Chemical Safety in the Laboratory

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Physical Hazards

• Allow researchers to predict the hazards from chemicals during the experiment.
• Allow researchers to ensure the appropriate control measures are in place.

Physical Hazards

• Flammable Liquid
• Combustible Liquid
• Oxidizer
• Organic Peroxide
• Explosive
• Compressed Gas
• Reactive Chemical
• Pyrophoric

Flammables

Most commonly used hazardous chemicals on campus
Flash point of not more than 93°C
One of four hazard categories on the basis of the flash point and boiling point
Examples: alcohols, ketones, xylenes and carboxilic acids
Most organic chemicals are also flammable or combustible

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flash point ≤ 23°C and initial boiling point ≤ 95°F (35°C)</td>
</tr>
<tr>
<td>2</td>
<td>Flash point ≤ 23°C and initial boiling point &gt; 95°F (35°C)</td>
</tr>
<tr>
<td>3</td>
<td>Flash point ≤ 23°C and ≤ 60°F (140°F)</td>
</tr>
<tr>
<td>4</td>
<td>Flash point ≤ 23°C and ≤ 93°C (200°F)</td>
</tr>
</tbody>
</table>

Corrosives (Acids & Bases)

• Corrosives- Irreversible tissue and/or metal damage
  low or high pH (<2.0 or >12.5)
  • can cause damage to equipment, storage cabinets and structural elements
  • contact with skin or eyes causes acute, irreversible and visible damage at the site of contact
Acute Corrosive Exposures

Oxidizers
- Compound itself is not necessarily combustible. Yields oxygen, causing or contributing to combustion of other material.
- Oxidizers are incompatible with organics.
- Examples:
  - Nitric acid
  - Hydrogen peroxide
  - Oxygen
  - Nitrous oxide
  - Perchloric acid
  - Nitrates

Nitric Acid/Alcohol Explosion

Specific Oxidizers
- Nitric Acid
- Sulfuric Acid
- Hydrogen Peroxide

Acid/Flammable Liquid Explosion
Peroxide formers

- Very unstable, can explode with impact, heat or friction
- Common peroxide formers in MSU Labs: Ethyl Ether, Dioxane, Tetrahydrofuran (THF)
  All peroxide formers must be tested regularly!

Organic Peroxides & Explosives

- Organic Peroxides
  Contains a "peroxy" group. (-O-O-) Shock, heat and friction sensitive when dry.
  Examples: Methyl ethyl ketone peroxide, Benzoyl peroxide
- Explosives
  Instantaneous release of pressure, gas and heat when agitated.
  Examples: Polynitrated organics, nitric acid, perchlorate salts of organic and inorganic complexes

Perchloric Acid

- Highly corrosive, strong oxidizer
- Anhydrous form and certain salts are highly explosive
- DO NOT USE perchloric acid in hot processes, use substitute process
- Store in a well-ventilated area separate from all other materials
- Must receive prior approval before use

Reactive and Pyrophoric

- Water reactive chemicals: some can release toxic or flammable gas in water
  - Handle inside fume hood
  Examples: Sodium metal, Lithium aluminum hydride
- Pyrophoric materials ignite spontaneously air at or below 45°C (113°F)
  - Store under a dry, inert atmosphere in sealed containers
  - Handle in a fume hood over a spill tray
  Example: White Phosphorous

Piranha Solutions

Compressed Gases

Mechanical and chemical hazards
Compressed Gas Cylinders

- Physical hazards
  - Flammables
  - Oxidizing
  - Decompression
- Health Hazards
  - Cryogens
  - Corrosives
  - Toxic

Gas Cylinders

Use proper regulator: avoid valves.

Gas Cylinders

- Secure cylinders and cap when moving.
- High pressure hazard if rupture occurs.

Examples of Gases

<table>
<thead>
<tr>
<th>Gas</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>Asphyxiant</td>
</tr>
<tr>
<td>Argon</td>
<td>Asphyxiant</td>
</tr>
<tr>
<td>Helium</td>
<td>Asphyxiant</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>Flammable</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Toxic</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Toxic/Flammable</td>
</tr>
<tr>
<td>Phosgene</td>
<td>Toxic</td>
</tr>
</tbody>
</table>

Chemical Reactions

- Interaction between two or more materials that release or absorb energy
- Reactions produce new chemical substances which may be toxic, corrosive or flammable.

Decomposition Products

- Fire and explosions
- Water Reactives
Chemical Abstract Service Number

Chemical Inventory

Chemicals in the Open Kept to a Minimum

Excessive Chemicals

Right-To-Know LAW

- Employees have the Right To Know about hazards in the workplace.

- 2 Provisions of RTK Law that still apply to Lab Workers
  – Labels
  – Material Safety Data Sheets (MSDS)
Labeling Secondary Containers

- Label containers stored for longer than 1 day with:
  - Full Chemical Name of hazardous material
  - Example: Hydrogen Chloride NOT HCl
  - Hazard warning (flammable, corrosive, etc.)

Labeling of Chemical Solutions in Lab

- Containers used within the work shift do not need hazard warnings
- Hazard labels on storage areas exempt labeling of individual containers

NFPA Labeling System

<table>
<thead>
<tr>
<th>Health Hazard</th>
<th>Flammability</th>
<th>Reactivity Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Extremely Hazardous</td>
<td>4 Extremely Flammable</td>
<td>4 Severe Explosion Risk</td>
</tr>
<tr>
<td>3 Moderately Hazardous</td>
<td>3 Moderately Flammable</td>
<td>3 Explosion Risk</td>
</tr>
<tr>
<td>2 Hazardous</td>
<td>2 Flammable</td>
<td>2 Potentially Explosive</td>
</tr>
<tr>
<td>1 Slightly Hazardous</td>
<td>1 Slightly Flammable</td>
<td>1 Not Violently Reactive</td>
</tr>
<tr>
<td>0 Not Hazardous</td>
<td>0 Not Flammable</td>
<td>0 Normally Stable</td>
</tr>
</tbody>
</table>

Special Hazard

- OXY: Oxidizing
- ☑️: Radiation Hazard
- ☣️: Do Not Use Water

Reactivity Hazard

- H: Health Hazard
- F: Flammability
- R: Reactivity Hazard
- PPE: Personal Protective Equipment Recommendation
NFPA/HMIS DIFFERENCES

• Layout
  – NFPA uses a diamond
  – HMIS uses vertically stacked bars

• Interpretation of White Field
  – NFPA refers to special handling
  – HMIS refers to PPE

• Audience
  – NFPA designed for firefighters
  – HMIS designed for HCS compliance
Chemical Storage and Handling

Gas Cylinders Are Properly Secured

Storage According to Compatibility

Storage According to Compatibility

Flammable and Corrosive Areas are Labeled

Flammables and Sources of Heat, Ignition and Flames