



Klozur® CR Slurry Preparation and Application Guidelines

Klozur® CR is a blended formulation of Klozur® SP and PermeOx® Ultra, providing a combined remedy (CR) of activated persulfate and bioremediation when applied into the subsurface in a single application. Klozur CR is self-activating with no mixing of additional chemicals or reagents.

Klozur CR is most commonly injected as a slurry, but can also be applied as an amendment to an excavation, trench, or with backfill. This document provides guidance for the makeup and delivery of the slurry via direct injection and some general recommendations for backfill applications.

Slurry Preparation

Klozur CR is not fully soluble in water, and upon makeup will form a slurry. The slurry should be stirred until the entire product is suspended in solution. Mixing should take place in a chemically compatible tank, such as high density polyethylene (HDPE), with a chemically compatible mechanical mixer, such as 304 or 316 stainless steel. If the temperature of the makeup water or the outside temperature is cold, then it may take a little longer to get the slurry suspended into solution.

Klozur CR slurries are typically made in small batches with the intent of immediate injection. PeroxyChem does not recommend making a Klozur CR slurry in advance or storing prior to use. (*See Tank and Pump Safety Note)

A 20 weight % (wt%) is the typical slurry concentration for Klozur CR. Table 1 provides slurry makeup ratios for common concentrations per every 45lb drums of Klozur CR or per 500 gallons of final slurry volume.

Klozur CR Slurry, wt%	Makeup water per 45lb pail of Klozur CR, gal	Ratios per 500 gallons of Slurry			Specific Gravity
		Klozur CR Mass, lbs	Makeup Water, gal	Total Slurry Volume, gal	
10%	45	436	470	500	1.031
20%	22	930	445		1.124
30%	13	1500	419		1.190

Table 1. Klozur CR slurry makeup formulations

Tank and Pump Recommendations

The Klozur CR slurry is typically made up in a chemically compatible, vented, vertical tank. A tank with a cone bottom and bottom drain can aid in the removal of the slurry. The slurry within the tank should be under constant agitation until emptied. In addition to the main line to the injection network, a small recycle loop from the pump back into the tank will prevent the accumulation of a final slurry contents that may be too high in solids or if the slurry begins to settle out when getting to levels below the mechanical mixer. Near the very end of the tank cycle, the pump recycle line should be shut-off entirely to allow full flow forward via the pump to the injection point. All wetted parts in the injection system, including the tank,



valves, flanges, gaskets, check valves, pumps, pipes, and gauges should be chemically compatible with Klozur CR.

Air-operated, positive displacement, self-priming double diaphragm pumps have been successfully used for the injection of 10 to 30 wt% Klozur CR. It is recommended that the double diaphragm pump with a minimum of 1 ½ inch inlet and outlet be used. A variety of these types of pumps are manufactured by Wilden[®] and Sandpiper[®]. All wetted parts of the pump and all parts coming in contact with Klozur CR must be constructed of or coated with materials compatible with oxidizers and high pH, such as 304L or 316L stainless steel, polyethylene, polyvinylidene fluoride (PVDF) or polytetrafluoroethylene (PTFE or Teflon[®]).

TANK AND PUMP SAFETY NOTE*

Klozur CR may undergo decomposition if stored or handled improperly or if it comes into contact with impurities. Please refer to the Klozur CR Safety Data Sheet (SDS) and the Klozur Persulfate Safety and Handling Technical Bulletin, available on PeroxyChem's website. Klozur persulfate slurries/solutions decompose auto-catalytically. Decomposition is a function of temperature, time, the presence of activators including transition metals, and exposure to incompatible materials.

The pump and tank system **MUST** be designed to relieve pressure that may build up upon normal decomposition, and includes over-pressure relief in zones between valves.

All equipment, such as pumps, tanks, and hoses, **MUST** be cleaned out with a water flush at the end of every work day. This is to avoid potential pressure buildup due to decomposition and to reduce potential corrosion on equipment.

Injection Approach

When injecting, Klozur CR needs to be applied in a manner that will allow for transport and distribution of the solid material into the subsurface. To facilitate this distribution Klozur CR is typically applied through large orifice direct push technology (DPT) tooling at pressures high enough to create fractures that aide distribution. If using DPT tooling, for each injection point, the rods are initially advanced to the top (or bottom) of the targeted depth interval and a specified volume of slurry is injected before proceeding to the next depth. Using DPT tooling allows for targeting vertical injection intervals of approximately 1 to 3 ft. The preferred approach for the injections is often in the top-down direction using an injection tip that directs the slurry horizontally. However, different contractors may prefer a bottom-up approach based on their specific tooling or evaluation of site conditions.

Injection Spacing

The recommended spacing between injection points is based on two factors: distribution (ROI) and soil acceptance. Both of these factors may vary greatly depending on injection technique and lithology. A flexible approach is recommended during a field installation and/or to evaluate these parameters during a pilot-scale test injection. Based on experience from a range of sites, a ROI of approximately 5 ft from an injection location and spacing of injection locations of 8 to 12 ft are typical. Injection locations tend to be



located in staggered rows with overlapping ROIs from different injection locations. Greater ROIs can be achieved with specific techniques and equipment. PeroxyChem recommends discussing injection spacing with your selected contractor.

Soil acceptance may also vary greatly depending on the Klozur CR slurry concentration, site lithology, the ability to fracture the soil, and injection depth. As a general guideline the amount of Klozur CR accepted by soils in more permeable formations is limited to no more than 100 lbs Klozur CR per vertical foot. For less permeable formations, soil acceptance is typically no more than 50 lbs per vertical foot. The actual soil acceptance can be tested and confirmed in field pilot scale tests. If greater amounts of Klozur CR are required, a closer spacing of the injection locations, or smaller ROI, may need to be used or the slurry concentration can be increased, if possible.

Note: Significantly greater ROIs have been observed with certain fracturing techniques. Please contact PeroxyChem for further information regarding ROI monitoring and site observations.

Backfill Approach

Absent any specific site information, a range of 1 to 4 lbs Klozur CR per square foot of the pit surface area, or approximately 5 to 20 Kg per square meter, is commonly used during mixing as a polishing treatment for residual contamination in the aqueous phase. If the Klozur CR is to be blended into the bottom of the excavation, 1 to 4 lbs Klozur CR 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 Klozur CR dosage rates:

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

Considerations for lower Klozur CR dosage rates:

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

Klozur CR can be applied as a backfill amendment in a variety of modes, including: 1) Directly applying Klozur CR to the base of the excavation and backfilling on top of the Klozur CR; 2) Applying directly to the base of the excavation and then using a device such as a mixing tool or excavator to blend the Klozur CR with the soil or soil slurry; or, 3) Blending Klozur CR with additional backfill material and applying the combined material to the bottom of the excavation. It is recommended that Klozur CR be applied very close to or directly on the base of the excavation to minimize dusting and that all personnel be wearing proper personal protective equipment (PPE) as specified in the Klozur CR SDS. The high pH (typically pH



>11) of Klozur CR will minimize the corrosive properties of the persulfate in the product, however, chemical compatibility with the equipment or other materials Klozur CR will contact should be considered.

Klozur CR is intended to be applied under saturated conditions, as it relies on a sufficient amount of water to facilitate the biotic reactions that are part of the intended treatment mechanism. Because of this, Klozur CR is intended to be applied as a backfill amendment in the saturated zone or in zones that will be saturated with water very shortly after the application of Klozur CR. If Klozur CR is applied as a dry reagent it should be wetted down and the area should be saturated with water so that the conditions will remain saturated for a sustained period of time. Applying Klozur CR with less than saturated conditions should be carefully evaluated, since if Klozur CR is applied with insufficient water it could easily react resulting in the evolution of heat and steam.

Materials of Compatibility

As specified by the Klozur CR SDS, Klozur CR is a DOT class 5.1 oxidizer and a corrosive material. Upon dissolution it typically creates alkaline conditions but also has the potential to be acidic. All materials contacting Klozur CR should be chemically compatible including tanks, pumps, injection rods, seals, gaskets, tubing, hoses, and mixing equipment.

Compatible materials include: stainless steel (304L and 316L), polyethylene (PE), polyvinylchloride (PVC), polytetrafluoroethylene (PTFE), Viton[®], polyvinylidene fluoride (PVDF), and butyl rubber are also compatible materials. Materials NOT compatible include, nitrile rubber, carbon steel, aluminum, brass, galvanized steel, or any other metal susceptible to corrosion. Please refer to PeroxyChem's Corrosion and Material Compatibility of Klozur Persulfate Technical Bulletin for more detailed information, available at www.peroxychem.com/remediation.

Health and Safety

Klozur CR 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 Klozur CR, ensure to have adequate ventilation and use the appropriate personal protective equipment, including safety glasses, suitable protective clothing, boots (steel toed or equivalent), 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 Klozur CR 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.

Klozur is a registered trademark of PeroxyChem. © 2017 PeroxyChem. All rights reserved. Document 89-03-ESD-17 The information contained herein is presented to the best of our knowledge, PeroxyChem makes no representations or warranties regarding the accuracy, quality, or reliability of this information and shall under no circumstances be liable with respect to such information. Teflon and Viton are registered trademarks of The Chemours Company. Wilden is a registered trademark of Wilden Pump & Engineering, LLC. Sandpiper is a registered trademark of Warren Rupp, Inc.