Environmental Health and Safety

Tufts University Standard Operating Procedures (SOP) for Hydrogen gas

CAS #: 1333-74-0
Synonyms: Hydrogen gas, Hydrogen, H_2.

NFPA Flammability=4, HMIS Flammability =4.

Purpose and Scope:

This standard operating procedure (SOP) is created by Tufts Environmental Health and Safety (TEHS) with the goal educating the Tufts community in the proper use of Hydrogen gas. This SOP covers the proper and safe storage and use Hydrogen gas.

Hazard:

Hydrogen is a flammable, colorless, odorless, compresses gas packaged in cylinders at high pressure. It poses an immediate fire and explosive hazard when concentrations exceed 4% and can be ignitable by static electricity. It is much lighter than air and burns with an invisible flame. The storage and use of hydrogen poses unique challenges due to its ease of leaking as a gaseous fuel, low-energy ignition, wide range of combustible fuel-air mixtures, buoyancy, and its ability to embrittle metals that must be accounted for to ensure safe operation. Liquid hydrogen poses additional challenges due to its increased density and the extremely low temperatures needed to keep it in liquid form.

Hydrogen gas forms explosive mixtures with air at concentrations of 4–74% and forms explosive mixtures with chlorine at concentrations of 5–95%. The mixtures spontaneously explode by spark, heat or sunlight. The detection of a burning hydrogen leak may require a flame detector; such leaks can be very dangerous. Hydrogen reacts with every oxidizing element.

Therefore, hydrogen gas leaking into external air may spontaneously ignite. Moreover, hydrogen fire, while being extremely hot, is almost invisible, and thus can lead to accidental burns.

The lower flammable limit is 4%, upper flammable limit is 74%.
Fume hood fans at Tufts are not explosion proof. Therefore discharging over 4% H_2 in a fume hood can result in an explosion on the roof.

Personal Protective Equipment (PPE):

Eye protection: Safety goggles.
Skin and body protection: Fire/flame resistant lab coat, preferably a nomex lab coat or a 100% cotton based lab coat.
The PI, lab manager or direct supervisor must assess their work areas and specific operations to determine the extent of the hazard and the type of lab coat required. Please see the section titled "Personal Protective Equipment Plan" at:

http://publicsafety.tufts.edu/ehs/chemical-safety/

Cotton based clothing/attire. Full length pants or equivalent. Close toed shoes

Incompatibilities:

DO NOT store Hydrogen & Oxygen/other oxidizing gases, oxidizing materials together

Storage: Please see safety requirements for storing compressed gas cylinders at:

http://publicsafety.tufts.edu/ehs/files/SafetyRequirementsforCompressedGasCylinders.pdf

Cylinder storage locations should be well protected, well ventilated, dry and separated from combustible materials. Cylinders should never knowingly be allowed to reach a temperature exceeding 122 F (50 C). Cylinders of hydrogen should be separated from oxygen cylinders or other oxidizers by a minimum distance of 20 ft., or by a barrier of noncombustible materials of at least 5 ft. high having a fire resistance rating of at least 1/2 hour. If space limitations do not allow for a 20 ft separation from oxygen and other oxidizers, the location must be reviewed by EHS.

Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling or being knocked over. Protect cylinder from physical damage; do not drag, roll, slide or drop. Use a suitable hand truck for cylinder movement. There should be no sources of ignition. All electrical equipment should be explosion proof in the storage and use areas. Storage areas must meet national electric codes for class 1 hazardous areas.

Good Practices:

- Do not "open" H_2 cylinder valve before connecting it to your equipment or apparatus, since self-ignition may occur. If user experiences difficulty operating cylinder valve, discontinue use and contact supplier.
- Use only approved CGA connections. Do not use adapters.
- Never insert an object (i.e. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps.
- It is preferable to use either Tygon or Stainless Steel (SS) tubing to convey hydrogen gas. Teflon tubing is okay *if* specified by the manufacturer. Tubing shall be minimal length and not be positioned where it may become heated, damaged or disconnected.
- Remove the regulator and place the safety cap on, when the cylinder is not in constant use.
- Hydrogen gas leak detector installation is recommended. As in natural gas, an odorant can be added to hydrogen sources to enable leaks to be detected by smell.
- Prevent hydrogen leaks by meticulously connecting gas regulator and tubing.
- Keep constant vigilance to immediately detect accidental leaks.
- Prevent accumulations of leaked hydrogen using plentiful ventilation.
- Eliminate likely ignition sources, and suspect unknown ignition sources.

- Store hydrogen gas cylinders away from egress doors/paths, electrical panels and emergency eyewash & safety shower.
- Always assume hydrogen is present, and verify the system has been purged to less than 1 percent when performing system maintenance on a hydrogen system. Inert gases such as Nitrogen & Argon can be used for purging.
- Always assume oxygen is present, and verify the system has been purged to the appropriate level when reintroducing hydrogen into a system.
- Have lab buddy system when working with highly flammable gases such as Hydrogen, Ethane, Methane, Acetylene etc.
- All users should have hands-on training to work with highly flammable gases. The training should be documented.
- Anyone using hydrogen, should get some level of fire extinguisher training. For more information on fire extinguisher training please see: http://publicsafety.tufts.edu/firesafety/
- Include compressed gases on your annual chemical inventory. There are building and fire code limitations on the maximum allowed in a building
- If high purity is not a concern, a flash back arrestor should be placed downstream of the regulator.

Handling Gas Leaks from Cylinders

- Only an acceptable, approved solution shall be used when testing for leaks.
- If a cylinder safety device leaks, personnel shall not attempt to correct the leak by tightening the safety device cap while the cylinder is under pressure. The contents of the cylinder shall be emptied in a safe location. The cap shall be removed to examine the condition of the threads, correct the damage, pressurize and leak test.
- The principal danger from a leak is the potential burns, fires and explosions
- When a leak occurs, the area shall be completely roped off and caution signs shall be posted
- Leaks can occur near the valve/regulator/tubing/tubing bends or joints or a pumping system.
- Controllable leaks are relatively small leaks that would not result in significant release before shut-off and relief valves can be made operational.
- Uncontrollable leaks may be large and involve major release.
- Leaking commercial cylinders should be safely vented, tagged as defective, and returned to the supplier ASAP.

Procedures to be followed during uncontrollable leaks

- The supply source shall be shut-off immediately *if possible*
- The area shall be evacuated and pull the alarm to ensure an immediate response. Once safely outside of the building notify TUPD, at 6-6911, about the incident and the location specifics.

Accidental release & fire:

Extinguish fire only if gas flow can be stopped. If possible, shut off source of gas and allow the fire to burn it-self out. DO not extinguish leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire. Move away from container and cool with water from a protected position. Keep adjacent cylinders cool. If flames are accidentally extinguished, explosive re-ignition may occur. Therefore appropriate measures should be taken (e.g. total evacuation to protect persons from cylinder fragments and toxic fumes should a rupture occur). Most cylinders are designed to vent contents when exposed to elevated temps.

Dial 6911 and EH&S immediately for assistance.

References:

-MSDS for Hydrogen gas, Air Products, Revision 1.14, 1/26/2015.

- OSHA. Occupational Safety and Health Standards, Subpart H, Hazardous materials, Hydrogen, 1910.103 https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9749
-Specific storage requirements; NFPA 50A

-Safety Standard for Hydrogen and Hydrogen Systems. Guidelines for Hydrogen System Design, Materials Selection, Operations, Storage, and Transportation. NASA, 2/12/1997. http://www.hq.nasa.gov/office/codeq/doctree/canceled/871916.pdf

-Air Products. Gaseous Hydrogen Safetygram 4. http://www.airproducts.com/~/media/Files/PDF/company/safetygram-4.pdf

-Hydrogen Safety, Fact Sheet Series.http://arhab.org/pdfs/h2_safety_fsheet.pdf

-NFPA, 70E HRC1

-NFPA 212 and 70E Cat 1.