Aceti-Oxigeno, S.A.
FABRICANTES DE GASES PARA USO MÉDICO, ALIMENTICIO E INDUSTRIALES

MATERIAL SAFETY DATA SHEET

(MSDS MATERIAL SAFETY DATA SHEET)

Annex 11

GASEOUS HYDROGEN

1. Product and company identification

1.1	Product name:	Compressed hydrogen
1.2	Common chemical name:	Hydrogen
1.3	IUPAC chemical name:	Hydrogen
1.4	Chemical family:	Family of flammable gases
1.5	Condensed formula:	H_2
1.6	Synonyms:	Protium
1.7	Company name:	Aceti-Oxígeno, S.A.
1.8	Company address:	Panama Mañanitas-Industrial Zone
1.9	Telephone:	Tel. 321-8888
1.10	Emergency Telephone:	103 Fire Brigade
1.11	REVISION DATE:	June 20. of 2022, rev. 1, valid until: June 20, 2027

1.12 Use:

1.12.1 In the saturation of hydrocarbons, oils and fats.

1.12.2 In cutting and welding with Oxyhydrogen

1.12.3 In the deoxidation and protection of surfaces, together with nitrogen

1.12.4 In the conservation of cardamom grains, together with nitrogen

1.12.5 As oxidizing gas in gas chromatography using flame ionization detector

2. Composition or information on ingredients

2.1	Ingredient name:	Hydrogen
2.2	CAS [1] Number:	1333-74-0
2.3	Percentage:	> 99%
2.4	OSHA PEL-TWA [2]:	None
2.5	ACGIH TLV [3]:	Simple asphyxiant
2.6	[LD_{50}]:	None
2.7	[LC_{50}]:	None

[1] Chemical Abstracts Service (International Material Identification Number according to the Chemical Abstracts Service)

[2] Occupational Safety and Health Administration. Permissible Exposure Limits. Time Weighted Average (Occupational Safety and Hygiene Administration. Permissible Exposure Limits. Time weighted average exposure)

[3] American Conference of Governmental Industrial Hygienists. Threshold Limit Value (North American Conference of Governmental Industrial Public Health. Threshold Limit Value)

3. Risk identification

3.1 Considerations and hazards during emergencies

3.1.1 High pressure flammable gas

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3.1.2 Can form explosive mixtures with air
3.1.3 Burns with practically invisible flame

3.2 Information on potential health effects
3.2.1 Exposure routes
3.2.1.1 Inhalation: Simple asphyxiant. It is important to note that before the suffocation level is reached, the flammability level of hydrogen in air can be exceeded causing both explosive and deficient breathing atmospheres. Exposure to moderate concentrations can cause dizziness, headache, nausea, and unconsciousness. Exposure to atmospheres containing 8 to 10% oxygen or less will produce unconsciousness without warning and so rapidly that the individual will be unable to help or protect himself. Severe oxygen deficiency can cause serious damage and even death.
3.2.1.2 Contact with eyes: No risk
3.2.1.3 Skin contact: No risk
3.2.1.4 Skin absorption: No risk
3.2.1.5 Ingestion: No risk
3.2.2 Chronic effects: None
3.2.3 Medical conditions aggravated by overexposure: None
3.2.4 Other effects of overexposure: None
3.2.5 Carcinogenicity: Hydrogen is not listed by NTP [4], OSHA or IARC [5]

[4] National Toxicology Program
[5] International Agency for Research on Cancer

4. First aid

4.1 Inhalation: Move person to fresh air. If there is no breathing, administer artificial respiration. If breathing is difficult, administer oxygen. Get immediate medical attention.

4.2 Contact with eyes: No first aid required.

4.3 Skin contact: No first aid required.

4.4 Ingestion: No first aid required

4.5 Remarks to the doctor: None

5. Measures in case of fire

5.1 Ignition point: Flammable gas.

5.2 Autoignition: 1050°F (565.5°C) at 1 atmospheric pressure

5.3 Flammable limits in air, volume by volume:
5.3.1 Lower: 4.0%
5.3.2 Superior: 74.0%

5.4 Extinguishing media: Carbon dioxide, dry chemical, water spray or fog for the surroundings. Do not proceed to extinguish the fire until the supply of the hydrogen source has been stopped.

5.5 Special instructions to firefighters: Evacuate all personnel from the danger area. Immediately proceed to cool the container with water spray (spray) from a maximum distance, taking care not to extinguish the hydrogen flame. If the flame generated by the combustion of hydrogen is accidentally extinguished, explosive resignation may occur. Stop the flow of hydrogen if it does not imply greater risks, while continuing to cool the containers with water.

5.6 Unusual fire and explosion hazards: Hydrogen burns with an almost invisible pale blue flame. It is capable of igniting with small amounts of ignition energy. Hydrogen is lighter than air and can collect

in the upper sections of enclosed spaces. The pressure inside any container can rise due to heat, and can cause it to rupture if pressure relief devices fail to function.

5.7 Hazardous Combustion Products: None

5.8 Sensitivity to static discharge: Ignitable by static electricity.

5.9 Sensitivity to mechanical impact: None

6. Measures in case of accidental release

6.1 Steps to be taken if material is released or spilled:

6.1.1 Evacuate the area immediately

6.1.2 Eliminate any possible sources of ignition and provide maximum explosion-proof ventilation.

6.1.3 Close the connection to the hydrogen source if possible.

6.1.4 If hydrogen is being expelled from the cylinder body or the valve, immediately contact Aceti-Oxígeno, S.A.

6.1.5 Never enter a confined space or any other area whose hydrogen concentration is greater than 10% of the lower flammability limit (0.4%).

6.1.6 The presence of a hydrogen flame can be evidenced by carefully approaching a long-handled straw broom to make it visible.

7. Handling and storage

7.1.1 Specific requirements are listed in NFPA 50A.

7.1.2 Hydrogen storage areas and places must be well protected, well ventilated and dry, and conveniently separated from those that store combustible materials.

7.1.3 Hydrogen cylinders must be separated from oxygen cylinders or other oxidizers by a minimum distance of 20 feet (6 meters) or by a barrier of non-combustible material at least 5 feet high (1.52 meters) that have a fire resistance rating of at least half an hour.

7.1.4 Cylinders must be stored upright with the valve protection cap in place, properly secured to prevent them from falling or being hit.

7.1.5 Protect cylinders from any physical damage. Do not drag, roll, slide or drop them.

7.1.6 Place "No Smoking" and "Avoid flames or sparks" signs in use or storage areas.

7.1.7 There should be no sources of ignition in the storage area.

7.1.8 All electrical equipment that must be installed in the storage area must be explosion-proof.

7.1.9 Storage areas must meet the National Electric Codes specifications for Class 1 hazard areas.

7.1.10 Do not allow storage temperature to exceed 125ºF (52ºC).

7.1.11 Full and empty cylinders must be separated.

7.1.12 Use a FIFO (first-in, first-out) inventory system to prevent full cylinders from being stored for long periods of time.

7.2 Precautions to be taken in handling

7.2.1 Use a handcart to move cylinders.

7.2.2 Hydrogen is the lightest gas known and can accumulate in the upper part of rooms and buildings that do not have adequate ventilation. Hydrogen can leak from systems that are guaranteed to be gas-tight.

7.2.3 All hydrogen piping systems and associated equipment must be grounded.

7.2.4 Any tool that is required to be used must be non-sparking.

7.2.5 Check and detect leaks with soapy water, never with a flame.

7.2.6 Never insert an object (a tool such as a wrench, a screwdriver, etc.) into the openings of the valve protection cap, as it may be damaged and generate hydrogen leakage.

7.2.7 If there is any problem with the proper operation of the cylinder valve, discontinue its use and contact Aceti-Oxígeno, S.A.

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7.2.8 Do not hit the valve protection cap with a hammer. Use an adjustable strap wrench to remove rusted or overtightened plugs.

7.2.9 Never bring an electric arc near a compressed gas cylinder or make it part of an electrical circuit.

7.2.10 For additional precautions in the use of hydrogen, see Section 16. Other Information.

8. Exposure control and personal protection

8.1 Infrastructure controls

8.1.1 Ventilation: Provide adequate natural ventilation or explosion-proof mechanical ventilation to ensure that hydrogen does not accumulate and reach its lower flammability limit of 4% v/v.

8.2 Respiratory protection

8.2.1 General routine use: Not required

8.2.2 Use in emergencies: Respirators that supply air are required in oxygen deficient atmospheres or environments (air purifying respirators are not functional in these cases). Before entering the area, the conditions of flammability and oxygen deficiency of the internal atmosphere must be reviewed.

8.3 Protective gloves: It is recommended to wear work gloves when handling cylinders.

8.4 Eye protection: The use of safety glasses is recommended for handling the cylinders.

8.5 Other protective equipment: The use of safety footwear is recommended for handling cylinders. It is advisable to wear cotton clothing to prevent the accumulation of static electricity.

9. Physical and chemical properties

9.1 Molecular weight: 2.0158 g/mol

9.2 Boiling Point: -423ºF (-252ºC) at 1 atmospheric pressure

9.3 Specific Gravity (Air = 1) at 32ºF (0ºC) and 1 atmospheric pressure: 0.069609.

9.4 Melting point: -434.55ºF (-259.2ºC) at 1 atmospheric pressure.

9.5 Vapor pressure at 20 ºC: Not applicable

9.6 Gas density at 70ºF (21.1ºC) and 1 atmospheric pressure: 0.00521 lb/cf or 0.08342 Kg/m^3

9.7 Evaporation rate (Butyl Acetate = 1): Not applicable because it is a gas.

9.8 Solubility in water:

9.8.1 Vol/Vol at 60ºF (15.6ºC) and 1 atmospheric pressure: 0.019

9.9 Expansion ratio: Not applicable

9.10 pH: Not applicable

9.11 Appearance, odor and condition: Colorless, odorless and tasteless gas at normal temperature and pressure

9.12 Water/oil distribution coefficient: Not available

9.13 Odor threshold: Not applicable

10. Stability and reactivity

10.1 Stability: Stable

10.2 Conditions to avoid: None

10.3 Incompatibilities (Materials to avoid): Do not expose to oxidizing agents. Some steels are susceptible to internal diffusion of hydrogen at high pressures and temperatures.

10.4 Reactivity:

10.4.1 Hazardous decomposition products: None.

10.4.2 Hazardous polymerization products: Will not occur.

11. Toxicological information

11.1 General toxicological effect: Simple asphyxiant

11.2 Ability to cause irritation: None

11.3 Sensitization to material: None

11.4 Effects on the reproductive system: None

11.5 Teratogenicity: None

11.6 Mutagenicity: None

11.7 Synergistic Materials: None

12. Ecological information

No adverse or negative ecological impacts are expected. Hydrogen contains no Class I or Class II chemicals, which deplete the ozone layer (40 CFR [6] Part 82). Hydrogen is not listed as a marine pollutant by DOT [7] (49 CFR Part 171).

[6] Code of Federal Regulations

[7] Department of Transportation

13. Disposal considerations

13.1 Waste disposal method: Do not attempt to dispose of residual or unused amounts. Return the cylinder to the supplier.

13.2 Discarded cylinders must be returned to the supplier for proper and safe disposal.

13.3 The presence of hydrogen residues in a process system must be ventilated in a controlled manner towards the atmosphere through extractors that discharge at points of higher level or height at which the process is carried out. Exhaust fans should be in an isolated area away from sources of ignition.

14. Transport information

14.1 DOT/IMO shipping name: Compressed Hydrogen

14.2 Hazard Classification: 2.1 (Flammable Gas)

14.3 Identification number: UN 1049

14.4 Product identification number: 1049

14.5 Product reportable quantity: Not applicable

14.6 Shipping labels: Flammable Gas

14.7 Placard: Flammable Gas

14.8 Special shipping information: Cylinders must be transported in a secure upright position, in a well-ventilated vehicle. The transport of compressed gases in automobiles or closed body vehicles can present great safety risks and should not be recommended or encouraged.

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Panama, July 28, 2022.

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15. Related regulations

The following information is related to United States regulatory requirements potentially applicable to this product in Panama. Users of this product are responsible for complying with their local or general regulatory requirements.

15.1 United States Federal Regulations

15.1.1 EPA - Environmental Protection Agency

15.1.1.1 CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (40 CFR Parts 117 and 302). Reportable Quantity RQ: Not applicable

15.1.1.2 SARA: Superfund Amendment and Reauthorization Act

Section 302/304: Requires emergency planning based on Threshold Planning Quantities (TPQ) and release reporting based on Reportable Quantities (RQ) of EPA-scheduled substances as extremely hazardous (40 CFR Part 355)

Extremely Hazardous Substance: Not Applicable
Planning Threshold Quantity: Not applicable

Section 311/312: Requires the submission of a Material Safety Data Sheet (MSDS) and a chemical inventory report with identification of the risk classes defined by the EPA (40 CFR Part 370). The hazard classes for this product are:

Immediate:	No
Late:	No
Pressure:	Yes
Reactivity:	No
Fire:	Yes

Section 313: Requires submission of annual toxic chemical release reports listed in 40 CFR Part 372. Hydrogen is not required to report under this Section.

15.1.2 40 CFR Part 68: Risk Management for Chemical Accidental Release: Requires the development and implementation of risk management programs in manufacturing facilities, use, storage, or any other Controlled substance handled in amounts exceeding specified thresholds. Hydrogen is listed as a regulated substance in quantities equal to or greater than 10,000 lbs. (4,553 Kg).

15.1.3 TSCA Toxic Substance Control Act: Hydrogen is listed on the inventory of controlled products by TSCA.

15.2 OSHA Occupational Safety and Health Administration

15.2.1 29 CFR 1910.119: Process Safety Management of Highly Hazardous Chemicals: Requires facilities to develop Process Safety Management based on Threshold Quantities TQ of highly hazardous chemicals such as those listed in Appendix A. Hydrogen is not listed in Appendix A as a high-risk chemical. In any case, any process that involves a flammable gas on site, in quantities equal to or greater than 10,000 lbs (4,553 Kg) is affected by this regulation unless it is used as a fuel.

16. Additional information

16.1 Special precautions: Use piping and equipment properly designed to withstand working pressures. Use a check valve or other cylinder protection device to prevent and avoid reverse flow.

Shipping compressed gas cylinders that have been filled without the consent of the cylinder owner is a violation of US federal law [49CFR Part 173.301(b)].

16.2 Mixtures: When two or more gases or liquefied products are mixed, their properties can combine to create additional unexpected hazards. Obtain and evaluate the safety information for each component before manufacturing the mixture. Seek advice from an industrial health worker or other qualified person, when carrying out the safety evaluation of the final product. Remember that gases and liquids have properties that can cause severe harm or death.

16.3 Other data:

16.3.1 NFPA Valuation (National Fire Protection Association)

Health	0
Flammability	4
Instability	0
Special	Simple Asphyxiant (CGA recommended designation)

16.3.2 HMIS Valuation (Hazardous Materials Identification Systems)

Health	0
Flammability	4
Reactivity	0

Classification of the chemical substance according to the SGA:

Physical hazards:
Flammable gases – Category 1.
Gases under pressure – Compressed gas.
Health Hazards: N/A.
Environmental Hazards: N/A.

Elements for the communication and signalization of hazards:

Word of warning: Attention.
Hazard statements:
H220: Contains gas under pressure; may explode if heated.
H280: Contains gas under pressure; may explode if heated.
Precautionary advice:
Prevention:
P210: Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No Smoking.
Response:
P377: Flammable gas leak. Do not extinguish the flames of the burning gas if it cannot be done without risk.
P381: In the event of a leak, remove all sources of ignition.
Storage:
P403: Store in a well-ventilated place.
Elimination: N/A.

Other hazards: Forms explosive mixtures with air. Will readily ignite in the presence of ignition sources (heat, sparks, hot surfaces or open flames, etc.). Its flame is invisible. It's an extremely flammable gas under pressure. The use of a self-contained breathing apparatus may be necessary. Hydrogen is not toxic, but it can act as a simple asphyxiant, by diluting or displacing atmospheric air to a point where the oxygen contained is not necessary to support life. There is a risk of immediate ignition and explosion in mixtures with air in concentrations that exceed the lower flammability limit (LEL).

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Pictogram/ Hazard Symbol:

ACETI OXIGENO, S.A.

COPIA CONTROLADA

16.4 Standard valve connection for the United States and Canada

16.4.1 Coiled: CGA Standard 350 for cylinders at pressures between 0 and 3,000 psig, CGA Standard 695 for cylinders at pressures between 3,001 and 5,500 psig, and CGA Standard 703 for cylinders at pressures between 5,501 and 7,500 psig. For Panama the standard is CGA 350.

16.4.2 Indexed Pin Yoke: Not Applicable

16.4.3 Ultra High Integrity: Standard 724

For information related to hydrogen application systems, refer to NFPA 50A, Gaseous Hydrogen Systems at Customer Sites.

Use the proper CGA connection. DO NOT USE ADAPTERS.

More detailed information on acetylene can be found in the following documents published by the Compressed Gas Association Inc. (CGA), 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202-4102. Phone (703) 412-0900:

G-5	Hydrogen
G-5.3	Commodity Specifications for Hydrogen
P-1	Safe Handling of Compressed Gases in Containers
P-14	Accident Prevention in Oxygen-rich and Oxygen-deficient Atmospheres
SB-2	Oxygen-Deficient Atmosphere

Conversion Table

HYDROGENO (H_2) 2.0158 g/mol PE=-252.8 °C						
UNITS	WEIGHT		GAS VOLUM		LIQUID VOLUME	
	Pounds	Kilogramos	SCF Gas	Nm³ Gas	Liquid gallons	Liquid liters
Pounds	**1.000**	0.454	192.000	5.047	1.693	6.408
Kilograms	2.205	**1.000**	423.300	11.126	3.733	14.128
SCF Gas	0.005	0.002	**1.000**	0.026	0.009	0.033
Nm³ Gas	0.198	0.090	38.040	**1.000**	0.336	1.270
Liquid gallons	0.591	0.268	113.410	2.981	**1.000**	3.785
Liquid liters	0.156	0.071	29.990	0.788	0.264	**1.000**

COMPATIBILITY WITH OTHER MATERIALS

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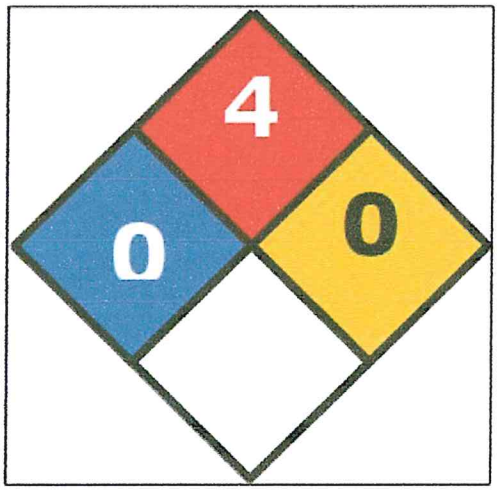
Metals	
Bronze	Satisfactory
303 Stainless Steel	Satisfactory
316 Stainless Steel	Satisfactory
Aluminum	Satisfactory
Zinc	Satisfactory
Copper	Satisfactory
Monel-metal	Satisfactory
Plastics	
PCTFE	Satisfactory
Teflon	Satisfactory
Tefzel	Satisfactory
Kynar	Satisfactory
PVC	Satisfactory
Polycarbonate	Satisfactory
Elastomers	
Kalrez	Satisfactory
Viton	Satisfactory
Buna-N	Satisfactory
Neoprene	Satisfactory
Polyurethane	Satisfactory



Change control:

Revision 01:

- Added safety color code for NFPA and the global harmonized system.
- The format was modified to the standards and approved by the sister companies Infra and Productos del Aire.

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