COMPRESSED HYDROGEN: Guidelines for Safe Use and Handling in Laboratories

Laboratory personnel work in a potentially hazardous and extremely unforgiving environment. Guidelines and procedures are to be closely followed to reduce risks to a level as low as possible and provide a safe environment in laboratories.

Gaseous Hydrogen

Safety Equipment

Typically there are no specific personal protection equipment requirements for working with gaseous hydrogen, other than wearing safety glasses or goggles when working with a compressed gas.

Basic Properties

Hydrogen poses unique challenges due to its ease of leaking (highly diffusive), low-energy ignition, wide range of combustible concentrations, and its ability to embrittle metals (e.g. carbon steel) which must be accounted for to ensure safe operation. These factors are further complicated in that it is colorless, odorless, and burns with an invisible flame in daylight conditions.

Chemical Reaction Potential

Hydrogen gas forms explosive mixtures with air if it is 4–74% concentrated and with chlorine if it is 5–95% concentrated. The mixtures spontaneously explode by spark, heat or sunlight. H_2 reacts with every oxidizing element. Hydrogen can react spontaneously and violently at room temperature with chlorine and fluorine.

Safe Use and Handling

Equipment

Piping, valves, and related components are to be specified for hydrogen service by the manufacturer or hydrogen supplier. This ensures that components are hydrogen compatible and are of adequate strength and durability to withstand the service pressures.

- Requirements for hydrogen delivery systems:
  - Hydrogen cylinders must be equipped with pressure-relief devices to release the gas at or below the maximum allowable working pressure.
  - An isolation valve shall be installed at an accessible location in a hydrogen pipeline so that hydrogen flow can be shut off when necessary.
  - Additional equipment that is required for hydrogen gas delivery systems includes regulators with pressure gauges.
  - Because of the extremely low energy required to ignite flammable mixtures of hydrogen gas, caution must be exercised when using hydrogen around electrical equipment.

Safe Work Practices

Select and use the correct regulator connector by checking the Compressed Gas Association (CGA) number. Incorrect connectors can sometimes be installed on inappropriate gas cylinders. CGA 350 is the standard connector for Hydrogen.

- Check the overall condition of the regulator:
  - Do not use a regulator that has been used for other gases
  - Leak test the system connections

Handling and Storage

- Always perform hydrogen work with adequate ventilation.

- Separate Hydrogen cylinders from oxygen, chlorine, and other oxidizers by at least 20 feet (6.1 meters) or use an approved gas cabinet.
- When a cylinder is not in use, screw the valve protection cap firmly in place.
- Secure cylinders upright at the top and bottom. Adjust the cylinder racks so that cylinders are tightly secured.

Using Hydrogen Gas Cylinders

- It is very important to secure all compressed gas cylinders in an upright position.
- Hydrogen gas cylinders should never be used if pressure has not been reduced by a suitable regulator at the cylinder, or at the outlet of the header valve of a cylinder manifold.
- Never crack a hydrogen cylinder valve to remove dust or dirt from fittings prior to attaching a regulator.
- Once the regulator is attached, be sure that the regulator adjusting screw is in the closed position before opening the cylinder valve.
- Never use a wrench, hammer, or other tool to open or close the hand wheel.
- When opening the cylinder valve to extract content, turn the hand wheel all the way open and then back toward the closed position one quarter turn. When the work is finished, turn the cylinder valve off and be sure to bleed off all remaining hydrogen from the regulator before removing it from the cylinder.

Emergency Procedures

Cold Burns

Exposure to cryogenic materials may result in serious injury to body tissues similar to heat burns. If a worker comes in contact with liquid or cold gaseous hydrogen, he/she should be transported to a Medical Center for treatment. If transportation for medical treatment is not available, the affected area can be thawed with tepid water; however, the area should not be rubbed.

If a Leak is Detected

When a hydrogen leak is discovered or when an alarm sounds, take the following steps:

1. Evacuate the immediate area of all personnel.
2. Shut off the hydrogen source immediately and vent all hydrogen to a safe outside location.
3. Increase indoor ventilation with emergency explosion-proof exhaust fans, if possible.
4. Initiate the emergency plan and make the required emergency contacts.

In Case of a Fire

To detect a small, local hydrogen fire (the flame is nearly invisible), use a piece of tissue paper on a stick; the paper will readily ignite when it contacts a flame. Ultraviolet/infrared detectors and alarms should be installed on systems with the potential for large leaks. If fire is present, perform the following:

1. Shut off the hydrogen source.
2. Let the fire burn itself out. (If the flame is snuffed out, it may reignite and cause greater damage.)
3. If you have received hands-on training in the proper operation of a water fire extinguisher then you may use water spray to thermally protect people and equipment if the fire is hot enough to warrant it. However, a venting hydrogen flame cannot normally be extinguished with water.
4. Initiate the emergency plan (which should include calling 9-1-1) and make the required emergency contacts.