



# Application Instructions



## PetroCleanze Quick Reference Table

The following table is a quick reference guidance providing only the most relevant information. Please review the entire document carefully, plus the product Safety Data Sheet prior to any application. Please contact REGENESIS Technical Support if you need any further assistance.

<b>Components</b>	PetroCleanze is a 2-component product: <ul style="list-style-type: none"> <li>- <b>RegenOx Part A</b> (oxidizer; white soluble powder)</li> <li>- <b>PetroCleanze</b> (catalyst; green/brown liquid gel)</li> </ul> Proportion is typically 1 kg PetroCleanze for 1 kg Part A, but can vary (proportion to be discussed with REGENESIS)
<b>Viable application methods</b>	Direct push. In wells. In excavation
<b>Number of injection campaigns</b>	Typically, multiple campaigns are required. Typical distance between campaigns: 2 to 4 weeks. Campaign structure to be discussed with REGENESIS
<b>Typical dilution factor &amp; mixing activities – Direct push and excavation</b>	<b>Typical dilution factor:</b> Part A and PetroCleanze can be mixed together. 5% on Part A weight (exact dilution to be discussed with REGENESIS). 1 kg of Part A in 20 litres of water. <b>Mixing:</b> Add Part A to tank <u>already filled</u> with water. Mix carefully to dissolve completely. Add some water to PetroCleanze bucket and mix, to make the gel more liquid. Add PetroCleanze only after Part A is completely dissolved. Maintain mixing throughout injection process
<b>Typical dilution factor &amp; mixing activities – In well</b>	<b>Typical dilution factor:</b> Part A and PetroCleanze to be applied separately. 5% for both Part A and PetroCleanze (exact dilution to be discussed with REGENESIS). 1 kg of Part A in 20 litres of water. 1 kg of PetroCleanze in 20 litres of water. <b>Mixing (repeat separately for each component, first PetroCleanze and then Part A):</b> Add component to tank <u>already filled</u> with water. Mix carefully to dissolve completely. Maintain mixing throughout injection process
<b>Recommended injection pump</b>	Diaphragm pump
<b>Recommended Injection pressure</b>	Low to average pressure injection. Typically 1-5 bar. Adjust pressure using pressure regulator Take note of pressure and flow rate for each step
<b>Direct push injection</b>	Retractable screen tip recommended; pressure activated tip as an alternative Typical injection steps every 30 cm
<b>In well application</b>	Apply first PetroCleanze; flush with clean water; then apply Part A. Pressure injection; <b>DO NOT</b> gravity feed. Use single or double packer. Flush well with clean water after application. Reduction in well efficiency to be expected over time, due to residual solid
<b>Excavation application</b>	Mix with water before application. Place at the bottom of excavation. Mix carefully with soil at the bottom using excavator, to enhance contact
<b>Other recommendations</b>	Always wash and flush equipment with clean water. Seal injection direct push points after injection
<b>Pumping and extraction activities</b>	Use pump or vacuum truck or other extraction system. Rule of thumb: extract at least 3-5 times injected volumes. Evaluate extraction activities observing regularly pH, LNAPL build up and groundwater appearance. Allow for flexibility on extraction timing and volumes
<b>Recommended monitoring</b>	After each injection event, frequent (i.e. approx. 3 times per week) field monitoring on pH, LNAPL increase and water appearance, in order to make decisions on extraction activities. Typically, monthly monitoring after last injection campaign. Monitoring period typically 2 to 3 months. One monitoring between injection campaigns recommended (after completion of extraction activities and before injection of following campaign). Parameters: contaminants of concern. Supporting evidence: O <sub>2</sub> , redox, pH, electrical conductivity

## Application Instructions

PetroCleanze<sup>®</sup> is a customised formulation of RegenOx<sup>®</sup> Part B, which is applied in conjunction with RegenOx<sup>®</sup> Part A. PetroCleanze is a thick liquid-gel that ships in 18.1kg buckets, while RegenOx Part A is a dry white powder that ships in 18.1kg bags.

PetroCleanze is designed to increase the viability and efficiency of enhanced recovery techniques such as dual-phase extraction, vacuum enhanced extraction and pump & treat systems. Subsurface application of PetroCleanze is commonly performed using either direct push drilling or via injection wells, usually over the course of several injection campaigns with corresponding groundwater pumping events to remove desorbed contamination. The precise programme of injection and abstraction will be specified by REGENESIS during the design phase.

An SDS for each part is provided with each shipment, which should be studied carefully by the user to ensure the PetroCleanze is handled and stored appropriately.

It is assumed that the user is appropriately trained and competent and will have completed a comprehensive site-specific health, safety & environmental risk assessment for the works they intend to carry out. This should include a thorough review of required personal protective equipment and its proper use.

## Pre-Application Process

Prior to PetroCleanze application, REGENESIS recommends completing a pre-application test injection using clean water. This procedure is useful to determine the quantity of liquid the target zone is able to accept and will provide valuable flow rate and pressure information.

REGENESIS recommends the injection test volume of water is in the range of **15-20% greater** than the single-point design volume e.g. if the design specifies a PetroCleanze volume of 1,000L per point then the water test injection should aim for 1,150 – 1,200L.

A diaphragm pump, capable of delivering at least **30 litres/minute** with a pressure in the range of **2-6 bar** would typically be suitable for the application of PetroCleanze. RegenOx Part A is a powder that will readily dissolve in water, provided that the user dilutes with the appropriate volume of water.

PetroCleanze is generally easy to handle, but it may become viscous particularly in colder temperatures. Product handling can be improved by adding a small quantity of water to the PetroCleanze bucket and mixing using a battery-powered drill with a mixing attachment or a hand-held paddle, making sure to reach any settled product at the bottom of the bucket. Once the product has been poured from the bucket a small amount of water should be added to wash it out to ensure all the PetroCleanze is being used.

The method of free product extraction will also require some consideration prior to product application. More information is provided under 'Free Product Extraction' in this document.

## Mixing and Application via Direct Push

When applying via direct push injection, PetroCleanze and RegenOx Part A can be mixed with water in the same tank and co-injected. Typically, a concentration of between **4% and 6%** is optimal. Table 1 demonstrates how these concentrations can be achieved. Please note the quantity of PetroCleanze and RegenOx Part A may vary between injection campaigns. If applicable, this will be highlighted by REGENESIS during the remediation design phase.

Solution to be prepared (%)	Amount of PetroCleanze (kg)	Amount of RegenOx Part A (kg)	Amount of mix water (L)	Approximate final volume (L)
4	18.1	18.1	430	470
5	18.1	18.1	340	380
6	18.1	18.1	280	320

Note: The % solution is based on the amount of RegenOx Part A used, with the PetroCleanze added directly to that solution.

PetroCleanze and RegenOx Part A mix readily into water when batched at the recommended solution ranges. The PetroCleanze solution should be mixed in appropriately sized tanks that match the project's requirements. Ideally the tank should be conical or flat bottomed to ensure thorough mixing and no settlement of undissolved solids. REGENESIS would not recommend reliance on recirculation to mix PetroCleanze, although this method can aid the mixing process.

REGENESIS recommends slow addition of RegenOx Part A powder to the requisite amount of water and mixing using appropriately sized equipment to ensure thorough mixing throughout the vessel.

Once the RegenOx Part A has dissolved in the water, PetroCleanze can then be poured directly from the bucket into the tank and mixed thoroughly. Any residue remaining in the Part B bucket should be removed using clean water and a battery powered drill with a mixing attachment and added to the mixing tank.

When PetroCleanze and RegenOx Part A are mixed in the same vessel, a small degree of flocculation can occur therefore we would recommend that the PetroCleanze is continually mixed throughout the injection process. Once a mixing tank has been emptied it is recommended to use clean water to flush/clean out the tank to ensure there is no build-up of undissolved solids over time. This will also help to flush out the pump, hoses and injection rods. REGENESIS would also advise that all equipment is flushed through with clean water at the end of each working day and on completion of the injection works. Mixed PetroCleanze should not be left for long periods e.g. overnight in the mixing tank.

REGENESIS recommends using a **300mm or 600mm retractable injection tip** for application of PetroCleanze, to provide optimal distribution in the subsurface.

Once the point has been completed, the injection hole should be properly grouted/sealed upon completion of the injection activities. The purpose of this effort is to seal off any potential pathways to the surface which may allow “day lighting” of injected PetroCleanze and/or groundwater.

## Mixing and Application via Injection Wells

REGENESIS recommends that injection wells should generally be constructed using **≥50mm diameter HDPE**, with slots in the range of **1-0.5mm**. Where possible, the well seal should consist of a maximum of **300mm of bentonite pellets**, above which a sand & cement mix should be applied to seal to the surface. Prior to injection of any remedial reagent, REGENESIS recommends that the injection wells be purged of fine-grained particles present in the well bore to the extent practicable.

Co-mixing and injecting PetroCleanze Part A and B is not recommended for application into injection wells due to the risk of blocking the well screen with flocculent created when the two parts mix and react together. Instead, REGENESIS recommends applying PetroCleanze first, flushing with 2-3 times the well volume with clean water, then following up with application of Part A and flush water within the same injection campaign.

Typically, a PetroCleanze concentration of between **4% and 6%** is **optimal**. Table 2 demonstrates how these concentrations can be achieved.

Solution to be prepared (%)	Amount of PetroCleanze Part B (kg)	Amount of PetroCleanze Part A (kg)	Approximate volume of water (L)	Total volume per injection campaign (L)
4	18.1		430	900
4		18.1	430	
5	18.1		340	720
5		18.1	340	
6	18.1		280	600
6		18.1	280	

The PetroCleanze solution should be mixed in appropriately sized tanks that match the project’s requirements. Ideally the tank should be conical or flat bottomed to ensure thorough mixing and no settlement of undissolved solids. REGENESIS would not recommend reliance on recirculation to mix PetroCleanze, although this method can aid the mixing process. PetroCleanze and RegenOx Part A mix readily into water when batched at the recommended solution ranges.

PetroCleanze should be added slowly to the requisite amount of water in the mixing vessel and agitated using appropriately sized equipment to ensure thorough mixing throughout the vessel. Any residue remaining in the PetroCleanze bucket should be removed using clean water and a battery powered drill with a mixing attachment and added to the mixing tank. PetroCleanze has a green/ brown appearance once dissolved in water. PetroCleanze should then be applied to the injection well followed by clean water equivalent to 2-3 times the well volume used to flush out the mixing tank, pump, hoses and ensure all the PetroCleanze has been displaced into the surrounding formation.

Once the PetroCleanze and flush water has been applied add the requisite amount of water to the mixing tank followed by the required amount of RegenOx Part A powder and mix thoroughly. RegenOx Part A has a milky white appearance once dissolved in water. Once the RegenOx Part A has been applied, clean water equivalent to 2-3 times the well volume used to flush out the mixing tank, pump, hoses and ensure all the RegenOx Part A has been displaced into the surrounding formation.

When wells are used for PetroCleanze injection, the injection wells and nearby groundwater monitoring wells should be either tightly capped or alternatively equipped with a pressure gauge and relief valve. This will reduce potential for short circuiting to the surface.

Whenever possible, the application should be performed by systematically working from the outside to the centre of the injection array to minimise displacement of contamination from the target area.

## Free Product Extraction

Applications of PetroCleanze should be followed by a period in which the wells are monitored frequently. This would typically be 3 times a week but is dependent on geological characteristics (REGENESIS will give advice about this during the design phase of the remediation strategy). Wells should be monitored for a drop in pH or an increase in Light Non-Aqueous Phase Liquid (LNAPL). When either observation occurs, total fluids recovery (e.g. via vacuum tank or pump and treat system) should be undertaken. Whilst these recovery activities would be planned before injection, ideally they should be as flexible as possible in order to optimise the timing of desorbed contaminant recovery. If no pH change or LNAPL increase is observed beyond a 2-week period, total fluid recovery should be undertaken regardless to prevent any desorbed product from returning to the soil-bound phase. Please contact REGENESIS if you are unsure when the abstraction event should take place.

If PetroCleanze application is completed via injection wells, the same wells can be used for extraction. If PetroCleanze application is completed via direct push, alternative extraction methods will need to be considered. Direct push locations can be located around extraction wells, sumps, or excavated trenches, providing suitable access is available for the direct push rig.