Safe Handling of Toxic, Corrosive and Flammable Gases - University of Nebraska - Lincoln
Overview

- Review some of the dangers of:
  - Flammable Gases
  - Toxic/Corrosive Gases

- Key Considerations and Best Safety Practices
  - Mitigate Dangers
  - Proper Handling
Flammable – Pyrophoric Gas

Pyrophoric
Flammable Gas

A substance that meets the definition of a compressed gas which:

- Is flammable in a mixture of 13% or less (by volume) with air

OR

- Has a flammable range with air wider than 12%, at atmospheric temp and pressure, regardless of the lower limit
### Flammable Gases

<table>
<thead>
<tr>
<th>Acetylene</th>
<th>Natural Gas</th>
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<tbody>
<tr>
<td>Butane</td>
<td>Propane</td>
</tr>
<tr>
<td>Ethylene</td>
<td>Methane</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>Isobutane</td>
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</tbody>
</table>
Gases & Locations - UNL

Beadle, Filley, Kiesselbach, Othmer, Hamilton, Walter Scott, Animal Science, Hardin, Home Economics, Architecture Hall West….locations might be other than expected!

Hydrogen and Hydrogen Mixtures

Acetylene, Propylene

Others…. 
Hydrogen and Fuel Gases

- **Hydrogen**

  Is colorless, odorless, tasteless, and highly flammable, and burns with an invisible flame

  **Straw broom test**

- **Hydrogen mixes**

  *Hydrogen mixes: flammable at 4% - 75% by volume*

- **Propylene, Propane, Butane, Ethylene**
Acetylene cylinders have special construction

- Cylinders contain a porous, sponge-like mass, saturated with acetone
- MUST STORE UPRIGHT!!

- Maximum safe upper pressure limit: 15 psi
- DO NOT use copper piping for Acetylene gas delivery systems!
Handling Flammable Gas

Correct Environment:

■ Shall not be used near ignition sources-open flame, sources of heat, oxidizers, non-intrinsically safe electrical equipment

Correct Equipment:

■ Manifold systems and regulators designed by experienced personnel...flash arrestors, check valves, PRV’s, spark-proof components, intrinsic safety features
Pyrophoric Gases

A gas that will spontaneously ignite in air at or below 54.4C (130F)

Silane

Phosphine
Pyrophoric Gas

- Unique gases, unique applications .......... Unique Training

- Contained Delivery Systems
  - Gas Cabinets/Coaxial Piping/Automated Controls and Emergency Shutdown Systems
NEVER trust a the color of a compressed gas cylinder. There is NO industry standard – varies by manufacturer.

NEVER assume cylinder contents – ALWAYS check the label!
Best Practices for Safety

- Good ventilation
- Check for leaks
- Keep all valves, fittings, connections free of oil or grease, verify Teflon tape is approved for use with flammables.
- Open valves slowly, pointed away from the direction of people
Incident Review

- Schweitzer Hall Explosion at University of Missouri June 28, 2010

- Lessons Learned:
  - Equipment
  - Process
  - Training
  - Remedies
  - Could this happen to you?

- EHS Safety Listserv - August 17, 2010 (access through http://ehs.unl.edu, ‘ListServ’ tab)
Toxic - Corrosive Gas
Toxic Gas

Toxic

- A substance that has the ability to produce injurious or lethal effects through its interaction with the body

- A toxic substance that has a median lethal concentration in air of <200 ppm
Corrosive

- A substance that rapidly attacks and produces irreversible damage to human tissue, such as eyes, skin, mucous and other living tissue.
Gases & Locations - UNL

Manter, Othmer, Hamilton, Walter Scott

Carbon Monoxide  Ammonia
Hydrogen Sulfide  Chlorine
Hydrogen Chloride
Some gases represent multiple hazards

- *Flammable, toxic and corrosive:*
  
  *Hydrogen Sulfide*

- *Flammable and toxic:*
  
  *Carbon Monoxide*

  *Ethylene Oxide*
Safety Considerations

- Product-specific training for users. Product knowledge is KEY!!!
  - Special valves and caps
  - Material Compatibility
- MSDS access/review and appropriate door posting
- Quantity of toxic gases kept on site?
Remember

AN EMPTY CYLINDER

IS NEVER 100% EMPTY!!!!

Handle, Store, and Transport an ‘empty’ cylinder as if it is a full cylinder
Best Practices for Safety

Engineering Controls

- **Forced ventilation areas for storage and use points**
- **Critical considerations for connections, leak test, shut-down procedures, purging/inerting the system and regular system maintenance**
- **Regular training & maintenance**
Best Practices for Safety

- Toxic Gas Monitors & Alarms

- Emergency Preparedness

- Adequate eye wash
- Respiratory equipment readily available
- Be aware of notification and evacuation procedures (Learned through web-based Emergency Preparedness training & discussions with supervisor)
Incident Review

- **Ames Laboratory – Hydrogen Sulfide**

  *Root cause: Leaking regulator, insufficient ventilation*

- **Argonne National Laboratory – Chlorine**

  *Root cause: Insufficient Training, unqualified personnel handling product and delivery system*
Praxair's Propylene Fire - June 2005
(security camera image)
**Incident**

TWO minutes later (security camera image) – ALL employees & customers evacuated safely due to emergency procedures and drills!
Review other incidents involving Compressed Gas Cylinders on the Chemical Safety Board web site:

http://www.csb.gov/

NOW....REVIEW YOUR LAB SPACE AS THOUGH AN ACCIDENT IS ABOUT TO HAPPEN

PROCEDURES?

TRAINING?

EQUIPMENT?
Have a Plan

What **IS** your department’s and laboratory’s plan?

The Emergency Plan is **KEY** to assuring the safety of persons and property!!
Resources

The Compressed Gas Association
www.cganet.com

Environmental Health & Safety
Safe Operating Procedures
http://ehs.unl.edu/sop/
If a regulator for an Oxygen cylinder is difficult to thread, you should:

A: Oil the threads – NEVER

B: Return the cylinder or the regulator to the supplier - ALWAYS

C: Use a crescent wrench to tighten it - NEVER

D: Use a regulator from a nitrogen cylinder – NEVER, or regulator designed for ANY other gas besides Oxygen
General Review

What type of cylinder should never be stored on its side?

A: Acetylene (per this training)

B: Helium

C: Breathing Air

D: Oxygen
Cylinders containing flammable gases shall not be stored near:

A: Areas where electrical sparks might be generated

B: Bunsen burners

C: Pilot Lights

D: All of the above – ANY source of ignition
It is acceptable to use plastic piping for parts of a flammable gas or high pressure gas delivery system:

A: True

B: False – plastic is a petroleum-based product and not designed to withstand the pressures involved
General Review

It is safe to conduct minor repairs to valves and regulators of cylinder gases:

A: True

B: False - NEVER. Instead, return to manufacturer.
General Review

It is acceptable to check if a cylinder is empty or full, by slowly opening the cylinder valve to listen for pressure and gas release:

A: True

B: False - NEVER. This bad habit can result in injury or death.
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