Chemical Laboratory Safety in Higher Education

MARTIN A. WALKER
PROFESSOR OF CHEMISTRY, STATE UNIVERSITY OF NEW YORK, POTSDAM
Overview

- General issues
- Students in the lab
- Bridging the hazard information gap
- Conclusion
Hazard and risk

Hazard

- “Highly flammable”
- “Highly toxic by inhalation”

Risk

- “Inhalation is extremely unlikely so risk is very low”
Immediate vs. long term hazard

**Acute hazard**
- “It will spontaneously catch fire”

**Chronic hazard**
- “Regular exposure over several years may cause cancer”

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Chemical laboratory hazards

### Substance hazards
- Found in *Safety Data Sheets (SDSs)*, e.g., “Ethanol is flammable”

### Equipment hazards
- “The sand bath is very hot”

### Process hazards
- “Mixing ethanol and nitric acid may cause a major explosion”
Chemical laboratory precautions

- General precautions
  - “Wear safety goggles”

- Experiment-specific precautions
  - “Add the butyllithium slowly, or there will be a runaway reaction”
Students are just learning!

► Students are usually unfamiliar with the lab environment, and may not understand what they’re doing. **BUT**

► Safety information is aimed at safety professionals, not beginners – so much responsibility lies with the instructor.

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Protection vs. Education

- We want to keep our students safe
  
  BUT

- We want them to learn to work with hazardous chemicals safely

- We want them to learn to read basic safety information

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The teaching lab

- General “safety talk” covers basic information
- Expt-specific hazards are assessed in advance
- Hazards are mostly known, but students are beginners
Hazard information for the teaching lab

- Published experiments will usually have substance hazards given, but often little on equipment hazards or process hazards.
- However, any major hazards will have been identified and described. Dangerous procedures will not be used.
Undergraduate research

- More formal, in-depth training used for general hazards
- Students are more experienced, knowledgable, and familiar with equipment
  
  BUT

- Hazards are more unpredictable and serious, esp. if no formal review is done
- Some substance information is often available, but little process information
- Almost every experiment is different
In labs in the UK, the law requires a COSHH assessment. This ensures that every experiment performed receives at least a cursory hazard assessment.
Chemical storage & handling

- Many chemicals have associated hazards => specific storage
  - Acids
  - Flammables
  - Highly toxic materials
  - Peroxide formers

- Incompatible chemicals should be kept separate
  - Oxidizing & reducing agents
  - Acids & bases
The hazard information gap

Expert information often fails to reach the student in the lab.

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Current sources of hazard information

- See Grace Baysinger’s talk for more complete information!
- For substance information, the usual reference is the Safety Data Sheet (SDS), formerly called an MSDS. Safety cards are also useful. Available for all manufactured substances.
- For information on reactivity hazards, the only major reference is “Bretherick’s Handbook of Reactive Chemical Hazards.” Unfortunately, this only lists recorded incidents, and it is proprietary.
Why the gap?

- Chemists are principally trained (and interested!) in chemistry – not chemical safety or toxicology
- Much hazard information is held in proprietary sources
- When an incident occurs, the causes may be unknown, and the event may be “hushed up”
What is needed

- An open and comprehensive database of chemical hazard information
- Different types of hazard should be searchable
  - Acute vs chronic
  - Substance vs process
- Information should be presented in a way that is clear for working chemists & students
- Ideally, there should also be predictive tools for prophetic substances/procedures

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iRAMP project

- Aims to collate information and present it via smartphone or computer at point of use
- Substance data from SDSs & known incidents
- Process information from known incidents
- Based on chemical ontologies, with controlled vocabulary to describe process operations
Conclusions

- Educational institutions have different issues than professional laboratories
  - Experiments are often more controlled, but students are beginners and may do “silly things”
- Hazard information may not be easily accessible, especially by the student
- A more open, comprehensive and user-friendly resource is needed for hazard information
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- Thanks for listening!