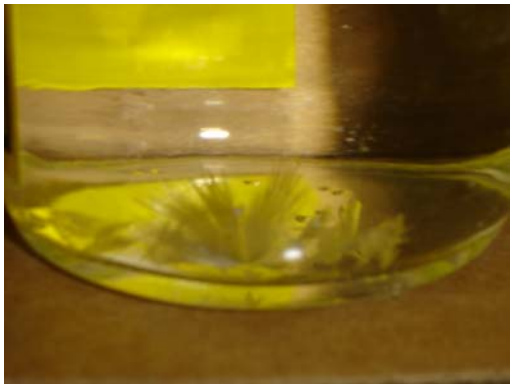
Environmental Health and Safety Update

Peroxide-Forming Chemicals

Overview

Peroxide-forming chemicals are a class of compounds that have the ability to form shock-sensitive explosive peroxide crystals. Many of the organic solvents commonly used in Weill Cornell Medical College's laboratories have the potential to form explosive peroxide crystals, diethyl ether and tetrahydrofuran are two of the more common peroxide-forming chemicals used at WCMC. Therefore, it is extremely important that this procedure be followed regarding the identification, handling, storage, and disposal of peroxide-forming chemicals.

Under normal storage conditions the materials listed in this document have the potential to generate and accumulate peroxide crystal formations, which may violently detonate when subjected to thermal or mechanical shock. Peroxide-forming chemicals react with oxygen – even at low concentrations – to form peroxy compounds. The risk associated with peroxide formation increases if the peroxide crystallizes or becomes concentrated by evaporation or distillation. Factors that affect rate of peroxide formation include exposure to air, light and heat, moisture, and contamination from metals.



Peroxide Formation

Peroxide crystals may form on the container plug or the threads of the lid and detonate when the lid is twisted. Do not open a liquid organic peroxide or peroxide-forming chemical if crystals or a precipitate are present.

Applicability

This Update applies to all College Faculty, Staff, and Students and any other college employee who is involved with the ordering, storage, or use of laboratory chemicals/reagents.

Definitions

A peroxide is a chemical that contains a peroxo (O-O) unit, one that has the chemical formula of O_2^{2-}.

Responsibilities

Environmental Health and Safety (EHS) provides technical assistance lab personnel about the safe handling, storage and disposal of peroxide-forming chemicals and training as needed.

Lab personnel ensure that peroxide-forming chemicals are properly managed and disposed in accordance with this Update.

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EHS Update – Peroxide-Forming Chemicals

Procedure

Purchasing Considerations

- When possible, purchase only peroxide-forming chemicals which contain a peroxide formation inhibitor (e.g., tetrahydrofuran or diethyl ether inhibited with butylated hydroxytoluene (BHT)).
- Only purchase quantities of peroxide-forming chemicals that you expect to use within expiration and disposal timeframes.

Labeling Requirements

- All bottles of peroxide-forming chemicals must have the **date received** marked on the container.
- When the bottle is first opened, the container must be marked with the **date opened**.

Example Label

Peroxide-Forming Chemical
Date Received:_____
Date Opened:_____

Storage and Use Requirements

- Do not store peroxide-forming chemicals in direct sunlight as light can accelerate the chemical reactions that form peroxides.
- If the peroxide-forming chemical is flammable and requires refrigeration, then an explosion-proof refrigerator must be used.
- Do not distill, evaporate or concentrate a peroxide-forming chemical until you have first tested it for the presence of peroxides. (Peroxides are usually less volatile than their parent material and will tend to concentrate in the hot distillation pot).
- NEVER UNDER ANY CIRCUMSTANCES touch or attempt to open container of a peroxide-forming liquid if there are whitish crystals around the cap and/or in the bottle. The friction of screwing the cap may detonate the bottle. If you encounter such a bottle, contact the Environmental Health and Safety office immediately for removal. DO NOT TOUCH OR MOVE THE SUSPECT BOTTLE YOURSELF FOR ANY REASON.

Disposal Requirements

- There are four classes of peroxide-forming chemicals based upon the peroxide formation hazard:
  Class A – Severe Peroxide Hazard
  Class B – Concentration Hazard
  Class C – Shock and Heat Sensitive
  Class D – Potential Peroxide-Forming Chemicals
- Peroxide-forming chemicals must be disposed within the timeframes specified in the table below regardless if the container has unopened. Disposal with EHS must occur within the timeframe allowed once the container is received or opened, which ever the earlier of the two dates.

	Class A	**Class B**	**Class C**	**Class D**
Date Opened	3 months	6 months	6 months	Only if peroxide crystals are present.
Date Received	1 year	1 year	1 year	

- Submit an online chemical collection request form to EHS to request the disposal of a peroxide-forming chemical. The online form is available on EHS' website at: www.med.cornell.edu/ehs

  NOTE: If the peroxide-forming chemical has a visible peroxide formation or is greater than a year old, bypass the online form and contact EHS immediately. ***Do not move or handle these containers.***

- EHS has contractors available to test and, if necessary, stabilize peroxide-forming chemicals.

EHS Update – Peroxide-Forming Chemicals

Peroxide Forming Chemical Lists

Class A – Severe Peroxide Hazard

Spontaneously decompose and become explosive with exposure to air without concentration.

Butadiene (liquid monomer)	Isopropyl ether	Sodium amide (sodamide)
Chloroprene (liquid monomer)	Potassium amide	Tetrafluoroethylene (liquid monomer)
Divinyl acetylene	Potassium metal	Vinylidene chloride

Class B – Concentration Hazard

Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated.

Acetal	Diethylene glycol dimethyl ether (diglyme)	4-Methyl-2-pentanol
Acetaldehyde	Diethyl ether	2-Pentanol
Benzyl alcohol	Dioxanes	4-Penten-1-ol
2-Butanol	Ethylene glycol dimethyl ether (glyme)	1-Phenylethanol
Cumene	Furan	2-Phenylethanol
Cyclohexanol	4-Heptanol	2-Propanol
Cyclohexene	2-Hexanol	Tetrahydrofuran
2-Cyclohexen-1-ol	Methylacetylene	Tetrahydronaphthalene
Decahydronaphthalene	3-Methyl-1-butanol	Vinyl ethers
Diacetylene	Methylcyclopentane	Other secondary alcohols
Dicyclopentadiene	Methyl isobutyl ketone	

Class C – Shock and Heat Sensitive

Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock and heat sensitive.

Acrylic acid	Chlorotrifluoroethylene	Vinyl acetate
Acrylonitrile	Methyl methacrylate	Vinylacetylene (gas)
Butadiene (gas)	Styrene Vinylpyridine	Vinyladiene chloride
Chloroprene	Tetrafluoroethylene (gas)	Vinyl chloride (gas)

Class D – Potential Peroxide Forming Chemicals

May form peroxides but cannot be clearly categorized in Class A, B, or C.

Acrolein	p-Chlorophenetole	4,5-Hexadien-2-yn-1-ol
Allyl ether	Cyclooctene	n-Hexyl ether
Allyl ethyl ether	Cyclopropyl methyl ether	o.p-Iodophenetole
Allyl phenyl ether	Diallyl ether	Isoamyl benzyl ether
p-(n-Amyloxy)benzoyl chloride	p-Di-n-butoxybenzene	Isoamyl ether
n-Amyl ether	1,2-Dibenzyloxyethane	Isobutyl vinyl ether
Benzyl n-butyl ether	p-Dibenzyloxybenzene	Isophorone
Benzyl ether	1,2-Dichloroethyl ethyl ether	b-Isopropoxypropionitrile
Benzyl ethyl ether	2,4-Dichlorophenetole	Isopropyl-2,4,5-trichlorophenoxy acetate
Benzyl methyl ether	Diethoxymethane	n-Methylphenetole
Benzyl-1-napthyl ether	2,2-Diethoxypropane	2-Methyltetrahydrofuran
1,2-Bis(2-chloroethoxyl)ethane	Diethyl ethoxymethylenemalonate	3-Methoxy-1-butyl acetate
Bis(2-ethoxyethyl)ether	Diethyl fumarate	2-Methoxyethanol

Bis(2-(methoxyethoxy)ethyl) ether
Bis(2-chloroethyl) ether
Bis(2-ethoxyethyl) adipate
Bis(2-methoxyethyl) carbonate
Bis(2-methoxyethyl) ether
Bis(2-methoxyethyl) phthalate
Bis(2-methoxymethyl) adipate
Bis(2-n-butoxyethyl) phthalate
Bis(2-phenoxyethyl) ether
Bis(4-chlorobutyl) ether
Bis(chloromethyl) ether
2-Bromomethyl ethyl ether
beta-Bromophenetole
o-Bromophenetole
p-Bromophenetole
3-Bromopropyl phenyl ether
tert-Butyl methyl ether
n-Butyl phenyl ether
n-Butyl vinyl ether
Chloroacetaldehyde diethylacetal
2-Chlorobutadiene
1-(2-Chloroethoxy)-2-phenoxyethane
Chloroethylene
Chloromethyl methyl ether
beta-Chlorophenetole
o-Chorophenol
Diethyl acetal
Diethylketene
Diethoxybenzene (m-,o-,p-)
1,2-Diethoxyethane
Dimethoxymethane
1,1-Dimethoxyethane
Di(1-propynl) ether
Di(2-propynl) ether
Di-n-propoxymethane
1,2-Epoxy-3-isopropoxypropane
1,2-Epoxy-3-phenoxypropane
p-Ethoxyacetophenone
1-(2-Ethoxyethoxy)ethyl acetate
2-Ethoxyethyl acetate
(2-Ethoxyethyl)-a-benzoyl benzoate
1-Ethoxynaphthalene
o,p-Ethoxyphenyl isocyanate
1-Ethoxy-2-propyne
3-Ethoxypropionitrile
2-Ethylacrylaldehyde oxime
2-Ethylbutanol
Ethyl-b-ethoxypropionate
Ethylene glycol monomethyl ether
2-Ethylhexanal
Ethyl vinyl ether
2,5-Hexadiyn-1-ol
3-Methoxyethyl acetate
2-Methoxyethyl vinyl ether
Methoxy-1,3,5,7-cyclooctatetraene
b-Methoxypropionitrile
m-Nitrophenetole
1-Octene
Oxybis(2-ethyl acetate)
Oxybis(2-ethyl benzoate)
b,b-Oxydipropionitrile
1-Pentene
Phenoxyacetyl chloride
a-Phenoxypropionyl chloride
Phenyl-o-propyl ether
p-Phenylphenetone
n-Propyl ether
n-Propyl isopropyl ether
Sodium 8-11-14-eicosatetraenoate
Sodium ethoxyacetylide
Tetrahydropyran
Triethylene glycol diacetate
Triethylene glycol dipropionate
1,3,3-Trimethoxypropene
1,1,2,3-Tetrachloro-1,3-butadiene
4-Vinyl cyclohexene
Vinylene carbonate

References

National Safety Council: Data Sheet I-655 Rev. 87
NFPA: NFPA 432, Code for the Storage of Organic Peroxide Formulations
Reactive Hazards Reduction, Inc. http://www.rhr-inc.com/
FDNY: 3 RCNY Chapter §10-01 – Chemical Laboratories