Chemical Safety and Use of Fume Cupboard

Department of Chemistry

The University of Hong Kong

Major Safety Related Incidents in Recent Years

Nature of Accident	No.	Injury
Spillage of methyl vinyl ketone	1	Y
Spillage of 2.5 L dichloromethane	1	Y
Spillage of 250 mL conc. HCl	1	N
Spillage of 10 mL *t*-butyl isocyanide	1	N

Nature of Accident	No.	Injury
Spillage of 2 L sulphuric acid	1	N
Spillage of 500 mL nitric acid	1	N
Spillage of 500 mL dimethyl sulfide	1	N
Chemical in eye	3	Y
Solvent overflow from stillhead	1	N
Cryogenic burn at hand	1	N
Explosion of high pressure reactor	1	N

Ignition of n-hexane by sodium	1	Y
Flash fire caused by ether from rotary evaporator	3	N
Fire from overheating oil bath	1	N
Flash fire from acetone	1	N
Fire from cutting sodium	1	N
Fire during disposal of sodium	5	Y
Fire during quenching of NaK alloy	1	Y
Fire during quenching of potassium	1	Y
Fire during quenching of CaH	1	N
Fire during quenching of $LiAlH_4$	1	Y

Safety Related Incidents in the Department of Chemistry (2009-2010)

- Acid got into eye
- Fire inside suction flask
- Fire in a desiccators
- Fire during quenching NaH
- Fire during quenching unknown chemicals
- Cut by broken glass
- Water flooding

Injury by broken glass

It happens when:

- Connecting glass adapter into a rubber tubing
- Running flash column
- Evacuating glasswares to vacuum
- Others….

- Check for cracks and do not pressurize glasswares

Quenching of Chemicals

- Always assume that the chemical is highly reactive, especially to water
- Use very small quantity to test the reactivity first. Then gradually increase the amount
- Do it inside a fume cupboard, use a safety shield as additional protection
- Clean up your chemicals when you graduate
- Consult your supervisor when in doubt

Flooding due to overnight experiment

- Several flooding incidents occurred recently, due to refluxing experiments running overnight: either the condenser hose came off, or the hose leaked due to the aging of the hose rubber. Flooding could potentially reek havoc for instruments and electrical wires, and affect electrical supply in the lab.

Lab coats and gloves

- Recently the Safety Office has already posted signs that if you are wearing gloves, you should not handle door knobs or press elevator buttons. This should be quite obvious as whatever chemicals you have on the gloves (and presumably you are wearing gloves to protect yourself from something) will be transferred and other people would be exposed.
- This kind of practice would not be tolerated in companies or professional labs. The same rationale goes for lab coats--which should come off when you leave an experimental area.

Handling of chemicals outside fume cupboard

- It was found that students handle (weighing, transferring, cleaning, disposing of) toxic/smelly chemicals outside fume cupboard
- Remember: many toxic chemicals may be odorless!

Handling of Chemicals

- Handle chemicals *inside fume cupboard*
- Wear *protective gloves* (note: some materials are permeable to organic substances)
- NO EATING in the lab
- DO NOT WEAR GLOVES when leaving the lab.

- Wear Lab Coat, which protects your body in case of chemical spillage
- Transport chemicals carefully-Use a second container if necessary
- Good House Keeping

A lesson from UCLA..

UCLA's Molecular Sciences Building was mostly closed for the holidays on Dec. 29 as research assistant Sheri Sangji worked on an organic chemistry experiment.

Only three months into her job in the lab, the 23-year-old Pomona College graduate was using a plastic syringe to extract from a sealed container a small quantity of t-butyl lithium -- a chemical compound that ignites instantly when exposed to air.

Related Content

Sheri Sangji

As she withdrew the liquid, the syringe came apart in her hands, spewing flaming chemicals, according to a UCLA accident report. A flash fire set her clothing ablaze and spread second- and third-degree burns over 43% of her body.

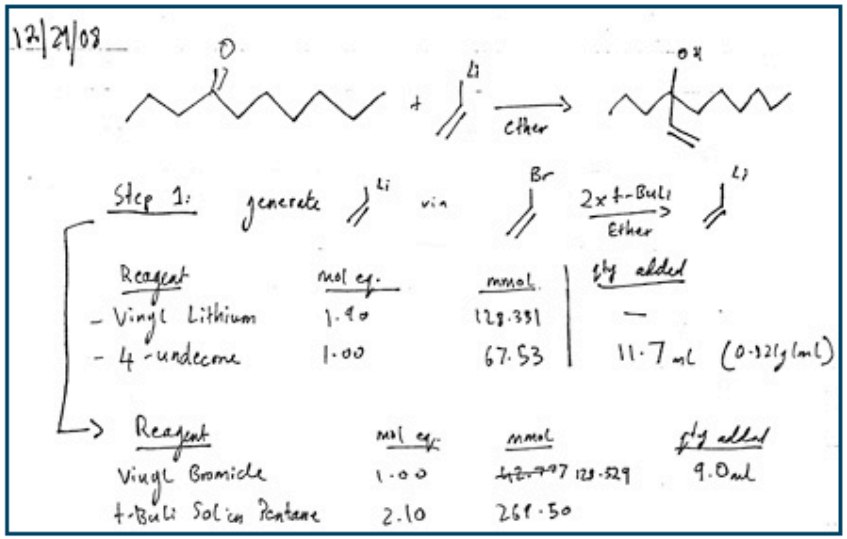
Eighteen excruciating days later, Sangji died in a hospital burn unit.

"It is horrifying," said her sister Naveen, 26, a Harvard medical student. "Sheri wasn't out doing something stupid. She was working in a lab at one of the largest universities in the world. She gets these horrific injuries and loses her life to these injuries and we still don't know how it happened or why it wasn't prevented."

Learning From UCLA

Details of the experiment that led to a researcher's death prompt evaluations of academic safety practices

Jyllian N. Kemsley



UCLA

View Enlarged Image

REACTION Sangji's lab notebook reveals that she planned to react vinyl bromide with tert-butyllithium as the first step of a larger synthesis.

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On Jan. 16, Sheharbano (Sheri) Sangji, a 23-year-old chemistry research assistant, died from injuries sustained in a chemical fire on Dec. 29, 2008, in a laboratory at the **University of California, Los Angeles** (***C&EN Online* Latest News, Jan. 22**).

The incident has trained a spotlight on safety practices in academic labs, with researchers highlighting the need for awareness of risks and regular hazard

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Sheri Sangji, UCLA, Cal/OSHA, Safety

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C & E News August 3, 2009

The accident report:

"The barrel of the syringe was either ejected or pulled out of the syringe, causing liquid to be released," the UCLA accident report stated.

An open flask of hexane was nearby

The panicked young woman ran away from a nearby emergency shower instead of toward it, records state, costing her precious time.

It is unknown whether a typical cotton lab coat would have saved her. But even if it caught fire, it could have been removed much more easily than a burning synthetic sweater, safety expert Phifer said.

"I can't imagine why she didn't have protective clothing if she knew she was working with chemicals that dangerous," Sheri's friend Bruce said.

On Oct. 30, two months before the fire, an annual safety inspection uncovered more than two dozen deficiencies in his four labs, including the one where Sangji worked. Among other things, inspectors found excessive amounts of flammable liquids and missing chemical spill cleanup kits.

"Eye protection, nitrile [rubber] gloves and lab coats were not worn by laboratory personnel," the inspection report said.

After the accident….

A first-aid kit and spill cleanup materials were still lacking; flammable materials and water- and air-reactive chemicals were still being stored improperly; and employees still weren't using protective equipment, the report said.

Both experts also wondered if Sangji and the postdoctoral researchers who risked their lives to help her had received adequate fire safety training. UCLA officials say they had.

"The response afterward is probably most responsible for her death," Phifer said. "The fact that she immediately turned away from the shower and went in the opposite direction is a problem. It means that she wasn't properly trained in what to do in the event she caught fire."

Common Chemical Hazardous Materials

- **Flammable Materials**
- Spontaneously ignitable materials
- Explosives
- Oxidizers
- Corrosive Materials
- Toxic Materials
- Radioactive Materials

Another lesson from Texas Tech U

C & E News August 23, 2010

What has happened:

- A senior graduate student was synthesizing and handling a potentially explosive chemical (believed to be nickel hydrazine perchlorate; but the student claimed that it was cobalt perchlorate hydrazinate)
- The chemical exploded in a mortar in his hand.
- He lost several fingers on one hand, and injuries to other exposed body parts. He had perforations in his left eye and lacerations in the other.
- He could easily have been killed.

What have been found:

- The graduate student was NOT wearing eye protection--he took off his goggles, and decided to go back for a 'final stir' when the explosion occurred.
- He was working on a bench, not the hood, and without blast shields.
- He did not listen to his Supervisor, who told him due to the nature of this compound and need, to prepare no more than 100 mg, but he prepared **10 g**. He did this while training another student--and thus subjected his mentored student to a great hazard also.
- His lab book record keeping was poor - he used only 14 pages in his lab notebook to document his experiments

  "$Ni(NO_3)_2$ +hydrazine / 10 g / purple ppt forms immediately/ also an exothermic rxn."

- Others working in the same lab had complained about his conduct in the lab, and there had been conflicts over his work space, cleanliness of the lab and use of chemicals--he may have been a particularly "messy" member of the group;
- He ignored other people's advice about safety: Others in the lab had warned him about the dangers of scaling up, and the student replied that things were "just fine", and dismissed other people's warning.
- Others in the lab told him not to transport or hold his potentially explosive chemicals in glass vials, but he also continued doing things his way.

- He was known to cut corners: his Supervisor reported that he avoided necessary steps to characterize compounds in order to save time.
- He transported chemical (potentially **explosive**) samples from one lab site to another, but some samples ended up in his home and he kept them there.
- Chemicals were NOT labeled, and explosive chemicals were stored in several places around the lab.

Lessons Learned

- Everyone should be well-aware of the properties of chemicals they are working with
- Safety equipment must always be used: goggles, fumecupboard, safety shield, gloves, lab coat etc.
- What to do in case of emergency?
- Never try to save time and compromise safety
- Proper labeling of chemicals-house keeping
- Follow instructions from your supervisor, and listen to suggestions/comments from your peers

Another Explosion happened in a local institute

- A hydrothermal vessel exploded in a furnace
- Furnace was destroyed, surroundings were significantly damaged
- Fortunately, no one was injured
- The vessel was not installed with a pressure relief valve
- Be extremely careful when carrying out experiments under high pressure (e.g. hydrogenation)

Flammable Materials

- Liquid: organic solvents-hydrocarbons, alcohol, ether, ketone…
- Solid: finely dispersed metal powder (Al powder, zinc dust, magnesium turnings etc.), **paper**, wood or other cellulose materials
- Gas: hydrogen, methane, natural gas
- and many others…...

Possible Ignition Sources

- Fire (of course!)
- Spark (from any electrical/electronic appliances, including ***your mobile phone***!)
- Hot surface (hot plate, heating mantle), particularly for ether and THF

Quenching of Reactive Metals/Metal Hydrides

- Sodium: isopropyl alcohol, 2-butanol (stir overnight)
  - (may add ethanol after most of the sodium has been destroyed)
- Potassium: *t*-butanol
- NaH: isopropyl alcohol
- $LiAlH_4$: ethyl acetate
- Cool down the mixture during the quenching process
- All the quenching processes must be done VERY SLOWLY, and carried behind a SAFETY SHIELD inside a FUME CUPBOARD

Spontaneously ignitable materials

- *Solid or liquid materials that ignite spontaneously without an ignition source*
- Na, K, Na/K alloy, Cs, Ca….
- Metal hydrides: NaH, KH, CaH, $LiAlH_4$
- BuLi, $AlEt_3$, RMgX

Handling of Flammable Solvents

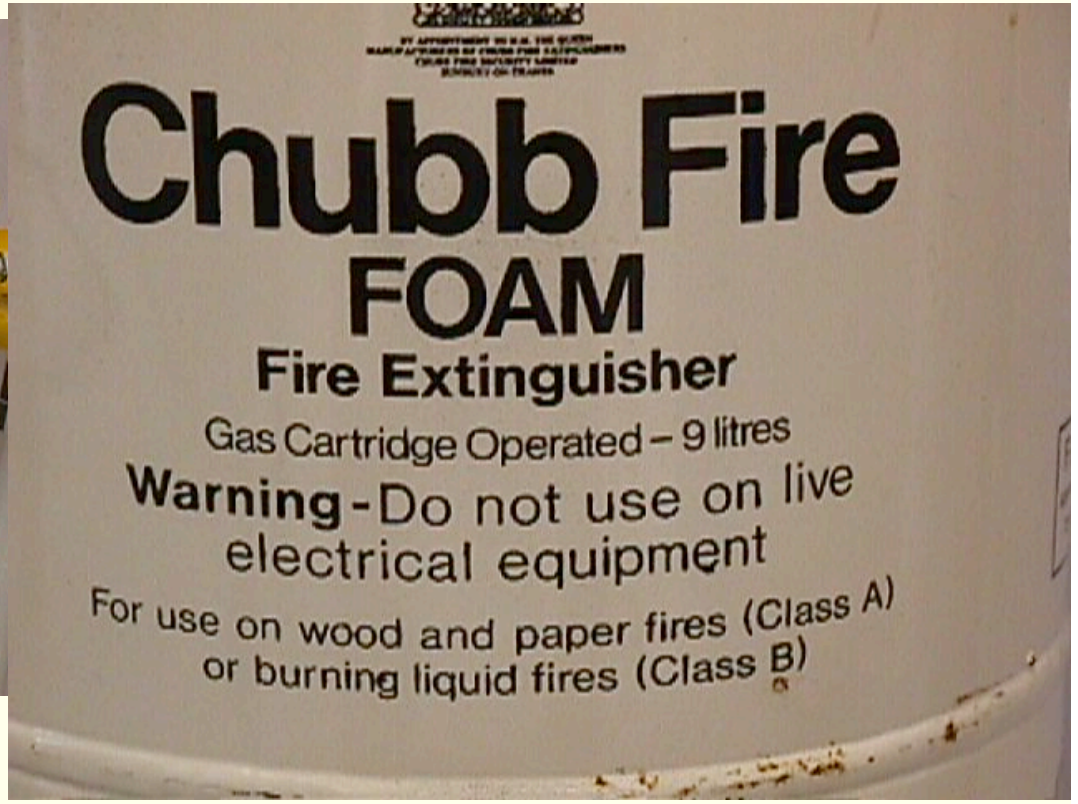
- Ether and THF–Keep away from any heat or ignition sources, including hot plate
- Avoid accumulation of solvent vapor–work in a ventilated environment
- Drying of ether and THF by distillation over Na/K is **NOT** allowed
- Use the solvent purification system instead
- Other solvents: distill in smaller scale

Types of Fire Extinguishers in the Department

(Use only when it is safe)

Foam


H K U
Chubb Fire
FOAM
F283


Chubb Fire
FOAM
Fire Extinguisher
Gas Cartridge Operated – 9 litres
Warning - Do not use on live electrical equipment
For use on wood and paper fires (Class A) or burning liquid fires (Class B)

CO_2


HKU
BRITANNIA
C89F


BRITANNIA
CARBON DIOXIDE
5 kg. STORED PRESSURE TYPE
FIRE EXTINGUISHER
FIRE TEST RATING 34B
SUITABLE FOR CLASS B,C,E FIRES
USE UPRIGHT
WOOD
LIQUID
ELECTRICAL
1 REMOVE SAFETY PIN
2 DIRECT HORN AT BASE OF FIRE
3 SQUEEZE HANDLE TO DISCHARGE
RECHARGE AFTER COMPLETE OR PARTIAL USE

Dry powder


POWDER ABC
FIRE TEST RATING 13A-89 B
A
B
C
USE UPRIGHT
1. 拉出保險匙
WITHDRAW SAFETY CLIP
2. 噴射向火源底部
AIM NOZZLE AT BASE OF FIRE
3. 按下手掣
SQUEEZE HANDLE TO OPERATE
RELEASE HANDLE TO INTERRUPT
FOR ALL FIRES EXCEPT METAL FIRES AND GASEOUS FIRES HAVING AN EXPLOSION RISK
CHECK EXTINGUISHER FOR OPERATIONAL SERVICEABILITY AT LEAST ONCE A YEAR.
IN ACCORDANCE WITH BS 5306
RECHARGE AFTER COMPLETE OR PARTIAL USE


RITANNIA
FIRE EXTINGUISHER

Fire Extinguisher for Metal Powder

Others….

Fire Hose Reel

Fire Blanket

In case of contact with chemicals..

Access to these equipments must not be blocked

You are suggested to flush the eye wash station from time to time in order to keep the water clean

Material Safety Data Sheets (MSDS)

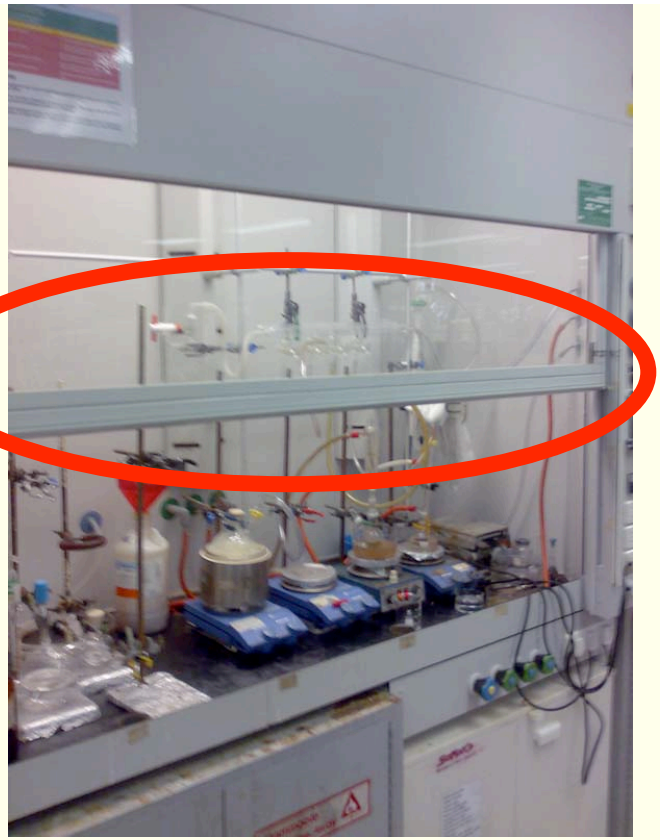
- A technical bulletin which contains detailed information about hazardous substances
- Contains much more extensive information
- Available in the web site of chemical companies
- Available from chemical companies
- For example:
  - http://www.merck-chemicals.com/is-bin/INTERSHOP.enfinity/WFS/Merck-International-Site/en_US/-/USD/ViewSearch-SearchFormMSDS
  - http://www.sigmaaldrich.com/Area_of_Interest/Asia__Pacific_Rim/China_Taiwan__Hong_Kong.html

Use of Fume Cupboard

New Fume Cupboard System

- Variable Air Volume (VAV)
- The volume of air to be drawn out depends on the position of the sash
- The face velocity of air flow is kept constant
- The sash position is detected with a sensor attached to the sash

Make sure that the metal plate is attached to the sensor



Lowest sash position

- Minimum flow
- Lowest fan speed
- Noise level reduced

Sash raised, increase air flow

- Air flow increased
- Fan speed increased
- More noise
- Consumes more electricity

The face velocity of air at the sash position are THE SAME!

- Keep the sash at the lowest position whenever the fume cupboard is not in use, which:
  - Minimizes the noise generated on the roof
  - Reduces the consumption of electricity (by reducing the workload of the air-conditioning system)
  - Maintain a cooler and less humid environment in the building (in summer)
  - Provides a safety shield for you
- DO NOT open any window in the building. This will introduce humid air in the lab and cause condensation of water everywhere.

Transport of chemicals in the department

- Use the freight elevator
- Use a second container for flammable/toxic substances
- In case of chemical spill:
  - Clean up only if it is SAFE to do so!!
  - Confine the spill by using the absorbing materials
  - Area/amount of chemicals

Solvent/chemical spills must be cleaned up immediately

- Recently a solvent bottle was broken inside a lab and solvent was spilled. Although the broken glass was swept up, the solvent was left in a pool on the floor and was not cleaned up. Other people in the lab were not alerted to this solvent spill.

Mercury Spillage

- Use a Hg Absorb Sponge to amalgamate mercury droplets onto the sponge, so that the resultant amalgam would not emit mercury vapors.
- The used sponges should be collected into a polyethylene bag, sealed, labelled, and the Safety Office should be informed (2859-2402) to collect the special waste. Hg Absorb Sponges are available from the Chemical Spillage Kit or the Safety Office.
- Guidelines on how to clean up a mercury spill.

  http://www.hku.hk/safety/pdf/CSL.pdf, Section 12.3.

Spill Control Station

Use only when it is necessary and safe!!

Spill Kit

Different absorbents work for different chemicals

If the amount of spillage if large or the chemical is dangerous, call for help immediately.