PersulfOx™
CATALYZED PERSULFATE

APPLICATION INSTRUCTIONS

Subsurface application of PersulfOx™ via pressure injection is commonly performed using either direct-push technology (DPT) or wells. PersulfOx is a single-part, sodium persulfate – based *in situ* chemical oxidant with built-in activation. It is a dry white powder that ships as a **DOT 5.1 Class Oxidizer** and should be handled according to regulations governing oxidizers. An MSDS is provided with each shipment.

Pre-Application procedures - Prior to PersulfOx application, Regenesis recommends pre-application test injection using clear water. This procedure is useful in determining if the target zone has hydraulic limitations that would reduce the anticipated volume applied or cause application pressures to exceed the commonly accepted application range. For *in situ* injection projects, Regenesis recommends the injection test volume range 15-20% greater than the single-point design volume.

Solution making procedures - Before application the PersulfOx is mixed with water to create an injection solution. PersulfOx can be mixed into solutions that range from 5% to 20% weight/weight (w/w). For most applications Regenesis suggests a 10-15% w/w solution. The PersulfOx+water solution should be mixed in appropriately sized tanks that match the projects requirements. Upon creation the PersulfOx solution is alkaline and so tanks and related mixing equipment should be configured with chemically resistant materials. When working in areas with cold water temps (temperatures <16^{o}C/ 65^{o}F) users should be aware of lessened overall chemical solubility resulting in relatively longer mix time requirements; in all cases it is recommended that periodic mixing be part of the application process. We recommend slow addition of dry PersulfOx powder to water and mixing during and after PersulfOx addition using appropriately sized power mixing equipment such as drum or tank-type vortex/cyclone mixers. Alternatively, lower volume batch mixing may also be used. Low volume mixing alternatives would include power drills equipped with paint-mixer attachments or chemically resistant centrifugal pumps set up in a recirculation configuration. PersulfOx mixes readily into water when batched at the recommended solution ranges. Once mixed PersulfOx will dissolve and remain in solution but as with all chemical mixtures we recommend that the PersulfOx solution be checked periodically throughout the workday. The PersulfOx solution will be typically have a cloudy white appearance that is associated with the formation of a small amount of flocculent (<1%). This flocculent is associated with minerals present in most mix waters. When adding the PersulfOx to the mix water, follow proper handling and dust precautions (see H&S sheet and MSDS).

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APPLICATION INSTRUCTIONS (cont'd)

The following table is a guideline for solution mixing % per bag of PersulfOx in water:

No. of Bags	Weight of Material (lbs.)	Desired Solution (%)	Volume of Water (gallons)	Final PersulfOx volume (gallons)
1	55	5	125	128
1	55	10	59	62
1	55	15	37	40
1	55	20	26	29

Volume of mix water (gallons/vertical foot of injection) can be calculated from the following equation:

$$\frac{\text{PersulfOx lbs/ foot}}{(8.34\ \text{lbs/gal water})(\%\ \text{PersulfOx solids})}\left[1-(\%\ \text{PersulfOx solids})\right]$$

Direct Push (DPT) Applications - It is imperative that the DPT injection holes 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 injection materials. Whenever possible, the application should be performed by systematically working from the outside to the center of the injection array. This methodology of application will limit the potential for expansion of the plume (also applies to wells).

Well-Applications - Regenesis recommends that injection wells be generally be constructed using ≥2-inch diameter Schedule 80 PVC with a screen slot size ≥0.02-inch. When possible the well seal should consist of a minimum of ≈6-12 inches of fine silica sand placed directly over the well filter pack. This will minimize bentonite infiltration into the well screen/filter pack interval. This should be overlain by ≥3 feet of hydrated and "cured" bentonite seal. The well should be sealed to the surface with cement or cement + bentonite grout (bentonite<10%). Prior to injection of any remedial reagent, Regenesis recommends that the injection wells be "surged and purged" of fine grained particles present in the well bore to the extent practicable.

After each PersulfOx injection event, each injection well should be flushed with clear-water. This clear-water "chaser" should be equivalent to approximately 2-3 borehole volumes. When wells are used for PersulfOx injection, the PersulfOx injection wells and nearby groundwater monitoring wells should be either tightly capped or alternatively equipped with a pressure gauge & relief valve. This will reduce potential for short circuiting to the surface.

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Surfacing - From time to time application related surfacing of oxidants or other high volume remedial reagents may occur. Regenesis has co-authored a document that addresses the specifics reagent surfacing before it occurs as well as proper management when it does occur. This document is entitled "Guidelines for Subsurface Injection of In Situ Remedial Reagents within the LARWQCB Region" (ISRR). This document can be found on the LARWQCB Website or on the Regenesis website www.regenesis.com