PermeOx® Ultra Slurry Preparation and Application Guidelines

PermeOx® Ultra is a calcium peroxide based product that is engineered to slowly release oxygen to stimulate aerobic bioremediation of many common environmental contaminants of concern. PermeOx Ultra is typically applied as an amendment to an excavation, through *in situ* soil mixing, or via direct push injection techniques.

PermeOx Ultra is a powdered product which has a low solubility and can be applied either as a dry powder or as a slurry, to assist in product distribution, to minimize dust, and to provide the hydration necessary to initiate the release of oxygen. PermeOx Ultra Granular is also available; providing ease of use for backfill applications.

This document provides recommendations for the preparation of PermeOx Ultra slurries from the powdered form. In addition, guidance for the application of PermeOx Ultra to excavations and *in situ* mixing, as well as direct injection strategies are also provided.

Slurry Preparation

PermeOx Ultra is often applied as a slurry to allow for easier handling, to minimize dust issues, and to help initiate the slow release of oxygen. The concentration of solids in the slurry can be adjusted depending on the amount of water added to alter the physical properties of the slurry such as viscosity depending on the type of application. PermeOx Ultra is applied using a direct injection strategy with a slurry that consists of 10 to 40 percent solids by weight. A 20 percent slurry concentration has been observed to provide a good balance between the ease of handling and the distribution of sufficient mass in the subsurface. The higher slurry concentrations may be desirable to minimize the injection volume for applications where reagent surfacing is a concern.

Depending upon the design, PermeOx Ultra slurries of 20 to 70 percent have been applied to backfill open excavations or open boreholes. Smaller volumes of greater than 40 percent slurries can be mixed in buckets, however larger volumes of >40 percent slurries may require specialized material handling and transfer equipment.

A slurry mixture can be prepared by adding the desired mass of PermeOx Ultra into a chemically compatible mixing vessel rated for the density of the slurry being prepared. To minimize dusting, it is recommended that the reagent is added to the vessel in three steps. First, the vessel should be partially filled with enough water to more than saturate the added PermeOx Ultra (at least 0.15 gallons of water per pound of reagent). Second, the PermeOx Ultra should be added to the vessel, making sure that volume from steps one and two is less than the total desired volume. Third, additional water is added to bring the slurry to its final concentration. The reagent should then be stirred thoroughly until the product is in suspension, uniformly mixed, and ready for injection.

The slurry should be continuously mixed to ensure the product is uniformly distributed and does not settle to the bottom of the tank. Smaller batches can be prepared using paddle mixers, recirculation, or manual mixing. A mechanical mixing system is recommended for larger projects. Continuous mixing in smaller batches (<100 USG / 400 L) is typically recommended. When needed, a positive displacement piston pump (grout pump) is usually preferred to pump the PermeOx Ultra slurries.

Below are slurry dilution ratios for multiple concentrations of PermeOx Ultra.
Note: This example is based on a single 25 lb pail of product. Other packaging sizes are also available.

Target concentration (wt % solids):	10%	20%	30%
Mass PermeOx Ultra per pail (lbs)	25	25	25
Volume water per pail (gallons)	27	12	7
Total Injection Volume (gallons)	29	13.5	8.4

In Situ **Mixing and Excavation Applications**

PermeOx Ultra can be directly mixed into the soil using soil mixing equipment or placed into an open excavation either as a dry powder or concentrated slurry. Installation techniques will vary depending on the application. The application of a slurry is recommended in order to minimize potential fugitive dust issues (especially in windy conditions) and as hydration is required to initiate the release of oxygen release. If the product is added dry, it is recommended that the product be wetted down with enough water to saturate the product following the application.

The amount of PermeOx Ultra required will be directly proportional to the mass of contamination being treated and other compounds that may be present that will be oxidized under aerobic conditions. In the absence of specific site information, 1 to 4 pounds per square foot, or approximately 5 to 20 Kg per square meter, of the pit surface area is commonly used during mixing as a polishing treatment for residual contamination in the aqueous phase. If the PermeOx Ultra is to be blended into the bottom of the excavation, 1 to 4 lbs PermeOx Ultra per cubic foot or approximately 16 to 64 Kg per cubic meter, is often used depending upon the vertical extent of the blending.

Considerations for higher PermeOx Ultra dosage rates:

- Site/receptors are more contaminant sensitive
- More extensive soil and groundwater impacts
- Relatively higher soil and groundwater contaminant concentrations
- High groundwater flow velocity environments

Considerations for lower PermeOx Ultra dosage rates:

- Site/receptors are less contaminant sensitive
- Less extensive soil and groundwater impacts
- Lower soil and groundwater contaminant concentrations
- Low groundwater flow velocity environments

Direct Injection Applications

PermeOx Ultra slurries have been injected into the subsurface using techniques such as direct injection through injection tooling, hydraulic fracturing, or other injection devices with large enough pore openings to allow the passing of the PermeOx Ultra slurry. **Note:** Injection through most fixed wells is not recommended given that the PermeOx Ultra slurry is too thick to pass through typical well slot sizes. If this is attempted, it will likely clog the wells.

PermeOx Ultra will typically persist in the subsurface up to 12 months. Multiple applications of PermeOx Ultra may be necessary if longer treatment periods are desired or if the desired mass cannot be applied in a single application.

It is recommended that the required mass of PermeOx Ultra be injected into the subsurface using direct injection strategies at slurry concentrations of 10 to 30 weight percent with a 20 weight percent slurry most typical. The volume of the slurry injected per injection point and the spacing of the injection points will depend upon several design parameters, but injection volumes are recommended to be up to 15 percent of a pore volume with injection points generally spaced 5 ft to 15 ft (1.5 m to 4.5 m) on center depending on the geology. Tight injection spacing can help distribute the reagents better within the targeted area.

Health and Safety

PermeOx Ultra has been applied safely and effectively at numerous sites. However, as with any chemical, proper procedures and equipment are recommended in its use. When working with PermeOx Ultra, ensure to have adequate ventilation and use the appropriate personal protective equipment, including safety glasses, suitable protective clothing, boots (steel toed), chemical resistant gloves, hard hat, and hearing protection (when direct push is used). For dust, splash, mist, or spray exposures wear a filtering dust mask and chemical protective goggles. A face shield can also be used in addition to goggles.

Please consult the PermeOx Ultra reagent Safety Data Sheet (SDS) for guidelines regarding proper handling procedures. The SDS can be found at: http://www.peroxychem.com/remediation. Additional safety equipment may be required for mechanical and site operations.

Please contact PeroxyChem for additional guidance.