



HYDROGEN

Material Safety Data Sheet

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name	HYDROGEN
Product Code(s)	G-4, 1031
UN-Number	UN1049
Recommended Use	Compressed gas.
Synonyms	Normal Hydrogen; Hydrogen, Compressed
Supplier Address*	Linde Gas North America LLC - Linde Merchant Production Inc. - Linde LLC 575 Mountain Ave. Murray Hill, NJ 07974 Phone: 908-464-8100 www.lindeus.com

Linde Gas Puerto Rico, Inc.
Las Palmas Village
Road No. 869, Street No. 7
Catano, Puerto Rico 00962
Phone: 787-641-7445
www.pr.lindegas.com

Linde Canada Limited
5860 Chedworth Way
Mississauga, Ontario L5R 0A2
Phone: 905-501-1700
www.lindecana.com

* May include subsidiaries or affiliate companies / divisions.

For additional product information contact your local customer service.

Chemical Emergency Phone Number Chemtrec: 1-800-424-9300 for US / 703-527-3887 outside US

2. HAZARDS IDENTIFICATION

DANGER!		
Emergency Overview		
Flammable gas		
May form explosive mixtures with air		
Simple asphyxiant		
Contents under pressure		
Keep at temperatures below 52°C / 125°F		
Appearance	Colorless	Physical State Compressed gas.
		Odor Odorless

OSHA Regulatory Status

This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Potential Health Effects

Principle Routes of Exposure Inhalation. Skin contact.

Acute Toxicity

Inhalation Simple asphyxiant. May cause suffocation by displacing the oxygen in the air. Exposure to oxygen-deficient atmosphere (<19.5%) may cause dizziness, drowsiness, nausea, vomiting, excess salivation, diminished mental alertness, loss of consciousness and death. Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that the individuals cannot help or protect themselves. Lack of sufficient oxygen may cause serious injury or death.

Eyes None known. Contact with rapidly expanding gas near the point of release may cause frostbite.

Skin None known. Contact with rapidly expanding gas near the point of release may cause frostbite.

Skin Absorption Hazard No known hazard in contact with skin.

Ingestion Not an expected route of exposure.

Chronic Effects None known

Aggravated Medical Conditions None known.

Environmental Hazard See Section 12 for additional Ecological Information.

3. COMPOSITION / INFORMATION ON INGREDIENTS

Chemical Name	CAS-No	Volume %	Chemical Formula
Hydrogen	1333-74-0	>99	H ₂

4. FIRST AID MEASURES

Eye Contact None required for gas. If frostbite is suspected, flush eyes with cool water for 15 minutes and obtain immediate medical attention.

Skin Contact None required for gas. For dermal contact or suspected frostbite, remove contaminated clothing and flush affected areas with lukewarm water. DO NOT USE HOT WATER. A physician should see the patient promptly if contact with the product has resulted in blistering of the dermal surface or in deep tissue freezing.

Inhalation PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF INHALATION OVEREXPOSURE. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious inhalation victims should be assisted to an uncontaminated area and inhale fresh air. If breathing is difficult, administer oxygen. Unconscious persons should be moved to an uncontaminated area and, as necessary, given artificial resuscitation and supplemental oxygen. Treatment should be symptomatic and supportive.

Ingestion None under normal use. Get medical attention if symptoms occur.

Notes to Physician Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Flammable Properties	Extremely flammable.
Suitable Extinguishing Media	Dry chemical or CO ₂ . Water spray or fog.
<u>Explosion Data</u>	
Sensitivity to Mechanical Impact	None
Sensitivity to Static Discharge	Yes.
Specific Hazards Arising from the Chemical	Hydrogen is very light and may collect in the upper portions of storage areas. Hydrogen burns with an almost invisible flame. High pressure releases may ignite with no apparent ignition source possibly via static electricity. Continue to cool fire exposed cylinders until flames are extinguished. Cylinders may rupture under extreme heat. Damaged cylinders should be handled only by specialists.
Protective Equipment and Precautions for Firefighters	If possible, stop the flow of gas. Do not extinguish the fire until supply is shut off as otherwise an explosive-ignition may occur. If the fire is extinguished and the flow of gas continues, use increased ventilation to prevent build-up of explosive atmosphere. Ventilation fans must be explosion proof. Use non-sparking tools to close container valves. Isolate spill or leak area for at least 100 meters (330 feet) in all directions. Vapors from liquefied gas are initially heavier than air and spread along ground. Vapors may accumulate in confined areas (basement, tanks, hopper / tank cars, etc.). Vapors may travel to source of ignition and flash back. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible withdraw from area and let fire burn. Use water spray to cool surrounding containers. Be cautious of a Boiling Liquid Evaporating Vapor Explosion, BLEVE, if flame is impinging on surrounding containers. As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA / NIOSH (approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions	ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Evacuate personnel to safe areas. Keep people away from and upwind of spill / leak. All equipment used when handling the product must be grounded. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Monitor oxygen level.
Environmental Precautions	Beware of vapors accumulating to form explosive concentrations. Prevent spreading of vapors through sewers, ventilation systems and confined areas.
Methods for Containment	Stop the flow of gas or remove cylinder to outdoor location if this can be done without risk. If leak is in container or container valve, contact the appropriate emergency telephone number in Section 1 or call your closest Linde location.
Methods for Cleaning Up	Return cylinder to Linde or an authorized distributor.

7. HANDLING AND STORAGE

Handling

Ground and bond all lines and equipment associated with the hydrogen system. All equipment should be non-sparking and explosion proof. Separate hydrogen from oxygen and other oxidizers by a minimum distance of 20 ft. or by a 5 ft. high barrier with a minimum fire resistance rating of a half an hour. Post "NO SMOKING" signs in use and storage areas. Remove all sources of ignition. Use only in ventilated areas. Hydrogen is non-corrosive. However hydrogen can interact with metals (hardened steels) to cause embrittlement.

Never attempt to lift a cylinder by its valve protection cap. Protect cylinders from physical damage; do not drag, roll, slide or drop. When moving cylinders, even for short distance, use a cart designed to transport cylinders. Use equipment rated for cylinder pressure. Use backflow preventive device in piping.

Use an adjustable strap wrench to remove over-tight or rusted caps. Never insert an object (e.g. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing leak to occur. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier.

Never put cylinders into trunks of cars or unventilated areas of passenger vehicles. Never attempt to refill a compressed gas cylinder without the owner's written consent. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit.

For additional recommendations, consult Compressed Gas Association's pamphlets P-1, G-5, G-5.3, G-5.5, P-6 and Safety Bulletin SB-2.

Storage

Outside or detached storage is preferred. Protect from physical damage. Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling. Store in cool, dry, well-ventilated area of non-combustible construction away from heavily trafficked areas and emergency exits. Keep at temperatures below 52°C / 125°F. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time. Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, pamphlet CGA-P1, Safe Handling of Compressed Gases in Containers.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

This product does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Engineering Measures

Explosion proof ventilation systems. Local exhaust ventilation to prevent accumulation of high concentrations and maintain air-oxygen levels at or above 19.5%.

Ventilation

Ensure adequate ventilation, especially in confined areas. Flammable gas concentration must be below 10% of the LEL (0.4%) prior to entry.

Personal Protective Equipment

Eye / Face Protection

Wear protective eyewear (safety glasses).

Skin and Body Protection

Work gloves and safety shoes are recommended when handling cylinders. Cotton or Nomex® clothing is recommended to prevent static build-up.

Respiratory Protection

General Use

No special protective equipment required.

Emergency Use	Use positive pressure airline respirator with escape cylinder or self contained breathing apparatus for oxygen-deficient atmospheres (<19.5%).
Hygiene Measures	Wear suitable gloves and eye / face protection.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Colorless.	Odor	Odorless.
Odor Threshold	No information available	Physical State	Compressed gas
Flash Point	No information available.	Autoignition Temperature	570 °C / 1058 °F
Decomposition Temperature	No information available.	Boiling Point / Boiling Range	-252.8 °C / -423.2 °F
Freezing Point	-259.2 °C / -434.8 °F	Molecular Weight	2.105 (as H ₂)
Water Solubility	0.019 vol / vol @ 15.6°C	Evaporation Rate	No information available
Vapor Pressure	Supercritical	Vapor Density	0.069 (air = 1)
Gas Density	0.00521 lb / ft ³ (0.08342 kg / m ³) @ 21.1°C (70°F)	VOC Content (%)	Not applicable.
Specific Vol. @ 21.1°C & 1 atm	190.8 ft ³ / lb (11.99 m ³ / kg)	Critical Pressure	190.8 psia (1315 kPa abs)
Flammability Limits in Air			
Upper	75%		
Lower	4%		

10. STABILITY AND REACTIVITY

Stability	Stable.
Incompatible Products	Oxidizing agents.
Conditions to Avoid	Heat, flames and sparks. Flammable or explosive when mixed with chlorine or other oxidizing materials. Fluorine and hydrogen react at -418°F (-250°C) when impurities are present. Chlorine / hydrogen mixtures explode if exposed to light. Lithium metal will burn in a hydrogen atmosphere.
Hazardous Decomposition Products	None known.
Hazardous Polymerization	Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

LD50 Oral:	No information available.
LD50 Dermal:	No information available.
LC50 Inhalation:	No information available.
Inhalation	Product is a simple asphyxiant.
Repeated Dose Toxicity	No information available.

Chronic Toxicity

Chronic Toxicity	None known.
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Carcinogenicity	Contains no ingredient listed as a carcinogen.
Irritation	Non-irritating to the skin. Non-irritating to the eye.
Sensitization	No information available.
Reproductive Toxicity	No information available.
Developmental Toxicity	Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.
Synergistic Materials	None known.
Target Organ Effects	None known.

12. ECOLOGICAL INFORMATION

Ecotoxicity

The environmental impact of this product has not been fully investigated.

Ozone depletion potential; ODP; (R-11 = 1): Does not contain ozone depleting chemical (40 CFR Part 82).

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods	Do not attempt to dispose of residual waste or unused quantities. Return in the shipping container PROPERLY LABELED WITH ANY VALVE OUTLET PLUGS OR CAPS SECURED AND VALVE PROTECTION CAP IN PLACE to Linde for proper disposal.
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14. TRANSPORT INFORMATION

DOT

Proper shipping name	Hydrogen, compressed
Hazard Class	2.1
Subsidiary Class	None
UN-Number	UN1049
Description	UN1049,Hydrogen, compressed,2.1
Emergency Response Guide Number	115

TDG

Proper Shipping Name	Hydrogen, compressed
Hazard Class	2.1
UN-Number	UN1049
Description	UN1049,HYDROGEN, COMPRESSED,2.1

MEX

Proper Shipping Name	Hydrogen, compressed
Hazard Class	2.1

UN-Number	UN1049
Description	UN1049, Hydrogen, compressed,2.1

IATA

UN-Number	UN1049
Proper Shipping Name	Hydrogen, compressed
Hazard Class	2.1
ERG Code	10L
Description	UN1049,Hydrogen, compressed,2.1
Maximum Quantity for Passenger	Forbidden
Maximum Quantity for Cargo Only	150 kg
Limited Quantity	No information available.

IMDG / IMO

Proper Shipping Name	Hydrogen, compressed
Hazard Class	2.1
UN-Number	UN1049
EmS No.	F-D, S-U
Description	UN1049, Hydrogen, compressed,2.1

ADR

Proper Shipping Name	Hydrogen, compressed
Hazard Class	2.1
UN-Number	UN1049
Classification Code	1F
Description	UN1049, Hydrogen, compressed,2.1

15. REGULATORY INFORMATION

International Inventories

TSCA	Complies
DSL	Complies
EINECS / ELINCS	Complies

Legend

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL / NDSL - Canadian Domestic Substances List / Non-Domestic Substances List
EINECS / ELINCS - European Inventory of Existing Commercial Chemical Substances / EU List of Notified Chemical Substances

U.S. Federal RegulationsSARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311 / 312 Hazard Categories

Acute Health Hazard	No
Chronic Health Hazard	No
Fire Hazard	Yes
Sudden Release of Pressure Hazard	Yes
Reactive Hazard	No

Clean Water Act

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

Risk and Process Safety Management Programs

This material, as supplied, contains one or more regulated substances with specified thresholds under 40 CFR Part 68 or regulated as a highly hazardous chemical pursuant to the 29 CFR Part 1910.110 with specified thresholds:

Chemical Name	U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Toxic Substances	U.S. - CAA (Clean Air Act) - Accidental Release Prevention - Flammable Substances	U.S. - OSHA - Process Safety Management - Highly Hazardous Chemicals
Hydrogen		10000 lbs	

Clean Air Act, Section 112 Hazardous Air Pollutants (HAPs) (see 40 CFR 61)

This product does not contain any substances regulated as hazardous air pollutants (HAPS) under Section 112 of the Clean Air Act Amendments of 1990.

CERCLA / SARA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

U.S. State RegulationsCalifornia Proposition 65

This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Chemical Name	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Hydrogen	X	X	X	-	X

International Regulations

Canada

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS Hazard Class

A Compressed gases

B1 Flammable gas



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 23 British American Blvd.
 Latham, NY 12110
 1-800-572-6501

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Revision Number 2

Revision Note Not applicable.

<u>NFPA</u>	Health Hazard 0	Flammability 4	Stability 0	Physical and Chemical Hazards -
<u>HMIS</u>	Health Hazard 0	Flammability 4	Physical Hazard 3	Personal Protection -

Note: Ratings were assigned in accordance with Compressed Gas Association (CGA) guidelines as published in CGA Pamphlet P-19-2009, CGA Recommended Hazard Ratings for Compressed Gases, 3rd Edition.

General Disclaimer

For terms and conditions, including limitation of liability, please refer to the purchase agreement in effect between Linde LLC, Linde Merchant Production, Inc. or Linde Gas North America LLC (or any of their affiliates and subsidiaries) and the purchaser.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

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End of Safety Data Sheet