

## Compressed Gas Cylinder Safety

Compressed gases in the lab present chemical and physical hazards. If compressed gases are accidentally released, they may cause the following:

- Oxygen depleted atmosphere
- Fire
- Adverse health effects

Cylinders that are knocked over or dropped can be very dangerous and can cause serious injuries. If a valve is knocked off a compressed gas cylinder, the cylinder can become a lethal projectile. Cylinders can travel through walls much like a torpedo travels through water. They can cause structural damage, severe injury, and death.

Because disposal of compressed gas cylinders is difficult and expensive, be sure to arrange a return agreement with suppliers prior to purchase.

Follow these guidelines to ensure safe storage of gas cylinders:

- Secure all cylinders in racks, holders, or clamping devices. Fasten cylinders individually (not ganged) in a well-ventilated area.
- Do not rely on color to identify container contents. Check the label.
- Close valves, and release pressure on the regulators when cylinders are not in use.
- Minimize the number of hazardous gas cylinders in a laboratory. Do not exceed the following:
  - Three 10" x 50" flammable gas and/or oxygen cylinders Two 9" x 30" liquefied flammable gas cylinders
  - Three 4" x 15" cylinders of severely toxic gases (e.g., arsine, chlorine, diborane, fluorine, hydrogen cyanide, methyl bromide, nitric oxide, phosgene)
- Store cylinders of flammable and oxidizing agents at least 20 feet apart, or separate these items with a fire wall.
- Do not store gas cylinders in hallways or public areas.
- Keep heat, sparks, flames, and electrical circuits away from gas cylinders.

When working with compressed gas cylinders, remember the following:

- Never move a gas cylinder unless the cylinder cap is in place and the cylinder is chained or otherwise secured to a cart.
- Do not move a cylinder by rolling it on its base.
- Only use regulators approved for the type of gas in the cylinder.
- Do not use adapters to interchange regulators.

When opening a cylinder valve, follow these guidelines:

- Direct the cylinder opening away from people
- Open the valve slowly.
- If a cylinder leaks, carefully move the cylinder to an open space outdoors. Have the supplier pick up the cylinder.
- Do not use oil or other lubricant on valves and fittings.
- Do not use oxygen as a substitute for compressed air.
- Do not lift cylinders by the cap.

- Do not tamper with the safety devices on a cylinder. Have the manufacturer or supplier handle cylinder repairs.
- Do not change a cylinder's label or color. Do not refill cylinders yourself.
- Do not heat cylinders to raise internal pressure.
- Do not use compressed gas to clean your skin or clothing.
- Do not completely empty cylinders. Maintain at least 30 psi.
- Do not use copper (>65% copper) connectors or tubing with acetylene. Acetylene can form explosive compounds with silver, copper, and mercury.
- Always wear impact resistant glasses or goggles when working with compressed gases.

### **Precautions for Compressed Gases**

There are several types of compressed gases, each with their own unique hazards and precautions.

#### **Flammables**

Flammable gases will ignite at a low flashpoint. Examples include propane, acetylene, hydrogen, methane, and iso-butane. Precautions include:

1. Do not use near ignition sources (except for protected fuel gases).
2. Have a portable fire extinguisher readily available for fire emergencies.
3. Do not use a flame to detect for leaks! A compatible leak-detection solution must be used.
4. Use spark-proof tools when working with, or on, a flammable compressed gas cylinder or system.
5. Post a sign stating "No Open Flames" on access doors to areas which use or store flammable gases.
6. Manifold systems must be designed and constructed by competent personnel who are thoroughly familiar with the requirements for piping of flammable gases. Consultation with the gas supplier, EHSS Fire Safety, and/or Facilities before installing manifolds is required.

#### **Oxidizers**

Oxidizing gases are non-flammable gases, but in the presence of an ignition source and fuel, can support and vigorously accelerate combustion. Examples include oxygen, chlorine, fluorine, and nitrous oxide. Precautions include:

1. Do not use oil in any apparatus where oxygen will be used!
2. Gauges and regulators for oxygen use should be labeled with a warning statement - "Oxygen - Use No Oil".

#### **Highly Toxic Gases**

Toxic gases are those having a health hazard of 3 or 4, as defined by [NFPA 704](#). The toxic effects of a substance can be either acute or chronic. Acute effects involve short-term, high concentrations that can cause irritation, illness, or death. Chronic effects involve continued

exposure to a toxic substance over an extended period of time, resulting in serious and irreversible illness. Examples include arsine, phosphine, phosgene, and nitric oxide. Precautions include:

- **Store all highly toxic gases in a continuously, mechanically ventilated gas cabinet, fume hood, or other enclosure (unless otherwise recommended by the supplier).**
- Review the Safety Data Sheet ([SDS](#)) to determine safe use guidelines.

## Cryogenic Gases

Cryogenic liquids and their boil-off vapors rapidly freeze human tissue and cause embrittlement of many common materials, which may crack or fracture under stress. All cryogenic liquids produce large volumes of gas when they vaporize, and may create oxygen-deficient conditions. Examples include liquid oxygen, hydrogen, nitrogen, argon, helium, and liquid neon. Precautions include:

1. Transfer operations of cryogenic liquids must be conducted slowly to minimize boiling and splashing. Use appropriate personal protective equipment when transferring cryogenic liquids, including insulated gloves, goggles and a face shield.
2. In the event of skin contact with a cryogenic liquid, do not rub the skin. Place the affected part in a warm water bath.
3. Use only equipment, valves, and containers designed for the intended product, service, pressure, and temperature.
4. Inspect the containers for loss of insulating vacuum. If the outside of the jacket on a container is cold or has frost spots, some vacuum has been lost. Empty the contents into another cryogenic container and remove the damaged unit from service. Repairs should only be made by the manufacturer of the container or an authorized service provider.
5. Excessive ice build-up (especially beneath the vaporizer or tank) could result in the discharge of excessively cold gas, or structural damage to the cryogenic container and surroundings.
6. All cryogenic systems, including piping, must be equipped with pressure relief devices to prevent excessive pressure build-up.
7. Do not use open flames or direct intense heat sources to thaw frozen equipment. Hot air, steam, or water can be used to thaw frozen equipment. Do **not** use water to thaw liquid helium equipment.

## Inert Gases

Inert gases are non-combustible, non-flammable, and non-reactive to many materials. Examples include argon, helium, nitrogen, and neon. Precautions include:

1. Inert gases also displace oxygen and can produce a localized oxygen-deficient atmosphere, and therefore should not be used in enclosed or confined spaces without proper ventilation and/or respirator protection.
2. Inert gases are odorless, colorless, and tasteless - making them even more dangerous because they cannot be detected by a person's senses. Always check for leaks and ensure

equipment is in proper working order.

### **Corrosives**

Corrosive gases react to other materials and produce a chemical reaction which eats into, or gradually wears away the material. Corrosives can be hazardous to all parts of the body, and the eyes and respiratory tract are especially sensitive to exposure. Example includes hydrogen chloride, chlorine, fluorine, and hydrogen fluoride. Precautions include:

1. Check equipment and lines frequently for leaks. Metals can become brittle when used in a corrosive gas service.
2. Use a diaphragm gauge with on equipment since steel or bronze gauges can be destroyed by corrosive gases. Check with the supplier for more information.
3. Remove regulators after use and flush with dry air or nitrogen.

Wear appropriate PPE such as safety glasses or goggles, face shields, chemical-protective gloves, and aprons.