University Health and Safety

Fact Sheet

Nitric Acid

Nitric Acid[1] is a strong oxidizer that is incompatible with organic materials. Nitric Acid is the chemical that is most frequently involved in reactive incidents[2].

"...this is a reflection of its exceptional ability to function as an effective oxidant even when fairly dilute (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 of the incidents in which closed, or nearly closed, reaction vessels or storage containers have failed from internal gas pressure."
Bretherick's 4430 pg 1633

The products of incompatible mixing are copious amounts of heat and gases. A large amount of pressure can build up inside even partially closed containers and potentially rupture the container.

Be Aware

- even trace amounts, are enough to catalyze a reaction with an incompatible material. See Video of ethanol plus Nitric Acid). https://www.youtube.com/watch?v=uFwiZYfEsuY (4 mL nitric acid is added to 2 mL ethanol inside a 100 ml erlenmeyer flask, there is a delay of 2 min 30 sec before the reaction begins, vigorous boiling shakes the flask and off-gassing blows the funnel off twice.)
- there is often a significant delay before the results of incompatible mixing are evident. An unexpected reaction involving nitric acid may not occur until typically several hours (1- 7 hours) later.
- Incidents have occurred in teaching labs (nitration gone wrong), during experiments (cleaning, trace metal analysis, and electro polishing) and because of improper waste handling.

[1] Also a strong acid and corrosive
[2] Bretherick's Handbook of Reactive Materials

Best practices

Solution Preparation

- Only prepare as much oxidizing acid solutions as will be used in one day.
- Prepare for heat. Mixing is typically exothermic and may need cooling. Note plastic may melt.
- Prepare for pressure. Choose pressure rated glass e.g. borosilicate, add mesh or poly-coated bottles.[3]
- Always add acid to water! Never add water to concentrated acids. The acid may splatter and generate acidic steam.

Teaching Labs

- Dispense nitric acid from an auto pump dispenser**.** These prevent students from attempting/ inadvertently putting materials back into the stock container. Limits the amount dispensed at a time.
- Check compatibility. Only some dispensers are appropriate for nitric acid.
- Implement preventative maintenance. Even compatible materials start to clog sometime around 10 years.

Cleaning

- DO NOT use organics e.g. ethanol/ether to assist in drying, if Nitric Acid has been used to remove trace contaminants, from glassware. Any residue of nitric acid remaining on the glassware will react.
  See Safety Alert in Nature

Storage[4]

- Must be closed. Precipitates build up on the threads of corrosive materials. Wipe clear periodically to ensure a tight seal.
- Store in a corrosion resistant (wood, plastic or painted metal) cabinet with spill containment.
- Isolate nitric acid.
  - Keep it away from incompatibles organic acids (e.g. formic or acetic acid) and all bases.
  - Consider storing inside a sealed container (e.g. bucket or tote) with neutralizer to contain corrosive vapors, separate from incompatibles and provide spill containment.
- Check red cap's integrity. Only use new never used before caps for replacement. Nitric acid slowly destroys its own red plastic bottle cap.

[3] A pressure relief line to a bubbler may be appropriate for some applications
[4] FYI- Yellowing of nitric acid does not mean it has become dangerous to handle. Over time exposure to light causes the release of nitrogen dioxide.

Post Use and Disposal considerations

Disposal options: A) neutralization, B) liquid waste bottle OR C) contaminated lab-ware

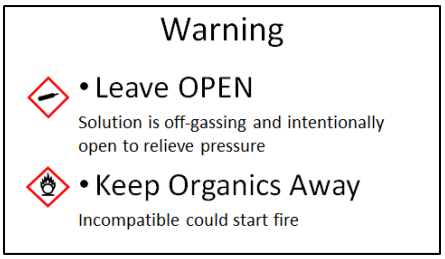
Neutralization	Liquid Waste Bottle	Contaminated Labware
Best for 10 ml- 1 L per batch	Appropriate for 1 L or more/ session	Recommended for less than 1 L volumes.
Not appropriate for • nitric acid solutions mixed with other hazards (flammable solvents, toxics, or heavy metals) or • high concentrations (fuming, > 70%) • multiple users, and not neutralized promptly	Not appropriate for • multiple users/ bottle if any incompatible materials are used in the same area.	Recommended for: • waste containers shared among several people where incompatibles are present in the room.
Possible for incompatible to be added to large volume of nitric (more a few mls) but unlikely to occur if neutralized promptly.	Possible for incompatible to be added to large volume of nitric (more a few mls). Making any incident more likely and larger.	Possible for incompatible to be added to small volume of nitric (< few mls) but unlikely to make contact and react. Making any incident less likely and smaller

A) Neutralization- Only appropriate if solution is free from other hazardous materials e.g. solvents, heavy metals

- Only do small batches at a time. Follow Solution Prep Best Practices
- Use a large surface area container to avoid bubbling over.
- Consider diluting slightly with water before to minimize foaming.
- Add neutralizer slowly e.g. sodium bicarb.
- Check ph, once near 7 ok to dispose of down the drain[5].

B) Liquid waste bottle

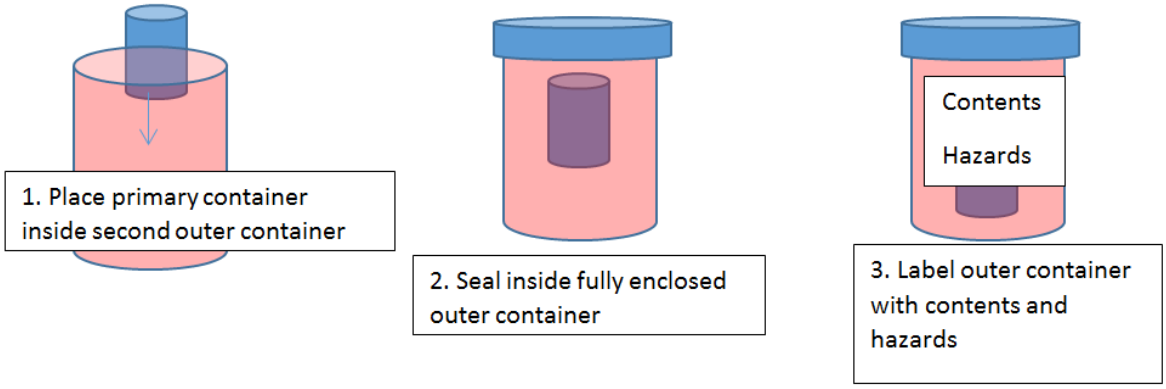
- Strong acids should be collected in glass bottles < 4 L[6]. Plastic bottles and pressure relieving caps are a good choice for relieving mild pressurizations but inadequate for nitric acid reactions.
- Leave oxidizing acid solutions (e.g. aqua regia) in a fume hood for at least 8 hrs post mixing. (most incidents occur in 1-7 hrs post mixing,)
  - Post a sign warning when these are in use and waiting.
  - "close" with a watch glass, septum, cork or something that will easily release in the event of unintended mixing.
- Only use fresh containers for waste. **Do not re-use old solvent bottles for oxidizing acid waste streams.**
- Students in class (and for people new to lab), should test for **pH/oxidizer just before adding to larger bottle** waste to confirm compatible.



[5] Again, only if corrosion was the only hazard and it no longer applies
[6] Exception HF. Glass will not contain HF sufficiently.

C) Over-pack of Contaminated lab ware

- Collect one day's worth of material in a sealed small container e.g. vial, tube, jar, bottle. Put the small container inside a larger sealed container[7] (e.g. bucket). This will prevent inadvertent mixing of larger volumes. Will also instill muscle memory of users of oxidizing acids that these don't simply get poured into a container.



- When outer container is full submit as hazardous waste "contaminated labware"
  - Description should include: what is contaminated (tubes, vials etc) and the hazardous chemicals present.
  - Indicate approximate amounts of:
    - concentrations of the contaminates (ex- 10% Nitric Acid, 20% PBS, 70% water)
    - amount of contamination per contaminated item (example: trace, or 10 ml per vial or 50/jar)
    - Final weight of the outer container. (a 1 gallon jar of contaminated labware is usually 0.5 kg for mostly gloves and light materials to 5 kg for contaminated silica)
- To balance in outer container add extra empty containers, sand or vermiculite (Do NOT use paper, cardboard, rags, paper towels, styrofoam etc)

For more information

Review the safety data sheet for nitric acid from your supplier
See Prudent Practices Laboratory Chemical Safety Summary: Nitric Acid
Contact your Research Safety Professional

[7] Contact UHS if you need an outer container. hazwaste@umn.edu