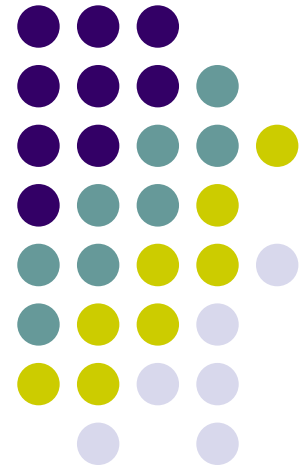


Hydrogen Safety



Hydrogen Basic Facts



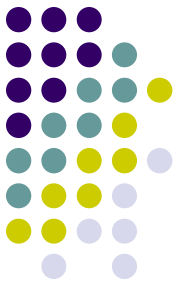
- Hydrogen is an odorless and colorless gas, with a boiling point of -252.77°C .
- Its density of 0.0899 grams/liter make it lighter than the surrounding air.
- Hydrogen has the highest energy to weight ratio of all fuels. 1 Kg of hydrogen contains the same amount of energy as 2.1 Kg of natural gas or 2.8 Kg of gasoline.
- Hydrogen has the lowest energy to volume ratio of common fuels. Hydrogen possesses 2.36 kWh/liter as a liquid, natural gas contains 5.8 kWh/liter and gasoline contains 8.76 kWh/liter.

Hydrogen Properties vs. Other Fuels



Property	Gasoline	Methane	Hydrogen
Density (Kg/M3)	4.4	0.65	0.084
Diffusion Coefficient In Air (Cm2/Sec)	0.05	0.16	0.61
Specific Heat at Constant Pressure (J/Gk)	1.2	2.22	14.89
Ignition Limits In Air (vol %)	1.0-7.6	5.3-15.0	4.0-75.0
Ignition Temperature (oC)	228-471	540	585
Flame Temperature In Air (oC)	2197	1875	2045

Hydrogen Safety



- **Emergency Overview**

- Hydrogen is not toxic, the immediate health hazard is that it may cause thermal burns.
- It is flammable and may form mixtures with air that are flammable or explosive. Hydrogen may react violently if combined with oxidizers, such as air, oxygen, and halogens.
- Hydrogen is an asphyxiant and may displace oxygen in a workplace atmosphere. However the concentrations at which flammable or explosive mixtures form are much lower than the concentration at which asphyxiation risk is significant.

Fire Safety

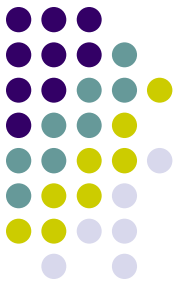


- Hydrogen flames are invisible
- If a hydrogen fire starts:
 - The only way to extinguish the fire is by stopping the flow of gas
 - If the flow cannot be stopped, allow the entire contents of the cylinder to burn.
 - Cool the cylinder and surroundings with water from a suitable distance.
 - Treat thermal burns by assuring that affected area is cool by flushing with cool water, then apply dry sterile dressings. If the patient is burned on the face, neck, head, or chest, assume that the airway may also have been burned and obtain professional medical assistance immediately.



Handling Hydrogen

- Handle this material only in sealed, purged systems.
- Cylinders should always stand upright (valve up, >45° from horizontal unless designed specially for use in horizontal position).
- Cylinder's should be properly secured with approved cylinder support.
- Protect the cylinders from direct sunlight, precipitation, mechanical damage, and temperatures above 55°C (130°F).
- Cylinders are to be fitted ONLY with the appropriate compatible regulator -- no adaptors.



Regulations

- Store cylinders in accordance with CGA P-1, *Safe Handling of Compressed Gases in Containers*
- *Although hydrogen is not specifically regulated by OSHA, it falls under U.S. OSHA 29 CFR 1910.101*