

## *Laboratory Accidents/Explosions Involving Nitric Acid and an Organic Solvent*

**There** have been a number of laboratory accidents and explosions at colleges and universities over the years involving the inappropriate use of nitric acid and one or more organic solvent(s) that have resulted in personal injury and physical destruction.

“...Nitric acid is the common chemical most frequently involved in reactive incidents, and this is a reflection of its exceptional ability to function as an effective oxidant even under fairly dilute conditions (unlike sulfuric acid) or an ambient temperature (unlike perchloric acid). Its other notable ability to oxidize most organic compounds to gaseous carbon dioxide, coupled with its own reduction to gaseous ‘nitrous fume’ has been involved in many incidents in which closed, or nearly closed reaction vessels or storage cabinets have failed from internal gas pressure.” (Bretherick 1990)

The accidents have occurred during one of the stages of the laboratory life cycle involving the use of these type of chemicals. The stages include the segregation of nitric acid from other organic solvents when purchased, the proper sequence of events during the course of experimentation, the washing of glassware, and improper waste handling.

Nitric acid must be physically segregated from organic solvents as well as all other acids since it is in a class by itself. Contact between a broken organic solvent bottle and a container of nitric acid can lead to the release of nitrous fumes and a potential violent explosion.

Incidents have occurred in teaching labs during the nitration step of the experiment. For example, too much nitric acid will be added to the organic solvent resulting in a violent explosion from the exceedance of the temperature. More than a few milliliters of an organic solvent or nitric acid can catalyze a reaction.

Explosions have also occurred when the organic acid is added to the nitric acid instead of the reverse.

Nitric acid is used to remove trace contaminants from

glassware. Nitric acid residue can react if ethanol/ether is used for drying.

Improper waste handling is a big problem in teaching and large research laboratories where there are significant number of personnel conducting experiments and using multiple satellite accumulation areas to collect their waste. Empty organic solvent bottles are many times used to collect nitric acid waste in these different satellite accumulation areas. Improper labeling of the containers can lead to the mixing of the two chemicals over time and can result in a violent explosion.

There are health and economic costs resulting from a laboratory explosion involving the mixing of nitric acid with an organic solvent.

Flying glassware and shrapnel have injured laboratory personnel when the fume hood has exploded.

Laboratory personnel have also suffered inhalation injuries from the release of nitrous fumes. The destruction of old fume hood panels made of transite could lead to the release of asbestos fibers.





There have been economic costs resulting from the destruction of fume hoods and laboratory equipment. Principal investigators working on grant deadlines lose valuable time being unable to conduct their research. Minus 40 and 80 degree freezers containing research samples could be compromised or destroyed.

Experts from Offices of Environmental Health and Safety at major colleges and universities believe laboratory accidents and explosions involving nitric acid and organic solvents can be significantly reduced if certain steps are followed in the laboratory life cycle. The steps are outlined below:

Teaching assistants, graduate students, and principal investigators need to be required to have annual lab safety training. Part of this training should center on standard operating procedures on the safe use of nitric acid and organic solvents. Principal investigators should alert the Office of Environmental Health at their institution if they plan on conducting experiments using nitric acid

and an organic solvent. EHS would develop a safety plan and give training to the respective lab group.

The Environmental Health and Safety Offices at many universities recommend the implementation of the following standard operating procedures for conducting experiments involving nitric acid and organic solvents.

- Limit oxidizing acid solutions to the amount generated in one day.
- Leave oxidizing acid solutions in a fume hood for 24 hours mixing (most incidents occur in 1-7 hours post mixing)
- Post a sign warning when these are in use and waiting
- “Close with a watch glass, septum, cork or something that will release in the event of unintended mixing.
- Place container (vial, tube, jar, bottle) of day’s material into a prelabeled bucket. This will prevent inadvertent mixing of larger volumes.

Other Environmental Health and Safety Offices recommend that an auto dispenser be used for the dispensing of nitric acid when the experiment involves the use of both solvents.

Laboratory accidents and explosions can be reduced with waste segregation that involves better labeling. Color coding nitric waste containers in some high hazard way is one recommendation put forth by experts in the environmental health and safety field.

Other recommendations put forward involve waste collection containers. Recommendations include having a standard operating procedure that prohibits the reuse of an empty organic solvent bottle to collect nitric waste, a standard operating procedure that requires that an organic solvent bottle be triple rinsed with water, or one where a safety coated amber glass bottle or PTFE container be used.

*There are health and economic costs resulting from a laboratory explosion involving the mixing of nitric acid with an organic solvent.*

## References

1. Bretherick, Leslie. Bretherick's Handbook of Reactive Chemical Hazards. Cornwall: Butterworth & Co. Ltd., 1990

\*PLEASE DISPLAY ON COMMUNITY BOARDS OR SHARE WITH ANYONE WHO WOULD BE INTERESTED