

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

Presented by

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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



Acetylene

Natural Gas

Butane

Propane

Ethylene

Methane

Hydrogen

Isobutane

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



- **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***

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**
- **Never manipulate fittings – do not attempt to repair a cylinder valve yourself. Return for a replacement cylinder.**

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 Gas



■ 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

Multiple Hazards

- **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

Incident

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!



Emergency Preparedness

**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/>

General Review

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 crecent 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

General Review

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

General Review

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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