



# Environmental Solutions

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## Procedure for Activating Klozur® Persulfate with a 25% Sodium Hydroxide Solution

### Background

For alkaline activation of Klozur Persulfate, the pH of the soil and groundwater will need to be maintained between 10.5 and 12. Sodium Hydroxide (NaOH, caustic soda) can be used to achieve the pH target range. The NaOH demand arises from two sources; 1) soil and groundwater acidity, and 2) the generation of acid formed during the decomposition of Klozur Persulfate. The amount of the NaOH needed to raise soil and groundwater pH must be determined experimentally (see procedure below). In addition, to address the persulfate generated acid, 2 moles of NaOH per mole of Klozur Persulfate must be added to neutralize the persulfate-generated acid.

**Total NaOH Demand = NaOH needed to raise soil and groundwater to target pH 10.5-12 +  
2 moles NaOH / mole Klozur persulfate**

### Safety and Handling

Sodium Hydroxide is a corrosive chemical and can cause severe chemical burns to body tissue if mishandled. Therefore, appropriate Personal Protective Equipment (PPE), including chemical goggles and face shield, is required when handling and transferring NaOH. **Review the MSDS with all workers prior to handling this chemical.**

Sodium Hydroxide is sold commercially in a variety of concentrations. Common concentrations include; 50%, 73%, and solid flakes or pellets (100%). These highly concentrated forms of NaOH may generate extreme exothermic reactions upon dilution. In certain circumstances, so much heat may be liberated that it can boil the solution causing steam eruptions, loss of product containment and damage to equipment. Use of concentrated NaOH require very long dilution times and/or heat exchange equipment with agitation or good mixing.

**FMC recommends NaOH solutions of no more than 25% by weight be used to activate Klozur persulfate.**

This will help to minimize the generation of heat upon mixing the NaOH with water. FMC does not permit use of NaOH concentrations greater than 25% in its Klozur mixing rental equipment.

**Use of NaOH solutions in excess of 25 wt% or in solid form may increase the risk of injury, loss of product containment and equipment damage.**



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## Activation Procedures

### Part A: Soil Titration Method for 25% NaOH determination

1. Take a 500 gram (1.1 lb) sample of the soil from an area that is representative of the contaminated site.
2. Take a 1500 gram (3.31 lb) sample of the ground water.
3. Place these samples in a clean glass or plastic container and mix thoroughly for 5 minutes.
4. Determine and record the pH of the water.
5. Take 100 ml aliquot of the mixed soil/ water slurry in a clean glass beaker. Insert a pH probe to measure the pH as NaOH is added.
6. Set up a burette with 25% NaOH solution.
  
7. Slowly dose 25% NaOH into the beaker until the pH reaches 10.5 and maintains 10.5 for 30 minutes. Add more 25% NaOH if the pH drops during the test.
8. Record the ml's of 25% NaOH required to neutralize 100 ml's of soil slurry.
9. Calculate and scale up the amount of NaOH to Field scale conditions based on total treatment soil volume.

Note: 3785 ml's (3.785 L) = 1 gallon.

### Part B: Determine the amount of 25% NaOH to neutralize the Persulfate-Generated Acid

1. Determine total Klozur® requirement in lbs
2. Multiply lbs of Klozur® by 0.1267 to determine gallons of 25% NaOH required

Note: 2 lb-moles NaOH required / lb-mole persulfate persulfate  
→ 1.344 lb of 25 wt% NaOH / lb of Klozur persulfate  
Density of 25 wt% NaOH = 10.61 lb / gal  
→ 126.67 gal 25 wt% NaOH / 1000 lb Klozur persulfate

**The total 25 wt% NaOH demand = amount from Part A + amount from Part B**

### Applying Klozur solution and NaOH activator to a contaminated site

1. 25% NaOH solution can be:
  - applied to a site prior to addition of the Klozur persulfate solution
  - applied to a site post addition of the Klozur persulfate solution



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- applied to a site simultaneous to the addition of the Klozur persulfate solution
2. It is recommended that if the Klozur persulfate and 25 wt% NaOH solution are added simultaneously
- No more than **0.2 gallons** of 25% NaOH should be added per gallon of 30% Klozur solution
  - No more than **0.4 gallons** of 25% NaOH should be added per gallon of 20% Klozur solution
  - No more than **0.6 gallons** of 25% NaOH should be added per gallon of 10% Klozur solution

Mixing of NaOH and persulfate solutions in ratios greater than mentioned above may lead to increases in solution temperature.