provided in Section I above.