ENVIRONMENTAL HEALTH AND SAFETY

Lab Chatter

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SAFETY SPOTLIGHT:
Peroxide Forming Chemicals

By Jesse Millen-Johnson

Some common laboratory chemicals like diethyl ether can react with oxygen over time to form potentially explosive peroxides. When these peroxides reach a high enough concentration, they may explode when exposed to heat, friction, or shock. Simply opening the cap of a container with peroxide crystals on the threads of the lid could cause an explosion.

Classes of compounds that can form peroxides include:

- Ethers, acetals, and ketals, especially cyclic ethers and those with primary and/or secondary alkyl groups
- Aldehydes, including acetaldehyde and benzaldehyde
- Compounds containing benzylic hydrogens
- Compounds containing allylic hydrogens, including most alkenes; vinyl and vinylidene compounds, and dienes

The most hazardous peroxide forming chemical classifications are:

Class A - Severe Peroxide Hazard
Spontaneously decompose and become explosive with exposure to air without concentration.
Includes: *potassium amide, isopropyl ether, potassium metal, vinylidene chloride, sodium amide (sodamide), etc.*

Class B - Concentration Hazard
Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated.
Includes: *diethyl ether (ethyl ether, ether), cyclohexene, furan, dioxanes, vinyl ethers, methyl isobutyl ketone, etc.*

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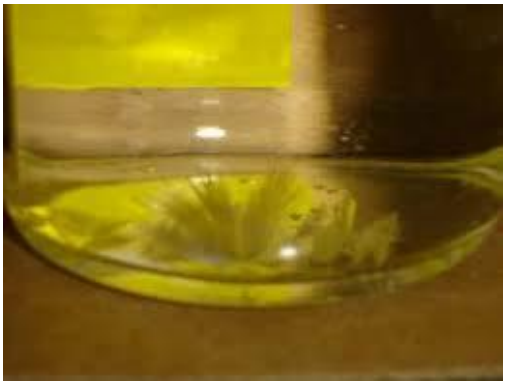
Class C - Shock and Heat Sensitive
Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock- and heat-sensitive. The chemicals often come with inhibitors (peroxide scavengers) added to them by the manufacturer for safety.
Includes: *acrylic acid, methyl methacrylate, styrene, vinyl chloride (gas), chloroprene, etc.*

Peroxidizable chemical classification	**Discard (or test) after**
All *unopened* Class A, B, C containers	1 year or by expiration date
Opened containers:	
Class A	3 months
Class B	1 year or by expiration date
Class C (uninhibited)	24 hours
Class C (inhibited)	1 year

Ethyl ether is a Class B peroxide former that is common in laboratories

Important considerations when using peroxide forming chemicals:

- Purchase the absolute minimum amount necessary and make sure chemicals are dated upon arrival from manufacturer and when first opened
- Store peroxide formers away from light in original container (especially diethyl ether).
- Never open a container of a potential peroxide former that is visibly old or of unknown age, has discolored or crystalized liquid inside, has crystals around the cap or in the lid, or has liquid that is stratified or rusty



Peroxide crystals in liquid

EARTH MONTH AT UNE:

A wide variety of sustainability events

Earth Month 2022 includes a multitude of forums, lectures, and activities, which can all be found on the **event calendar.**

One unique offering is a Sustainable Ocean Foods presentation on Friday, April 15th in Commons 204 from 11-12:20.

The UNE Planetary Health Council will host Sophie Scott of the Gulf of Maine Research Institute as she discusses their Sustainable Seafood Project, including its Responsibly Harvested labeling program. This effort helps support local fishing communities while guiding consumers toward more sustainable dining choices.

Immediately following the event, Parkhurst will offer a $5 seafood lunch in the Dining Commons.

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University of Pennsylvania Vacuum Pump Explosion

Courtesy of Penn Environmental Health and Radiation Safety

On the evening of August 14, 2020, a University of Pennsylvania chemistry graduate student was attempting to evaporate ethyl acetate and hexane using a Buchi Rotavapor (R-200) connected to a Savant VP100 rotary-vane roughing pump. The vacuum pump was located in a designated pump cabinet in the base of the fume hood, and power to the cabinet was controlled by a toggle switch on the face of the fume hood.

The student was alone in the lab at 6:30 PM when he engaged the power switch on the hood to turn on the vacuum pump. He reports that the vacuum monitor on the rotary evaporator indicated that the pump was not supplying vacuum, so he turned off the power switch. When he flipped the switch back on, he heard "a loud bang" and saw the cabinet door "burst open." The vacuum pump was on fire, producing orange flames and black smoke.

The student was not standing in front of the cabinet when the explosion occurred and as a result was uninjured. The fire alarm was activated, and the fire department extinguished the fire using water.

Based on the information provided by the witnesses and responders, the most likely direct cause of the explosion was the ignition of an explosive concentration of diethyl ether vapor expelled from the pump exhaust. The source of ignition may have been either a spark from the pump motor or from the cooling fan inside the cabinet, both of which are controlled by the same power switch. Diethyl ether, which was evaporated using this system earlier in the day, may have been pulled into the vacuum pump and then been exhausted into the cabinet. The vapor from the pump exhaust could have ignited when the student flipped the toggle switch to energize the pump and cooling fan.

Penn vacuum pump after explosion

Lessons Learned:

- All vacuum exhaust must be properly vented and include sufficient condensing capacity prior to the pump. The exhaust ports of pumps stored in vacuum pump cabinets must be connected directly to the vent port inside the cabinet. The pump may not vent into the cabinet interior.

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- Any rotary evaporator systems that are using rotary vane pumps should be reviewed to determine whether the vacuum pressure is appropriate to the application and is well controlled. A less powerful vacuum pump with more precise vacuum control (such as a diaphragm pump) is more appropriate for rotary evaporation of low boiling solvents. Diaphragm pumps offer advantages including their small size, chemical-resistance, and ability to fit next to the Rotavapor in the fume hood.

- It is important to select the right pressure and temperature when condensing solvent vapor in rotary evaporation. For a sufficient condensation of the vapor, you should set the cooling temperature at about 20°C lower than the vapor temperature. This is known as the "Delta 20 Rule": set the bath temperature at 50°C to yield a solvent vapor temperature of 30°C, which is subsequently condensed at 10°C.

- Keep detailed records of all pump maintenance including routine maintenance and vendor-provided services.

- Use a second cold trap between the pump and the experiment to minimize the amount of volatile chemicals reaching the pump. This will also help to protect the pump from damage caused by degradation and contamination of the pump oil.

- Empty the condenser trap immediately after evaporation is complete to eliminate the possibility that solvent will evaporate as the condenser warms to room temperature.

Pump cabinet at base of fume hood

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Centrifuge Safety Tips

Source: The University of Texas at Austin EHS

If hazardous materials such as toxic or infectious agents will be placed in a centrifuge, precautions must be taken to prevent an exposure of lab personnel to aerosols or liquids. Improper care of a centrifuge and its components can lead to exposure to hazardous substances, injuries, damaged equipment and lab space, and a loss of research, money, and time.

Types of Centrifuges:

- Microcentrifuge ~15,000 rpm
- Low/High speed 2,000 - 20,000 rpm
- Ultracentrifuge ~120,000 rpm

Operating Procedures:

- Develop and implement a strict cleaning, storage, and maintenance protocol
- Only use manufacturer compatible centrifuge, rotor, buckets, caps, and adapters
- Replace centrifuge parts, including bottles, tubes, and O-rings at the first sign of damage
- Assemble the bottles, buckets, and rotor per manufacturer's instructions
- Tightly seal all tubes and safety cups
- Close lid during operation
- Allow to come to complete stop before opening

Safe Operation:

- Use safety cups whenever possible
- Disinfect or clean weekly and after all spills or breakages
- Lubricate O-rings and rotor threads weekly
- Do not operate the centrifuge without the rotor properly balanced
- Do not use rotors that have been dropped
- Inspect the speed disk for signs of damage if using an ultra-speed unit and discontinue use if damaged
- Inspect the rotor and tube cavities and discontinue use if damaged

Using Swinging Bucket Rotors:

- Ensure all metal buckets are in place
- Use matching buckets, caps, and adapters
- Load symmetrical to axis of rotation and to pivotal axis within the manufacturer's recommended load tolerance
- Ensure buckets are properly seated to the rotor and the rotor is properly attached to the centrifuge spindle.

Additional Controls for Fixed Angle Rotors:

- Tighten rotor lid correctly
- Properly install and attach rotor to spindle
- Gently pull up on the rotor to confirm rotor is attached
- Contact your centrifuge representative for specific information
- *If you suspect leakage occurred from the centrifuge, leave the area, notify individuals on laboratory emergency contact cards if applicable, do not open the centrifuge for at least 30 minutes to allow aerosols to settle, then only return after taking necessary precautions and while wearing appropriate PPE.*

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