



Safety and the Use of Peroxygens

Peroxygens are a class of chemicals that are highly reactive by nature. As a result, attention and care should always be paramount when handling such materials, including Klozur® activated persulfate, hydrogen peroxide and PermOx® Ultra engineered calcium peroxide. We take the safe use of our products seriously, and is a member of the American Chemistry Council's Responsible Care® Program¹, which promotes the proper use, handling, storage and disposal of our chemicals and the communication with our customers and neighbors on managing a safe and healthy work environment. This month's *Peroxygen Talk* is a continuation of providing guidance on safety when dealing with peroxygens^{2,3}. With proper precaution, peroxygens can and have been safely used for many years in soil and groundwater remedial applications.

The first source of safety and handling information is the SDS (material safety data sheet) for the chemical that you are using. The SDS should always be reviewed with all personnel handling the chemical prior to use, and it is recommended that the local fire department proximate to the field site be notified of the presence of oxidants in case of emergency. The SDS's can be found on the PeroxyChem website. Contact your technical representative if there are any questions regarding safety and handling of PeroxyChem products.

Several rules apply when dealing with peroxygens. These are:

- Never contact
- Never contaminate
- Never confine
- Always have water available

Never Contact

You should never allow an oxidant to contact you personally or allow the oxidant to contact flammable or combustible materials. Chemical safety goggles and chemically resistant gloves are a must. Wearing a face shield can provide extra protection, and may be required under certain circumstances (please contact us for more information on this topic). Contact between the oxidant and your eyes can lead to possible ulceration of the cornea and potential blindness. Exposure to skin can lead to chemical burns. It is also recommended that a protective over-suit and chemically resistant boots be worn. Concentrated hydrogen peroxide solutions may actually catch cotton clothing or leather boots on fire, depending upon its concentration and duration of contact. Persulfate solutions can lead to holes in cotton shirts and leather boots, damaging the clothing and leading to a potential skin exposure route. For persulfate handling, a dust respirator approved by NIOSH / MSA is required.

While oxidants themselves are not flammable, contact between an oxidant and a combustible material may lead to a fire. Rapid decomposition of the oxidant may generate heat and oxygen, which make up two sides of the fire triangle. When combined with the third side of the triangle, a fuel source, there is potential for fire. Never store oxidants next to strong reducing agents or incompatible materials.

Never Contaminate

Exposure of an oxidant to a contaminant may lead to the rapid decomposition of the oxidant, potentially increasing risk of fire or injury. Contaminants may include heat or energy, improper materials of construction and externally introduced materials. The oxidant should be stored under proper conditions, away from sources of excess heat (examples include storage in direct sunlight or near a steam line). As an example, for hydrogen peroxide solutions, heat can rapidly increase the peroxide decay rate. At 75 F, peroxide decomposition may be 1% per year, whereas at 151 F, the decomposition rate can climb to 1% per week, and at 218 F, 2% per day. For persulfate and calcium peroxide, bags and drums and hydrogen peroxide containers should be stored in a cool, dry



place. Placement under a tarp in direct sunlight or storage next to point heat sources can lead to excessive heating and decomposition loss of the product.

For any oxidant, contact with metals can lead to rapid decomposition. Examples of metal contamination sources may include improper materials of construction of tanks and piping or the use of metal scoops and mixers. For Fenton's chemistry – type remediation applications, it is never recommended to add iron, the activation system for Fenton's reactions, directly to concentrated peroxide solutions, as this will result in rapid and uncontrolled peroxide decomposition. For iron activated persulfate applications, it is recommended that the iron be mixed in a separate tank, only mixing prior to application at the well head. Materials also may be introduced externally into an oxidant. For persulfate and calcium peroxide materials, never return unused portions back into the original packaging, as dust and dirt may contaminate the product as a result. If excess oxidant remains from the project, it is recommended that it is also diluted and applied to injection well (in other words, it is best to use up any oxidant from an open package rather than leave it exposed or returned to storage). Do not use rusty scoops or shovels as these may impart metals and contamination into the product. With hydrogen peroxide prevent materials from backing up in the delivery system and being returned to holding tanks. Deliver the material into properly maintained and compatible tanks and never return unused peroxide back to the original tank.

Never Confine

Never confine an oxidant solution in enclosed vessels or piping without adequate pressure relief. Oxidant solutions are always decomposing and generating gases, it is just a matter at what rate they decompose. As an example, with hydrogen peroxide, decomposition may generate oxygen at a volume 200 times that of the liquid. As a result high pressure situations may occur. Insure proper venting on all tanks and on pipes between closed valves. Properly vented ball valves may be required in order to prevent pressure build-up within the valve system.

A recent near miss incident demonstrates the need to insure adequate venting of tanks and piping. The incident involved the use of Klozur® CR, which is a combination of Klozur sodium persulfate and PermeOx Ultra calcium peroxide. Excess oxidant solution was left in a tank overnight, without sufficient ventilation. In the morning, as the tank was being hooked up to the injection rigging, the oxidant solution erupted from the tank fitting due to excess pressure build-up. In turn several site operators were splashed with the oxidant solution. Safety glasses were being worn, but the remaining personnel protective equipment were not in place. Fortunately, no injury or property damage occurred, other than the loss of some clothing. However, the situation might have been worse and could have been avoided if: 1) the tank had the appropriate ventilation and 2) the oxidant solution was drained prior to shut down for the evening and the equipment rinsed out. We do not recommend holding persulfate solutions overnight and should be utilized within several hours. If the project requires persulfate solutions to be trucked over a distance, insure adequate venting on all tanks or totes and minimize the distance of travel.

Always Have Water Available

As with any oxidant solution, water will dilute it. A dilute oxidant solution is always less hazardous than a concentrated solution. Water is critical for potential fire control, and the solution to any oxidant spill is first to dilute with copious amounts of water. For persulfate spills, it is important that a large amount of water is used to dilute solid material spills. At least one gallon of water per pound of persulfate solid should be used. Using a quart of water or less per pound of persulfate may cause further decomposition. Water should be available for safety showers and eye wash stations in the advent of personal contact with an oxidant solution. If contact with eyes or skin should occur, flush with large volumes of water and consult the SDS for care instructions.



Activated persulfate, hydrogen peroxide and calcium peroxide can be used safely to treat contaminated soils and groundwater. However, these chemicals should be handled with care to prevent potential injury and property damage.

- Always review the SDS prior to use
 - Make sure all personnel are familiar with the safe use and handling of the oxidant
 - Never contaminant, contact or confine an oxidant solution
 - Always have water on hand
 - Always contact your representative if you have any questions regarding the safe handling of oxidants.
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1. For more information on the ACC Responsible Care program, please visit http://www.americanchemistry.com/s_responsiblecare.
 2. “The Safe Use of Klozur Activated Persulfate Solutions”, *Peroxygen Talk* November 2006.
 3. “The Safe Use of Klozur Persulfate Activators”, *Peroxygen Talk* August 2010.

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