HYDROGEN

HXX

CAUTIONARY RESPONSE INFORMATION

Common Synonyms para-Hydrogen Liquid hydrogen	Gas Colorless Odorless Floats and boils on water. Flammable visible vapor cloud is produced.

Evacuate.
Keep people away. Avoid contact with liquid and vapor.
Shut off ignition sources. Call fire department.
Stay upwind. Use water spray to ``knock down'' vapor.

Fire	FLAMMABLE. Flame is almost invisible. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Evacuate surrounding area. Stop flow of gas if possible. Cool exposed containers and protect men effecting shutoff with water.
Exposure	VAPOR If inhaled in high concentrations will cause difficult breathing, or loss of consciousness. Move victim to fresh air. If breathing has stopped, give artificial respiration. LIQUID Will cause frostbite. Flush affected areas with plenty of water. DO NOT RUB AFFECTED AREAS.
Water Pollution	Not harmful to aquatic life.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: Not listed.
2.2 Formula: H_2
2.3 IMO/UN Designation: 2/1966 (Refrigerated) 2/1049 (Compressed)
2.4 DOT ID No.: 1966 (Refrigerated) 1049 (Compressed)
2.5 CAS Registry No.: 133-74-0
2.6 NAERG Guide No.: 115
2.7 Standard Industrial Trade Classification: 52221

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Safety goggles or face shield; insulated gloves and long sleeves; cuffless trousers worn outside boots or over high-top shoes to shed spilled liquid; self-contained breathing apparatus containing air (never use oxygen).
3.2 Symptoms Following Exposure: If atmosphere does not contain enough oxygen, inhalation can cause dizziness, unconsciousness, or even death. Contact of liquid with eyes or skin causes freezing similar to burn.
3.3 Treatment of Exposure: The only effect of exposure to liquid hydrogen is that caused by its unusually low temperature and its action as a simple asphyxiant. INHALATION: if victim is unconscious (due to oxygen deficiency), move him to fresh air and apply resuscitation methods; call physician. EYES: treat for frostbite. SKIN: treat for frostbite; soak in lukewarm water; get medical attention if burn is severe.
3.4 TLV-TWA: Gas is non-poisonous but can act as a simple asphyxiant.
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Not pertinent (gas with low boiling point)
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: None
3.10 Vapor (Gas) Irritant Characteristics: Currently not available
3.11 Liquid or Solid Characteristics: Currently not available
3.12 Odor Threshold: Odorless
3.13 IDLH Value: Not listed.
3.14 OSHA PEL-TWA: Not listed.
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: Not pertinent
4.2 Flammable Limits in Air: 4.0%-75.0%
4.3 Fire Extinguishing Agents: Let fire burn; shut off gas supply.
4.4 Fire Extinguishing Agents Not to Be Used: Carbon dioxide
4.5 Special Hazards of Combustion Products: Not pertinent
4.6 Behavior in Fire: Burns with an almost invisible flame.
4.7 Auto Ignition Temperature: 1,065°F
4.8 Electrical Hazards: Class I, Group B
4.9 Burning Rate: 9.9 mm/min.
4.10 Adiabatic Flame Temperature: 2497. (Est.)
4.11 Stoichometric Air to Fuel Ratio: 2.4 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 1.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): N_2 diluent: 5.0%; CO_2 diluent: 5.2%

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: Ambient temperature of water will cause vigorous vaporization of hydrogen.
5.2 Reactivity with Common Materials: No chemical reaction, but low temperature causes most materials to become very brittle.
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: None
6.2 Waterfowl Toxicity: None
6.3 Biological Oxygen Demand (BOD): None
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile: Not listed

7. SHIPPING INFORMATION

7.1 Grades of Purity: Commercial
7.2 Storage Temperature: -434°F
7.3 Inert Atmosphere: No requirement
7.4 Venting: Safety relief
7.5 IMO Pollution Category: Currently not available
7.6 Ship Type: Currently not available
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable gas
8.2 49 CFR Class: 2.1
8.3 49 CFR Package Group: Not pertinent.
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue).....	0
Flammability (Red).....	4
Instability (Yellow).....	0

8.6 EPA Reportable Quantity: Not listed.
8.7 EPA Pollution Category: Not listed.
8.8 RCRA Waste Number: Not listed
8.9 EPA FWPCA List: Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Gas
9.2 Molecular Weight: 2.0
9.3 Boiling Point at 1 atm: –423°F = –253°C = 20°K
9.4 Freezing Point: –434°F = –259°C = 14°K
9.5 Critical Temperature: –400°F = –240°C = 33°K
9.6 Critical Pressure: 188 psia = 12.8 atm = 1.30 MN/m^2
9.7 Specific Gravity: 0.071 at –253°C (liquid)
9.8 Liquid Surface Tension: 2.3 dynes/cm = 0.023 N/m at -255°C
9.9 Liquid Water Interfacial Tension: Not pertinent
9.10 Vapor (Gas) Specific Gravity: 0.067
9.11 Ratio of Specific Heats of Vapor (Gas): 1.3962
9.12 Latent Heat of Vaporization: 190.5 Btu/lb = 105.8 cal/g = 4.427 X 10^5 J/kg
9.13 Heat of Combustion: –50,080 Btu/lb = –27,823 cal/g = –1164.1 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: 13.8 cal/g
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: Very High

NOTES

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9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square foot-F	Temperature (degrees F)	Centipoise
-426	4.531	-426	0.570	-425	0.795	-432	0.020
-425	4.493	-425	0.570	-424	0.804	-431	0.019
-424	4.455	-424	0.570	-423	0.813	-430	0.018
-423	4.417	-423	0.570			-429	0.017
						-428	0.016
						-427	0.015
						-426	0.015
						-425	0.014
						-424	0.014
						-423	0.013

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	I	-434	1.231	-434	0.00894	0	3.500
	N	-433	1.678	-433	0.01173	10	3.500
	S	-432	2.237	-432	0.01506	20	3.500
	O	-431	2.921	-431	0.01898	30	3.500
	L	-430	3.746	-430	0.02352	40	3.500
	U	-429	4.726	-429	0.02871	50	3.500
	B	-428	5.874	-428	0.03456	60	3.500
	L	-427	7.205	-427	0.04109	70	3.500
	E	-426	8.729	-426	0.04831	80	3.500
		-425	10.460	-425	0.05621	90	3.500
		-424	12.400	-424	0.06479	100	3.500
		-423	14.570	-423	0.07405	110	3.500
		-422	16.970	-422	0.08397	120	3.500
		-421	19.620	-421	0.09452	130	3.500
		-420	22.500	-420	0.10570	140	3.500
		-419	25.640	-419	0.11750	150	3.500
		-418	29.030	-418	0.12980	160	3.500
						170	3.500
						180	3.500
						190	3.500
						200	3.500
						210	3.500
						220	3.500
						230	3.500
						240	3.500
						250	3.500