TECH TUESDAY

Tip of the Week

Exploring Alternative Fuels - Hydrogen (H^1)

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Hydrogen
1.008

The most abundant element in the universe, hydrogen is also a promising source of “clean” fuel on Earth. Named after the Greek words hydro for “water” and genes for “forming,” hydrogen makes up more than 90 percent of all of the atoms, which equals three quarters of the mass of the universe, according to the Los Alamos National Laboratory.

Hydrogen is considered an alternative fuel under the Energy Policy Act of 1992. The interest in hydrogen as an alternative transportation fuel stems from its ability to power fuel cells in zero-emission electric vehicles, its potential for domestic production, and the fuel cell’s potential for high efficiency. In fact, a fuel cell is two to three times more efficient than an internal combustion engine running on gasoline. Hydrogen can also serve as fuel for internal combustion engines, but unlike with fuel cells, will produce tailpipe emissions and is less efficient.

Hydrogen is a commercially important element. Large amounts of hydrogen are combined with nitrogen from the air to produce ammonia (NH3) through a process called the Haber process. Hydrogen combines with other elements to form numerous compounds. Some of the common ones are: water (H2O), ammonia (NH3), methane (CH4), table sugar (C12H22O11), hydrogen peroxide (H2O2) and hydrochloric acid (HCl).

Common Uses of Hydrogen

It is primarily used to create water. Hydrogen gas can be used for metallic ore reduction. Chemical industries also use it for hydrochloric acid production. The same hydrogen gas is required for atomic hydrogen welding (AHW).

Electrical generators use the gas as a rotor coolant. The element is relied upon in many manufacturing plants to check for leaks. Hydrogen can be used on its own or with other elements. Other applications include fossil fuel processing and ammonia production. Ammonia is part of many household cleaning products. It is also a hydrogenating agent used to change unhealthy unsaturated fats to saturated oils and fats.

Hydrogen is also used for methanol production. Tritium is generated in nuclear reactions. It is a radioactive isotope used to make H-bombs. It can also be used as a luminous paint radiation source. Tritium is used in biosciences as an isotopic label.

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Hydrogen and Fuel Cells

The element is often used as fuel because of its high calorific value. Combustion generates plenty of energy. Hydrogen fuel cells generate electricity from oxygen and hydrogen. These electrochemical cells generate only water vapor so it is considered as environment friendly.

Fuel cells are used in spacecraft, remote weather stations and submarines. When in liquid form, it is used as rocket fuel. Deuterium is heavy hydrogen. This isotope is used for nuclear fusion reaction in nuclear reactors.

Use in Weather Balloons

Because hydrogen is light, scientists are able to use it with weather balloons. Meteorologists' weather balloons have this element installed. These balloons are fitted with equipment to record information necessary to study the climate. During the First World War, these were utilized in balloon airships.

Industrial Applications

Other uses of hydrogen are in the fertilizer and paint industries. It is also used in the food and chemical industries. Food industries use the element to make hydrogenated vegetable oils such as margarine and butter. In this procedure, vegetable oils are combined with hydrogen. By using nickel as a catalyst, solid fat substances are produced.

In petrochemical industry, hydrogen is required for crude oil refinements.
Welding companies use the element for welding torches. These torches are utilized for steel melting. Hydrogen is required as a reducing agent in chemical industries. Chemical industries use them for metal extraction. For example, hydrogen is needed to treat mined tungsten to make them pure.

Chemical Compounds

This element is used for producing several chemical compounds. Apart from ammonia, hydrogen can be harnessed in other ways. It can be used to make fertilizers, hydrochloric acids and an assortment of bases. The same element is required for methyl alcohol production. Methyl alcohol is used in inks, varnishes and paints. Hydrogen peroxide is another vital compound.

Hydrogen peroxide is used in many ways. First and foremost it is used for medication. It is included in most first aid kits. It is primarily used for treating wounds and cuts. Peroxide is also a toenail fungus disinfectant. Hydrogen peroxide can be diluted in water. It can kill bacteria and germs if used as whitewash. The same element can be used for teeth whitening and canker sores treatment.

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Hydrogen peroxide can be used in non-medical ways. Other applications include a pest controller in gardens, removing stains on clothing and functioning as a bleaching agent for cleaning homes.

Hydrogen Production Methods

The element is produced in several ways. They can be harvested to be used as hydrogen fuel cells. It can also be generated via industrial processes. Other methods include bio hydrogen production, thermolysis or electrolysis. Hydrogen pinch and steam reforming are also used by many industries. The most common technique for harvesting the element is steam reforming.

Steam reacts with methanol to generate carbon monoxide and hydrogen. This process is done at high temperatures. When the temperature is set down, carbon monoxide will be produced. It can produce carbon dioxide and hydrogen. The efficiency rate is around 75%. Pinch is another technique.

This method moves the element through the hydro cracking sections. The objective is to produce the final procedure so no more hydrogen is emitted. Any hydrogen generated is stored. They are used for other means.

Thermolysis and Electrolysis

These are used for hydrogen production for industrial uses. The method is also known as water splitting. In this method, hydrogen and oxygen molecules are separated using electric currents. Heat is not necessary for electrolysis.

However, high temperatures will produce better hydrogen yields. Sometimes urine is used in lieu of water. Many uses of hydrogen rely on this method.

There is also bio hydrogen. The element it produces is useable. The process includes electrohydrogenesis, enzyme reactions and fermentation. With fermentation, biological materials are destroyed.

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Evergreen Midwest
Material Safety Data Sheets (MSDS)

Section 1 : PRODUCT AND COMPANY IDENTIFICATION

Product name: Hydrogen (Gaseous),

Section 2 : COMPOSITION/ INGREDIENT INFORMATION

C.A.S.	CONCENTRATION %	Ingredient Name	OSHA PEL	ACGIH TLV	OSHA STEL
1333-74-0	Typically > 99.99	HYDROGEN	NONE	Simple asphyxiant	NONE

Section 3 : HAZARD IDENTIFICATION

Emergency Overview: Hydrogen gas is colorless, odorless and flammable. It forms flammable and explosive mixtures with air over a wide range of concentrations.

The chief physical hazard associated with releases of the gas is asphyxiation by displacement of air and hence, oxygen. Hydrogen presents a serious fire hazard when accidentally released. Emergency personnel must practice extreme caution when approaching hydrogen releases **hydrogen burns with an almost invisible blue flame** which can cause much localized heating and explosion or rupture of pressure vessels.

It is non-toxic. The primary health hazard is asphyxiation by displacement of oxygen.

Route of entry: Inhalation, skin and eye contact.

Effects of acute exposure

Eye contact: No adverse effects expected.

Skin contact: No adverse effects expected.

Inhalation: Asphyxiant.
May cause dizziness, ringing in ears
Can cause nausea, vomiting.
May result in unconsciousness.
May cause excitation, excess salivation, rapid breathing.
May cause headaches and drowsiness.
May cause stinging of the nose and throat.

Ingestion: Not a likely route of exposure.

Effects of chronic exposure: None known - none expected.

Section 4 : FIRST AID MEASURES

Skin contact: None required.

Eye contact: None required.

Inhalation: **RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO THIS PRODUCT WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. At a minimum, Self-Contained Breathing Apparatus should be worn. IN ADDITION, RESCUERS MUST BE MADE AWARE OF HIGH POTENTIAL FOR FIRE AND EXPLOSION.**

Remove victim(s) to fresh air, as quickly as possible. If not breathing qualified personnel should administer artificial respiration. Get medical attention.
Keep person warm and at rest.

Ingestion: No first aid should be needed.
Not considered a potential route of exposure. Product is a gas.

Section 5 : FIRE FIGHTING MEASURES

Flammability: Flammable over wide range of concentrations in air.

Conditions of flammability: Contact with open flames or electrostatic discharge.

Extinguishing media: Carbon dioxide, regular dry chemical, fine water mist.

Special procedures: Self-contained breathing apparatus required.
Firefighters should wear the usual protective gear.
Cool fire exposed containers with water spray from greatest possible distance. Remove containers from fire area if without risk.

Personnel should be evacuated, if necessary, to upwind area.
Unless and until flow of gas can be cut off, let the fire burn.
Continue to cool containers until well after leak is stopped and fire is extinguished.

Recognize that hydrogen gas is very light and rises rapidly in air, if gas is not burning, it may collect in the upper levels of structures, creating an explosion hazard.

Auto-ignition temperature: 1058 ˚F (570 ˚C).

Flash point (°C), method: Not applicable.

Lower flammability limit (% vol): 4.0%

Upper flammability limit (% vol): 75%

Explosion Data

Sensitivity to mechanical impact: Avoid impact against container.

Explosive power: Closed containers may rupture or explode due to pressure build-up when exposed to extreme heat.
Cylinders are equipped with temperature and pressure relief devices but may still rupture under fire conditions.

Section 6 : ACCIDENTAL RELEASE MEASURES

Leak/Spill: Evacuate all non-essential personnel.
Stop leak without risk.
Wear gloves and goggles
Use a self-contained breathing apparatus.
Ventilate area. Hydrogen rises and disburses rapidly. l

Section 7 : HANDLING AND STORAGE

Handling procedures and equipment: Protect system components against physical damage.
Use adequate ventilation.
Avoid inhalation.
Never work on a pressurized system.
If there is a leak, close the upstream valve, blow down the system by venting to a safe place, and then repair the leak.

Storage requirements: Use storage containers, piping, valves and fittings designed for storage and distribution of Gaseous Hydrogen. Protect cylinders against physical damage. Store in cool, dry, well-ventilated, fireproof area, away from flammable materials and corrosive atmospheres. Store away from heat and ignition sources and out of direct sunlight. Do not store near elevators, corridors or loading docks. Do not allow area where cylinders are stored to exceed 52°C (125°F). Post "No Smoking or Open Flames" signs in use and storage areas. Electrical equipment in storage areas must meet codes for Class 1 hazardous areas and be explosion proof.

Move cylinders with a suitable hand-truck. Do not drag, slide or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap in-place (where provided) until cylinder is placed into service and after it is taken out of service.

Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Use check valve or trap in discharge line to prevent hazardous backflow into the cylinder. Do not use oils or grease on gas-handling fittings or equipment. Piped systems must be grounded. Use soapy water for leak checks, use no open flames around hydrogen systems.

After use, close main cylinder valve. Replace valve protection cap (where provided). Mark empty cylinders "EMPTY".

Section 8 : EXPOSURE CONTROLS / PERSONAL PROTECTION

Precautionary Measures

Gloves/Type:

Wear appropriate gloves.

Respiratory/Type: None required in normal use, only in confined spaces.

Eye/Type: As per OSHA29 CFR 1910.133 and local regulations.

Footwear/Type: Safety boots per local regulations.

Clothing/Type: Wear adequate protective clothes.

Other/Type: As per OSHA29 CFR 1910.133 and local regulations

Ventilation requirements: Mechanical ventilation is satisfactory. Ensure oxygen concentration remains above 19.5% and Carbon Dioxide concentration does not exceed 5000 ppm,
Local exhaust at points of emission preferred.

Exposure limit of material Simple asphyxiant.

Section 9 : PHYSICAL AND CHEMICAL PROPERTIES

Physical state: Gas

Appearance & odor: Colorless, odorless gas.

Odor threshold (PPM): Odorless.

Vapor pressure : Gas@ 70°F (21°C)

Vapor sp. gravity (air=1): 0.069 @ 70°F (21°C)

Boiling point : -252.8°C (760 mmHg)
-423.0°F

Freezing point : -259°C
-434.6°F

Solubility in water (%): Slight.

Section 10 : STABILITY AND REACTIVITY

Chemical stability: Product is stable.

Conditions of reactivity: Heat

Hazardous polymerization: Will not occur.

Incompatible substances: Oxidizing materials (oxygen, chlorine, bromine, chlorine bromide, nitrogen trifluoride)
Metal oxides, metal salts, halo carbons.

Hazardous decomposition products: None

Section 11 : TOXICOLOGICAL INFORMATION

LD50 of product, species & route: Simple asphysiant.

LC50 of product, species & route: Simple asphysiant.

Section 13 : DISPOSAL CONSIDERATIONS

Waste disposal: Gas will dissipate in air. Cylinders should be returned in the original shipping container, properly labeled, with residual product, valve outlet plugs or caps secured and valve protection cap in place.

Section 14 : TRANSPORT INFORMATION

DOT/ TDG classification:

For cylinder shipments:
Hydrogen, compressed
UN1049
Class 2.1(Flammable Gas).

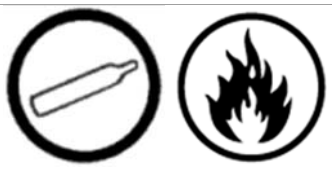
North American Emergency Response Guidebook Number:

115

Section 15 : REGULATORY INFORMATION

WHMIS classification:

A, B1



DSL status: Appears on DSL.

Section 16 : OTHER INFORMATION

Definitions and other useful data:

CAS #: The Chemical Abstract Service Number which uniquely identifies each constituent.

ACGIH - American Conference of Governmental Industrial Hygienists, a professional association which establishes exposure limits.

TLV - Threshold Limit Value - an airborne concentration of a substance which represents conditions under which it is generally believed that nearly all workers may be repeatedly exposed without adverse effect.

OSHA - U.S. Occupational Safety and Health Administration.

PEL - Permissible Exposure Limit - The same value as a TLV, except it is enforceable by OSHA.

IDLH - Immediately Dangerous to Life and Health **-** A concentration from which one can escape within 30-minutes without suffering permanent injury.

NATIONAL FIRE PROTECTION ASSOCIATION:
Health Hazard Rating Scale (Blue):
0 (material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials);
1 (materials that on exposure under fire conditions could cause irritation or minor residual injury);
2 (materials that on intense or continued exposure under fire conditions could cause temporary incapacitation or possible residual injury);
3 (materials that can on short exposure could cause serious temporary or residual injury);
4 (materials that under very short exposure could cause death or major residual injury).

Flammability Hazard Rating Scale (Red):
0 (minimal hazard);
1 (materials that require substantial pre-heating before burning);
2 (combustible liquid or solids; liquids with a flash point of 38-93°C [100-200°F]);
3 (Class IB and IC flammable liquids with flash points below 38°C [100°F]);
4 (Class IA flammable liquids with flash points below 23°C [73°F] and boiling points below 38°C [100°F].

Reactivity Hazard Rating Scale (Yellow):
0 (normally stable);
1 (material that can become unstable at elevated temperatures or which can react slightly with water);
2 (materials that are unstable but do not detonate or which can react violently with water);
3 (materials that can detonate when initiated or which can react explosively with water);
4 (materials that can detonate at normal temperatures or pressures).

TOXICOLOGICAL INFORMATION:

Possible health hazards as derived from human data, animal studies, or from the results of studies with similar compounds are presented. Definitions of some terms:
LD50 -Lethal Dose (solids & liquids) which kills 50% of the exposed animals;
LC50 - Lethal Concentration (gases) which kills 50% of the exposed animals;
ppm concentration expressed in parts of material per million parts of air or water;
mg/m3 concentration expressed in weight of substance per volume of air;
mg/kg quantity of material, by weight.

REGULATORY INFORMATION:

EPA is the U.S. Environmental Protection Agency.

WHMIS is the Canadian Workplace Hazardous Materials Information System.

DOT and **TC** are the U.S. Department of Transportation and the Transport Canada, respectively, which assign DOT and **TDG** (Transportation of Dangerous Goods) identification numbers, hazard classifications, and proper shipping name and shipping label information. This material is hazardous as defined by 49 CFR 172.101 of the US Department of Transportation and Dangerous Goods as defined by Transport Canada Transportation of Dangerous Goods Regulations.

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