Nitric Acid Acts Upon Trousers: Learning About Hazardous Chemicals

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Ira Remsen (1846-1927)
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- Founded Johns Hopkins University chemistry department.
- Founded one of the first centers for chemical research in the United States.
- Saccharin was discovered in his research lab.
- Had a vivid “learning experience,” which led to a heightened interest in laboratory work.
Nitric Acid Acts Upon Copper

I had only to learn what the words “act upon” meant. ... I put one of them [cent] on the table, opened the bottle marked nitric acid, poured some of the liquid on the copper and prepared to make an observation. But what was this wonderful thing which I beheld? The cent was already changed and it was no small change either. ... A great colored cloud arose. This was disagreeable and suffocating. How should I stop this? ... Nitric acid not only acts upon copper, but it acts upon fingers. The pain led to another unpremeditated experiment. I drew my fingers across my trousers and another fact was discovered. Nitric acid acts upon trousers. ... Plainly, the only way to learn about it was to see its results, to experiment, to work in a laboratory.
Nitric Acid acts upon Copper
Descriptive Chemistry

• Often learned informally outside of classes.
• Interesting chemistry is usually because of reactivity: indicators, production of gas, flame, formation of polymer, oxidation/reduction, chemiluminescence, thermite, decomposition, and explosion.
• But not always reactivity: liquid nitrogen or oxygen, dry ice, He or Ne gas, Hg, “slime”.
Sensing Chemistry

• Interesting chemistry is usually “sensed” by the student: see, hear, smell, taste (just kidding), touch (texture, skin/eye reaction or temperature change).

• Does use of microscale chemistry reduce or eliminate the factor of sensing chemistry?
Making chemistry labs safe

• There has been a general trend in general chemistry lab experiments to eliminate the use of hazardous chemicals. This trend intends to make the laboratory course safer for the students.

• How does a chemistry student, especially a chemistry major, learn how to work with hazardous materials?
Green Chemistry Issue

• Do the principles of green chemistry lead students to infer that the best way to deal with hazardous chemicals is to replace them with non-hazardous chemicals? (see Chem. Health Saf., 2014, 21(6), 45.)

• What the chemical safety professional considers toxic, the synthetic chemist views as reactive.
Work with hazardous chemicals

• Corrosive: HCl, HNO₃, H₂SO₄, NaOH, NH₄OH
• Flammable/combustible: ethanol, methanol, hydrocarbons
• Odor: butyric acid, ammonia, hydrogen sulfide, formaldehyde/formalin
• Cryogenic: liquid nitrogen, dry ice
• Discuss the concept of scaling up a reaction.
Educating Chemistry Majors

• Working with hazardous chemicals – design lab experiments that require use of hazardous materials (corrosives, flammables, noxious odors, air-sensitive).

• Setting up an experiment – glassware, heating and cooling equipment, methods of stirring reactions, blast shields, lasers, waste disposal.

• Discuss, if not experiment with, scale-up.
Non-chemistry Majors

• Safety is a fundamental and important factor in experimental chemistry (science).

• Hazardous chemicals are reactive chemicals. Some of those reactions are good for us (e.g., pesticides, chlorine, ammonia, vaccines, drugs).

• Many (most) chemicals are not hazardous.

• Hazardous waste is disposed of using established procedures that depend on the specific hazard present. Recycling can reduce lab waste.
Conclusions and Recommendations

• Young chemists need to learn how to work safely with hazardous chemicals.
• Hazardous chemicals are often reactive chemicals that facilitate molecular transformations. They make chemistry interesting.
• Design experiments that require use of hazardous materials, including equipment set-up.
• Discuss how scaling up a reaction can change the risk of an experiment.