Department of Chemistry
Columbian College of Arts & Sciences

Chemistry's Cautionary Chronicles

Mar. 2024

Q: What is the smartest piece of lab equipment?
(Flip page for answer)

Daily Reminders

- Always wear proper personal protective equipment (PPE) in lab.
- Wash your hands before leaving the lab.
- Always use caution when handling chemicals.

Picture yourself on an American ranchland, when suddenly you hear hoofbeats. Would you expect to see a zebra? Of course not! Why would an African equine be in the land of stars and stripes? Every day we establish expectations of what is plausible, and on most days our expectations are met. Likewise, we set expectations in our chemistry labs and have an idea of what could happen in our research. Unfortunately, what ought to happen and what does happen does not always align. In 2022, the American Chemical Society (ACS) hosted a webinar titled "Zebras or Horses? How a False Sense of Security Can Lead to Lab Accidents."[1] In it, over 80% of the attendees admitted to having witnessed a lab accident. The ominous part of lab accidents is that while some may be expected (horses), others may not (zebras). This multipart series will use the ACS webinar to identify and analyze a variety of unexpected laboratory calamities.

"Research is what I'm doing when I don't know what I'm doing." - Wernher von Braun, founder of modern rocketry

While venturing into the unknown is exciting, research also carries a responsibility for safety. After an accident at The Huntsman Corporation, lead scientist, Dr. Matthew Meredith, believes Dr. von Braun would even agree that to achieve successful research, a robust groundwork and a thorough grasp of the subject matter are essential. Dr. Meredith's research focused on amine-catalyst stabilization using strong acids.[2] While his research group was ready to face the horses of working with cycloaliphatic diamine catalysts and a variety of strong acids, a zebra was soon to take them by surprise.

The group's procedure for adding acid to amine was very simple. Strong acid was added dropwise to an aqueous amine solution followed by mixing via gentle shaking. If significant exotherm or fuming occurred, the solution was set aside to cool. The low maintenance of the experiment and familiarity with safety protocols created a safety net that lab members were comfortable with. Almost all of the screened acids were carboxylic acids, which were known for having energetic, yet nonviolent exothermic reactions with amines. Nonetheless, on the day of the incident, a lab member found nitric acid, and, unaware of its explosive nature with amines, deemed it suitable for testing. The mixing of 90% nitric acid and the cycloaliphatic diamine catalyst soon led to fuming. As per protocol, the solution was left to cool on a balance inside a ventilated trunk. About 3 minutes later, the glass bottle exploded, bursting into flames. While the blast was mostly contained by the ventilation trunk, the researcher faced first and second-degree burns and glass cuts. Although the lab was able to swiftly respond and contain the fire, this zebra encounter almost turned deadly.

An internal investigation concluded that the precautions in the experimental design were not enough to counteract the reactivity of the newly introduced nitric acid, and without thorough mixing nor extra cooling, the volatile nature of nitric acid was kept unchecked. Simply, the real cause of the accident was a lack of knowledge of nitric acid. By expanding the parameters of the experiment, the researcher ventured into new territory without appropriate comprehension of the environment. Unexpected situations can emerge at any moment, especially when introducing new variables. Therefore, it is critical to minimize surprises by possessing a thorough understanding of all the chemicals involved. For an in-depth analysis of this accident including background information, its pitfalls, corrective actions, and tips on future experimental setups, read the full article.[2]

1. ACS Webinars. (Producer). (2022). Zebras or Horses? How a False Sense of Security Can Lead to Lab Accidents [Video]. https://www.acs.org/acs-webinars/library/false-security.html
2. Lessons Learned from a Delayed Exothermic Decomposition—Amine Neutralizations with Strong, Oxidizing Acids. Matthew T. Meredith. ACS Chemical Health & Safety (2022) 29 (1), 72-78. https://pubs.acs.org/doi/full/10.1021/acs.chas.1c00042

Important Contacts

GW Police Department & EMerge: (202) 994-6111
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Office of Emergency Management: (202) 994-4936 or oem@gwu.edu
Chemistry Stockroom: (202) 994-6582

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You've probably used hydrochloric acid (HCl) in your lab. It's that clear, colorless to light yellow liquid with a sharp, pungent odor, marked by hazardous symbols of a chemical spill on hand (corrosive) and an exclamation mark (harmful/irritant). It is one of the most common chemicals used in acid-base titrations and one of the first to come to mind when we think of strong acids. HCl is highly corrosive and will cause irreversible damage to most substances—it is certainly not something that you would want to chug down nor dip your hands in—but are you really taking the necessary precautions when storing, using, and disposing of this corrosive, toxic chemical? Let's set the scene.

It's April 1957, in Albany, NY. A cool breeze is blowing through the trees, the sun is shining through the leaves, and you are walking along the streets. Suddenly, you see a haze of greenish-yellow fumes drifting toward you. A moment of silence ensues, and then murmurs arise about a possible alien invasion. Sirens soon break through the chaos, and within minutes, everyone in a 10-block radius is being evacuated. Rest assured, little green men did not land on Earth. This phenomenon was, instead, the result of a 4,800-gal 31% concentrated HCl spill.[1]

While filling a 5,700-gal HCl storage tank, the Surpass Chemical Co., Inc's tank ruptured, surging gallons of the corrosive chemical out into the open. 8 workers and 32 others were hospitalized. The immediate cause of the rupture was identified as an over-pressurization of the tank. There are major takeaways from this incidence that can be applicable to our labs. For instance, do you have precautions in place for the generation and build-up of hydrogen and chlorine gasses in your HCl and HCl-related product waste containers? That's right, the same chlorine gas experienced in the horrors of WWI can be present in the containers that you use for everyday chemical disposal. Always check your waste solutions for evolving gasses before transferring them to another waste container, and always use a vented cap to avoid violent ruptures. HCl produces corrosive and toxic vapors at ambient temperature—always store HCl in its original container in a cool, dry, well-ventilated environment.

The sheer force of the 1957 spill was enough to break through the secondary containment of the HCl storage tank. In most other cases, the secondary container is the last line of defense against further spillage, such as in the instance of a broken flask or beaker. Always store and use HCl inside a secondary container, but NEVER in metal—HCl will corrode right through it. Instead, use corrosive-resistant glass or plastic containers made from PVC or polyethylene for HCl storage and disposal. When preparing dilute HCl solutions, always add acid to water. The reverse results in a very exothermic reaction, and the acidic solution may boil, fume, and splatter out of control.

Direct contact with HCl causes severe skin burns and eye damage—let's avoid an embarrassing trip to the ER by wearing the appropriate PPE, like safety goggles, gloves, and lab coats. Emergency eye wash stations and safety showers should be located within easy access; their regular maintenance should also be upheld. We want to avoid scenarios where safety equipment is inoperable in times of need. The unique properties of each chemical may mean additional hazards that require further precautions—always follow lab safety protocol and refer to the SDS.

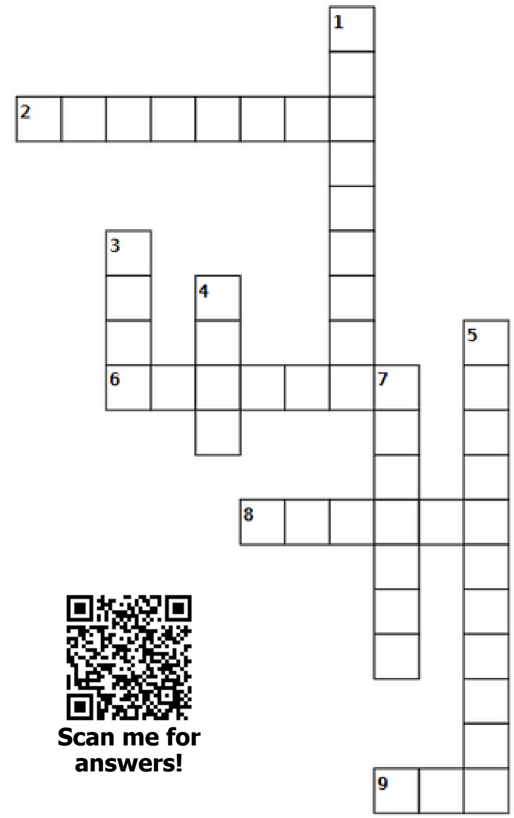
1. US Environmental Protection Agency; US Occupational Safety and Health Administration. EPA/OSHA Joint Chemical Accident Investigation Report (1998): 6. https://archive.epa.gov/emergencies/docs/chem/web/pdf/surpass.pdf (accessed 2023-01-27).

Additional Resources & Training

- **GW Environmental Health & Safety Trainings**: https://safety.gwu.edu/training
- **Free ACS Online Chemical Safety Course**: http://dchas.org/2021/01/28/free-on-line-chemical-safety-course-from-acs/

A: Graduated cylinder.

Chemistry Crossword



Across

2. ___ chemicals tend to evaporate easily.

6. You should always ___ of chemicals properly when finished.

8. Use this feature if you spill chemicals on your body.

9. The acronym for the sheets that give you information about chemicals.

Down

1. These can hurt your eyes and skin.

3. Remember that ___ goes into water and not the other way around.

4. The opposite of a conjugated acid.

5. Something carried out in lab.

7. If a chemical gets into your eyes, you go to the _____ station to flush them.

Upcoming Event(s)

- Flammable Storage Room Best Practices Training - S24 TBD
- Compressed Gases Best Practices Training - S24 TBD