

A Manual to Handling Gases in the Laboratory

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Type of Gases

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Introduction

Safety rules and instructions are essential to avoid serious accidents in the laboratory. Compressed gases are used in various research activities. These gases can be dangerous and could compromise safety and severely impact performance if handled improperly.

Type of Gases Used in Laboratories

Inert gas is resistant to chemical action under normal temperature and pressure conditions i.e., Nitrogen, Argon, Neon, and Helium.

Flammable gas burns if it is mixed with air, oxygen or other oxidants, in the presence of a source of ignition i.e., Hydrogen, LPG, Methane, Ethylene, Ethane, Propylene, and Isobutylene, see figure 1.



Fig. 1. Globally Harmonized System -Physical Hazards Pictograms

Toxic gas harms humans when it exceeds the allowable limits in air i.e., Sulphur dioxide, Carbon monoxide, and Boron trichloride, see figure 2.

Oxidizing gas supports combustion i.e., Oxygen and Nitrous oxide.



Fig. 2. Globally Harmonized System -Health hazards Pictograms

Pyrophoric gas ignites when exposed to air i.e., Silane and Phosphine.

Corrosive gas can harm human tissue upon contact i.e., Ammonia, Chlorine, Hydrogen, and Nitrogen dioxide.

Gas Cylinders

Gas cylinders used in the laboratory are stored in a special room away from the main working areas and are connected centrally. In some cases, cylinders are used on a much smaller scale and require the gas cylinders to be brought into the lab when they are used during an experiment. Gas cylinders are large, heavy and relatively unstable due to the ratio of the base diameter to the height. The following instruction for handling, storing and transportation your gas cylinders:

Handling and Storing

- Store cylinders in a well-ventilated area.
- Ensure the lowest possible number of gas cylinders are stored in the laboratory.
- Store the oldest cylinders at the front, so they can be used first.
- Secure cylinders vertically to prevent them from toppling.
- Gas cylinders stored according to their physical and chemical properties i.e., flammable, oxidant, see figure 3.
- Gas cylinders should be purchased from a reliable supplier.
- Gas cylinders must be carefully inspected before accepted.
- Set up safety signs according to legislations in the storage area.
- Laboratory staff should receive instruction regarding the safe handling of cylinders.

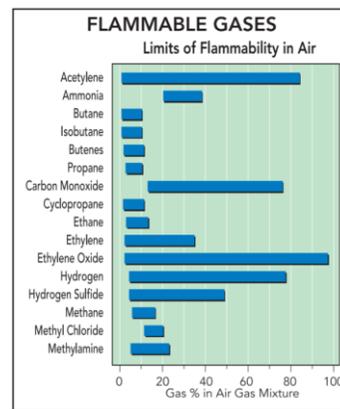


Fig. 3. Flammable range of gases (Source: 8)

Transportation

- During transportation, compressed gas cylinders must be stored in an upright position.
- Cylinders should be moved through the laboratory in small numbers.
- Safety cylinders' caps should always be in place and secured.
- Avoid dragging and sliding cylinders, even for a short distance.
- A suitable gas cylinder trolley should be used for transportation with a chain or belt for securing the cylinder, see figure 4.



Fig. 4. Gas cylinder trolley (Source: 5)

Regulators

- Regulators and valves are checked on a regular basis.
- Use pressure regulators that are equipped with pressure relief devices.
- It is very important to keep regulators free of surface oil and grease.
- Check the information on the regulator to ensure that it is suitable for the intended application (i.e. type of gas, pressure, etc.) before connection to the cylinder.
- Check the connections from the gas regulator to the cylinder for leaks using a detector.
- Regular maintenance of cylinders, valves, regulators, is best performed by the supplier.

Gas Leakage Detections

Gas detectors used to warn of the leakage and the presence of toxic concentrations. An emergency plan can function efficiently with training to follow the procedures cases of emergency. Measures and procedures to follow:

- a. Self-contained gas masks must be available for handling gas leakage.
- b. Inspect cylinders regularly for corrosion or leaks. In case of a leak.
- c. Areas contaminated by corrosive gases must be vented, washed down.
- d. *In case of fire accident:* 1. call the fire department 2. evacuate the area 3. remove the cylinders if possible 4. cool the cylinders that cannot be removed with water.
- e. *In case of a leaking cylinder:* 1. Emergencies involving flammable gases managed with the maximum care to prevent ignition. 2. properly worn all personnel required to evacuate. 3. shut off electrical power. 4. promptly remove the cylinder to the outside in accordance with the supplier.

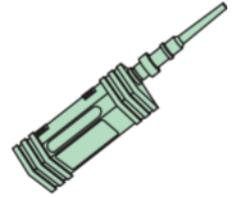


Fig. 5. Portable Gas Detector

Risk Assessments

A risk assessment must be carried in the laboratories where the gas is handled. The process of handling and storing gas in the laboratory should include conducting a comprehensive Risk Assessments for both gas and the gas cylinders. Gases can be flammable, corrosive, and toxic. Since the gases are under high pressure in cylinders, any release of these gases can spread quickly and cause threats and explosions. Because of these threats, standards have been established for handling, storing and transportation compressed gas cylinders i.e.,:

The Swedish Work Environment authorities have regulated that through i.e., Chemical work Environment Risks ([AFS 2011:19](#)), Regulations on Gas Cylinders ([AFS 2001:4](#)), Regulations on Inspection of Pressurized Devices ([AFS 2005: 3](#)), Regulations for Gases ([AFS 1997:7](#)). The following steps for conducting a Risk Assessments for both gas and the cylinders:

1. Implementation of full control of substances hazardous to health regulations though:
 - a. Identify the hazards.
 - b. Identify who might be harmed and how.
 - c. Evaluate the risks and decide on precautions.
 - d. write down a list of the actions taken to control the risks to the staff.
2. Implementation of the dangerous substances and explosive atmospheres regulations though:
 - a. Identify dangerous substances.
 - b. Introduce control measures to reduce the effects of incidents.
 - c. Prepare plans to deal with accidents.
 - d. Inform employees to control or deal with the risks from dangerous substances.
 - e. Identify areas of the workplace of the explosive atmospheres and avoid ignition sources.
3. Avoid the main causes of accidents and reduce the risk of injuries involving gas and gas cylinders in the laboratory through training the new and existing laboratory staff and every member of the research team for safe practice and correct implementation.

Resources

1. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards: Updated Version. Washington (DC): National Academies Press (US); 2011. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK55884/>
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6. Work Environment Authority, Sweden. Accessed from the website:<https://www.av.se/>
7. Gas Cylinder Safety Manual, Indian Institute of Technology Bombay, Available from:http://www.iitb.ac.in/safety/sites/default/files/Gas%20Cylinder%20Safety%20Manual_0.pdf
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