Incident Case Study – Friday, December 2nd, 2011

Incident description

This report details an explosion in a laboratory fume hood on Friday, December 2nd. A graduate student was reproducing a published experimental technique requiring the use of nitric acid. This was the labs first time working with nitric acid and no protocols were in place before hand. Before experimentation, safety and handling protocols were discussed informally among lab members but no formal procedures were written up or established. A new waste container was made for the nitric acid. The experiment called for soaking material in nitric acid to remove a polymer layer and then rinsing with ethanol to remove the debris. Assuming it to be safe, the graduate student rinsed the material directly into the new waste container. After rinsing, the student emptied the used nitric acid into the waste container, capped the container, closed the fume hood glass, and walked away. Seconds later the waste container exploded. Fortunately, no one was in the immediate area. Two panes of the fume hood glass were severely damaged, glass shards were scattered throughout the hood and the surrounding area, and the general area was contaminated with nitric acid. During the experiment the stock solution on nitric acid remained in the hood. The hood also had waste containers for biohazard waste and saturated KOH solution. The explosion damaged the stock nitric acid container, compromising its integrity and shattered the top of the KOH waste container. EHS was contacted immediately to assess the situation and clean-up and the lab was evacuated until an all clear was given.

Prevention

There were two factors that directly lead to the incident. The first was mixing organics with nitric acid. Nitric acid reacts violently to a number of chemical classes and organics is one of the strongest reacting. The second was sealing the waste bottle container while it was reacting. The volumes of both liquids were relatively small compared to the volume of the waste bottle. The reaction, however, resulted in significant gas generation which pressurized the container and led to an explosion.

This incident was preventable. The laboratory members should have taken the time to carefully assess the hazards of working with these chemicals and each of the steps of the protocol. Subsequently, a detailed nitric acid handling protocol has been devised, detailing risks and precautions that ought to be taken. This document can be found at the end of this report.

Risk assessment recommendations

Incidents like these can be prevented in the future by:

- Requiring written procedures and handling protocols when working with any new chemicals and have them verified by others in the research group, as a safety check.
- During the creation of these documents researchers should seek out existing materials detailing standard operating procedures for working with new chemicals.

Recommendations for the types of guidance PIs should provide

PIs must provide clear and understandable guidance to all members of the lab on research safety and risk assessment.

- PIs can provide resources explaining the importance of research safety and risk assessment and how to perform risk assessments upon joining the lab.
- These guides should focus specifically on the type of research being conducted in the lab
- PIs can provide more guidance as needed depending on the level and type of risks associated with laboratory work and the understanding of the individual lab member
- PIs can also stress the importance of adhering to safety procedures and performing appropriate risk analysis.
- PIs can set up safety checks within the lab, having more senior and experienced members, such as post-docs and senior graduate students, monitor and keep aware of the activities of newer and inexperienced members such as undergraduates and new graduate students.

Recommendations on how PIs should verify understanding of various risks and how to protect against them

PIs are the first line of enforcement for safety and training in their laboratories, as such their involvement in these processes are very important.

- PIs should verify that procedures have been documented and rigorously evaluated prior to procurement of new chemicals or allowing experiments to commence.
- PIs should encourage regular follow-ups and revisions of said documents based on the experiences of those working with the chemical both inside and outside of the laboratory.

- PIs should also perform periodic checks to ensure that documented procedures are being followed, ensuring compliance and understanding of the risks.
- PIs should also check on safety and protocol compliance during group meetings.

Nitric Acid Handling Procedure

Adapted from Guidelines for the Safe Use of Nitric Acid, University of Pittsburgh Safety Manual, Acc. 11 Dec 2011; Hazardous Materials: Nitric Acid Safe Handling Guideline, Stanford University ES&H Manual, Upd. 30 Dec 2008

General

Nitric Acid (**HNO3**) is a clear, colorless to slightly yellow inorganic acid. In concentrations above 70%, nitric acid is called "fuming" or "red fuming." The material is not combustible, however it is a strong oxidizer and care should be taken in storing it away from incompatibles (see below). Spontaneous ignition or combustion takes place when a substance reaches its ignition temperature without the application of external heat. Materials susceptible to spontaneous combustion due to contact with nitric acid include oily rags, dust accumulations, and many organic materials. Routes of entry to the body include inhalation and ingestion. Skin contact results in severe irritation and burns. Nitric acid is not listed as a carcinogen.

Exposure Hazards

Inhalation

Inhalation burns are serious and require immediate attention. Inhalation may result in a burning sensation, cough, labored breathing, chemical pneumonia, unconsciousness, and death. Symptoms maybe delayed. If inhalation occurs, bring victim out into fresh air. Do not allow them to lay flat as fluid may accumulate in lungs. Provide oxygen and/or artificial if needed.

Ingestion

Ingestion causes abdominal pain, vomiting, hemorrhaging, and organ perforation. In case of ingestion, drink copious amounts of water and seek medical attention. Do NOT induce vomiting.

Surface Contact

Skin contact may result in serious skin burns, pain, and yellow discoloration. Eye contact may result in redness, pain, and severe deep burns. In case of surface contact, wash surface with generous amounts (running) of water for 15 minutes. If appropriate, use emergency shower or eye wash.

Limits

OSHA permissible expose limit (PEL) is 2 ppm. Immediately dangerous to life and health (IDLH) levels are greater than or equal to 25 ppm.

Safety Precautions

1. All members of the lab working with nitric acid should familiarize themselves with the dangers and special requirements of handling nitric acid as well as this document.
2. Work with nitric acid should always be performed in the chemical fume hood. Ensure that the hood is cleared of organics, flammables, and other incompatibles.
3. Incompatibles include: flammables, bases, hydrogen sulfide, organic materials, carbides, metals, and metal compounds. Reacts with water to produce heat.
4. Always wear appropriate gloves (double glove with neoprene and chloroprene gloves), safety glasses, and a lab coat when handling nitric acid. An apron and full face shield are optional.
5. Nitric acid must have its own waste container and not be mixed with any other chemicals.
6. Small or dilute concentrations of nitric acid can be cleaned up using a spill kit.
7. Call EHS at 314-362-6816 for large spills and evacuate the laboratory.

Storage and Waste

Nitric acid should be either stored in its own acid cabinet or with other inorganic acids and in secondary containment. Nitric acid must have its own waste container and not be mixed with any other chemicals.