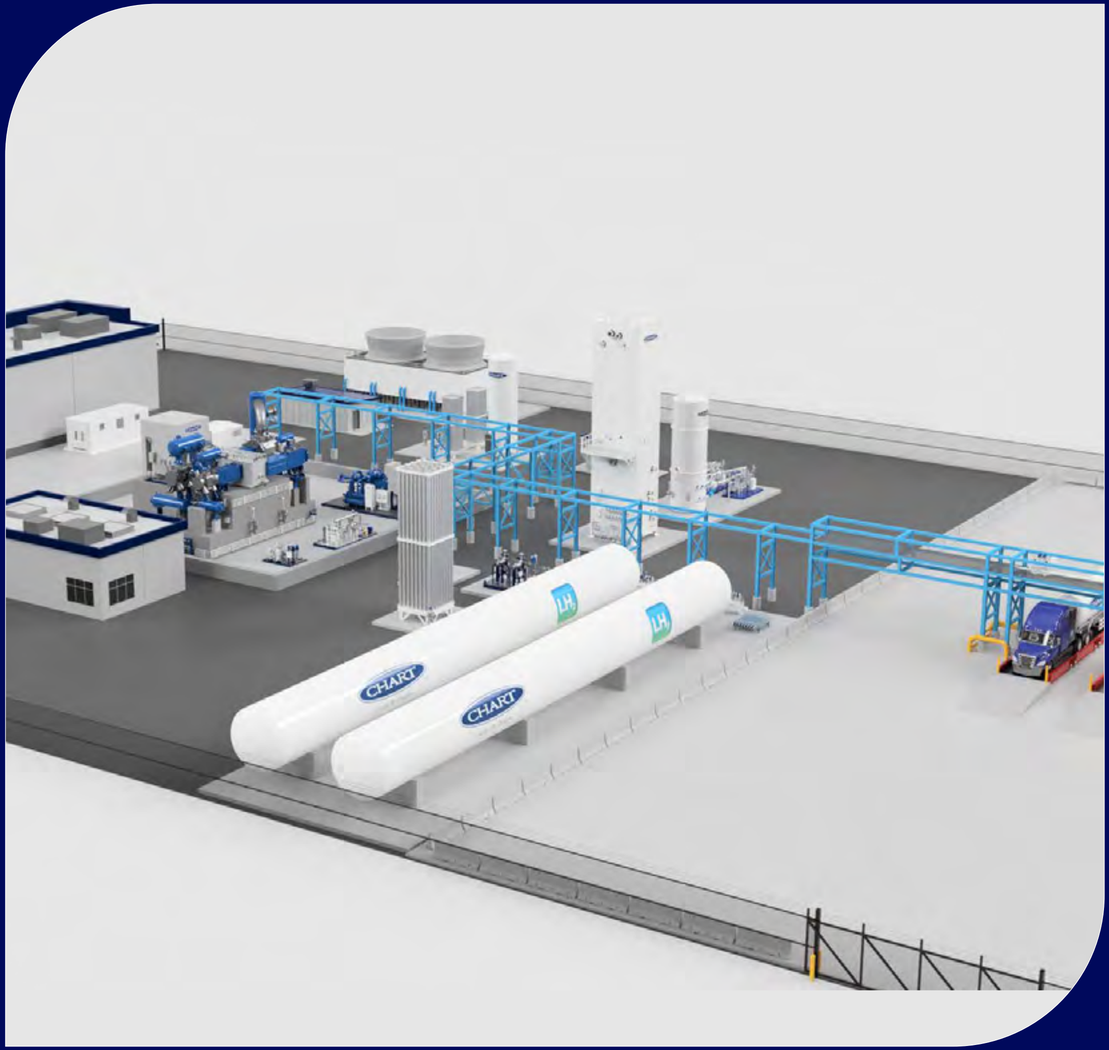
LIQUEFIED HYDROGEN

Production, storage and distribution

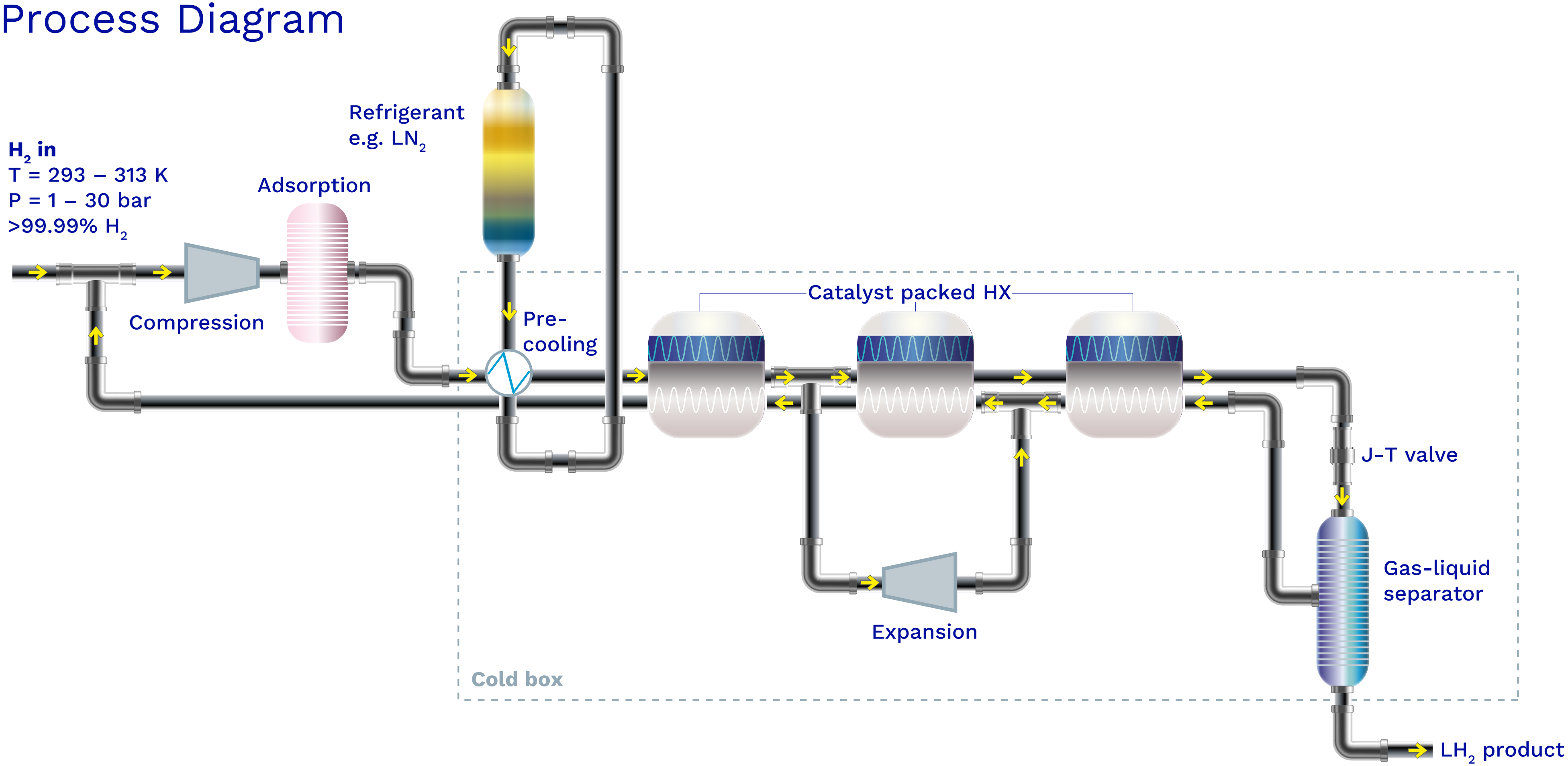
Overview

Liquid hydrogen is produced via cryogenic liquefaction, requiring temperatures as low as 20 K (–253°C) to ensure complete conversion. This process is highly energy intensive, consuming approximately 12–15 kWh per kilogram of hydrogen in modern industrial plants, and is typically reserved for bulk transport over large distances where alternatives like compressed hydrogen or pipelines are less practical. Most existing hydrogen liquefaction plants have a minimum of 5 tonnes/day of production capacity, as smaller scales impact negatively on efficiency. Liquefaction involves a sequence of compression, heat exchange, and adiabatic expansion, with non-liquefied hydrogen recycled, and requires pre-cooling with another refrigerant such as liquid nitrogen due to hydrogen's unique thermodynamic properties. Various cycles, including Hampson-Linde and Claude, follow this principle but may incorporate additional compression or expansion steps and recycle loops to enhance efficiency. Most of the process occurs within a well-insulated 'cold box' to minimise heat transfer and energy loss. The higher gravimetric density of liquid hydrogen (71 kg/m³ at 1 bar) compared to compressed hydrogen (40 kg/m³ at 700 bar and 20°C) makes it attractive for storage and transport, despite technical challenges and capital costs. Ongoing research aims to improve efficiency and increase production capacity through process optimisation and integration with other systems.



Hydrogen Liquefaction Plant

Basic liquefaction
Process Diagram



Compression, purification, pre-cooling, heat exchange and ortho-para conversion

Compression
Liquefaction requires hydrogen gas to perform thermodynamic work, reducing its internal energy and temperature. This is achieved by compressing hydrogen, typically up to 80 bar, using reciprocating or diaphragm compressors with intercooling to maintain near-isothermal conditions. Compression is covered in detail in our compression fact sheet.

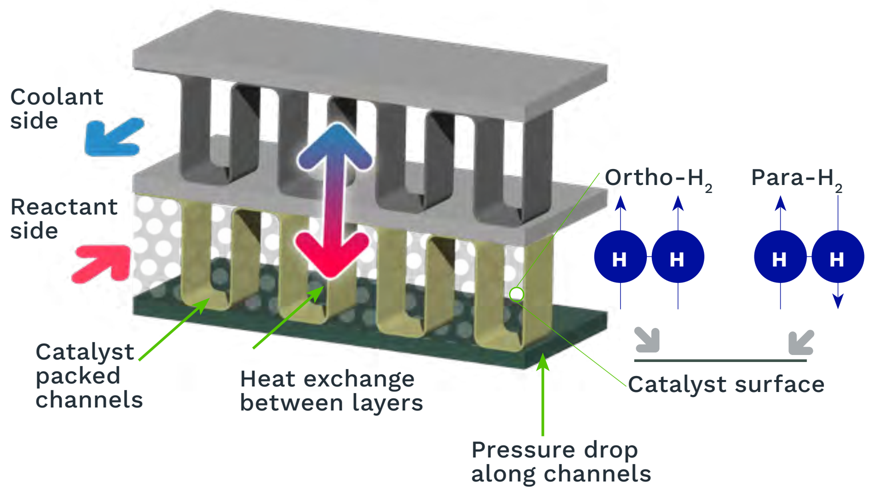
Purification – adsorption
Hydrogen purity is critical, as impurities can freeze during liquefaction and cause blockages, leading to safety and operational/commercial issues. An adsorption step, often using Pressure Swing Adsorption, is included to remove residual impurities before heat exchange, taking advantage of the compression step prior to adsorption.

Pre-cooling
Because hydrogen's Joule-Thomson inversion temperature is below room temperature, pre-cooling to below 193 K is required to ensure that it cools during the refrigeration cycle. This is often achieved using external refrigerants such as liquid nitrogen, cooling the compressed hydrogen to around 80 K.

Heat exchange
In a standard liquefaction cycle, compressed hydrogen passes through multiple heat exchangers, reducing its temperature to below 30 K. When using the Hampson–Linde and Claude cycles this takes place via self-refrigeration with returning hydrogen. In Brayton cycles, mainly used for small-scale production i.e. < 2 tonnes/day, heat exchange uses another refrigerant in a separate closed-loop system. Aluminium is often the material of choice.

Catalytic ortho-para conversion
Hydrogen exists as a mixture of ortho and para isomers, with increased levels of para-hydrogen at very low temperatures. Catalysts are used to accelerate the conversion from ortho-hydrogen to para, maximising this conversion helps to minimise boil-off losses during storage. This step is usually combined with the heat exchange step, using a packed bed typically within a plate & fin heat exchanger. Maximum heat transfer and negligible pressure drop are critical.

Ortho-to para-conversion at catalyst surface



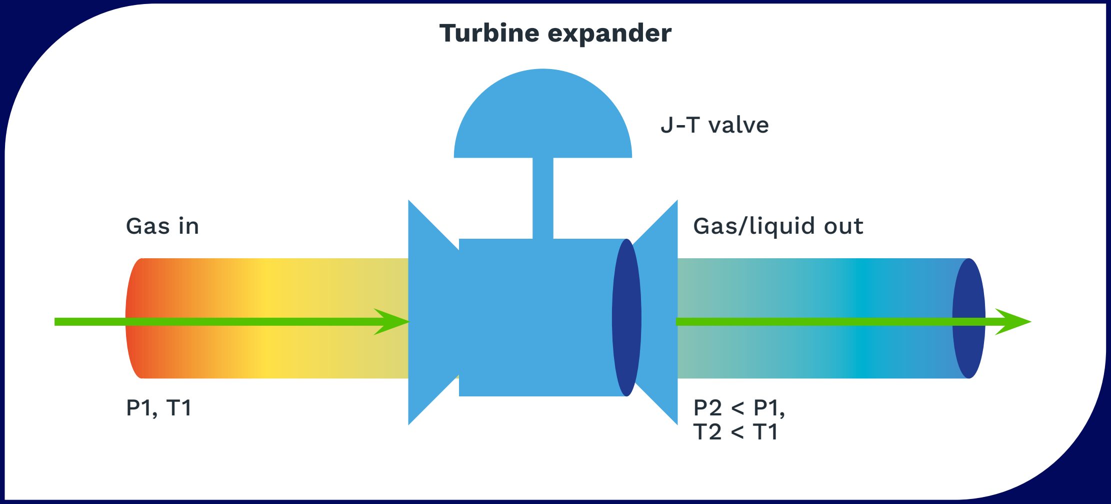
Component	Material
Heat exchange and ortho-para conversion	
Heat exchanger - plate fin or tube shell configuration, packed with ortho-para catalysts	Aluminum or alternatively, copper or stainless steel (e.g. AISI 316L)
Ortho-para catalysts	Typically based on (para)magnetic transition metal e.g. Iron(III) oxide (Fe_2O_3), Chromium(III) oxide (Cr_2O_3), Nickel (II) oxide (NiO), or Cobalt (III) hydroxide ($Co(OH)_3$)
Catalyst supporting materials	e.g. alumina beads and monolothic materials
Adiabatic expansion - cooling	
J-T Valves including insulation suitable at cryogenic temperature	
Phase separation vessels	Stainless steel e.g. AISI 316L or 304L
Turbine expanders	
Pressure and temperature monitoring	

Adiabatic expansion and Additional liquefaction components

Expansion general
During the expansion stage, the gas is allowed to 'do work'. This step is conducted under more-or-less adiabatic conditions. Under the hydrogen liquefaction process conditions, that is at temperature below 193K, the isenthalpic Joule-Thomson effect is usually utilised which causes the gas to cool down during this expansion. After the heat exchange steps, the hydrogen is typically < 30K, and during the final J-T expansion step, a fraction of the gas liquefies and is separated. The remaining gaseous fraction is recycled into the self-refrigeration loop and re-compressed to start the liquefaction cycle again.

Expansion methods
Currently the most common method of expanding the gas, is by throttling through a Joule-Thomson valve. The valve needs to be well-insulated to ensure adiabatic conditions and the pressure drop across the valve causes a temperature differential through the JT effect.

Another method of expansion is by means of an expansion turbine, whereby the gas is allowed to expand whilst driving turbine blades under cryogenic conditions. As is the case for the Joule-Thomson valve, insulation is key to ensure near adiabatic conditions. This type of isentropic expansion can either be used for the final liquefaction step, but is more commonly used elsewhere within the liquefaction cycle to improve efficiency (see process diagram), e.g. by cooling the hydrogen feed in between HX steps as done in the Claude cycle and also by recovering mechanical energy from rotating turbine blades.



Additional liquefaction components
The liquefaction process requires various process monitoring and control equipment, such as pressure transducers, thermal sensors and mass flow control. Various different types of valves can be employed, including automatic shutoff valves in case of a safety incident, linked to process shutdown. The bulk of the cryogenic componentry is all housed within a so-called cold box to minimise heat transfer from ambient. The cold box is typically a vacuum insulated double walled rectangular vessel with additional multi-layer superinsulation.

Additional refrigeration cycles can be used for instance for pre-cooling. These require their own set of compressors, heat exchangers and expanders. The type of compressor and materials choice will be determined by the refrigerant that is used in this cycle. Turbo/centrifugal compressors for instance may be preferred over reciprocal, as the refrigerant is likely to have higher molecular mass than hydrogen/helium.

Component	Material
Additional liquefaction components	
Cold box	Vacuum insulated, additionally insulated with multi-layer superinsulation e.g. Polyurethane foam
Cold box - outer wall	Carbon steel
Cold box - inner wall	Stainless steel e.g. AISI 316L or 304L
Pipework and manifolding	Stainless steel e.g. AISI 316L
Valves (bi-directional, non-return, ball valves or solenoids)	
Pressure and temperature monitoring and control systems	
Mass flow control	
Pressure relief devices	
Hydrogen detection systems	
Steel mounting frames and personnel access (e.g. mezzanine levels and stairways)	
Concrete plinths	
Additional refrigeration cycles	
Compressors	
Heat exchangers	
J-T valves and turbine expanders	
Phase separation vessels	
Pure or mixed refrigerants	e.g. LN2, LNG, LPG, Neon, or Helium
Cryogenic pumps	

Storage and distribution

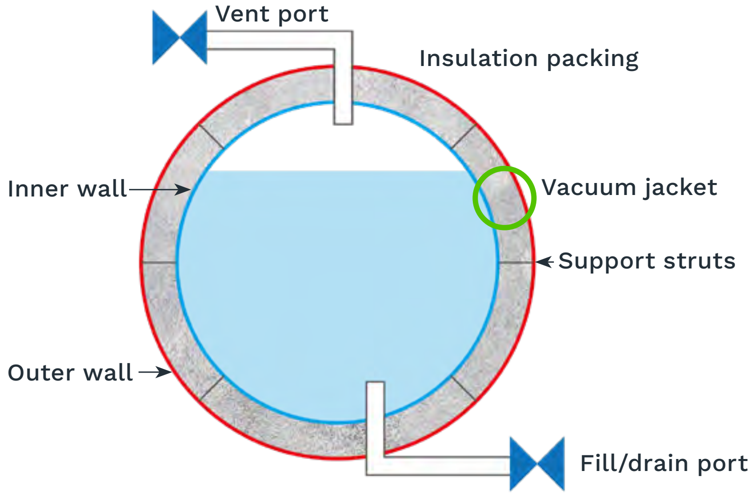
Handling, moving and storing liquid hydrogen

Liquid hydrogen storage

Storage general

Although liquid hydrogen is mostly envisaged as a means of transporting bulk quantities of hydrogen across large distances, where the additional cost and energy of liquefaction make economical sense, some stationary storage will be required at the point of use, such as a refuelling station or port terminal.

Storage vessels require the liquid hydrogen to remain at c. 20 K, with minimum heat ingress from the outside ambient. Evidently, under realistic conditions, a finite amount of heat will enter the tank, causing some of the hydrogen to turn gaseous. This boil off is inevitable but must both be kept to a minimum, in particular for long duration storage to be economical. Boil off is also a safety concern and must therefore be managed carefully. See further in Liquid Hydrogen Transportation



Liquid hydrogen storage - general componentry
Liquid level measurement - e.g. differential pressure gauge
Vapour pressure gauge above liquid level
Protection against overfill e.g. level limiter or try-cock
Filling/draining and venting valves
Isolation valves and emergency shut-off valves
Stainless steel pipework and manifolding e.g. AISI 316L
Braided stainless steel Flexible hoses or rigid pipework for transfer e.g. AISI 316L or 304L
Pressure relief valves
Burst valves in case of catastrophic vacuum failure
Non-return vavles (backflow arrestor)
Vent stacks
Suitable earthing - protection against static, lightning and electrical bonding
Carbon steel tank support frames or structure

Liquid hydrogen storage

To date, liquid hydrogen is predominantly moved by road on trailer trucks, with capacities up to 60 m^3 or c. 4 tonnes. Trailer mounted tanks are essentially identical to those described for storage, but additional care must be given to mounting the tank safely and securely on a trailer including protection from impact. Other consideration for the vehicle are ATEX rated ancillary equipment (e.g. transfer) pumps, warning placards and inclusion of anti-towaway devices.

- Although liquid hydrogen is not specifically listed, road transport of dangerous goods is governed by ADR (Agreement concerning the International Carriage of Dangerous Goods by Road)

Shipping LH_2 is also often touted as a means of moving bulk hydrogen. Indeed trials have begun, such as the SUISO Frontier sailing between Australia and Japan, designed to carry 1250 m^3.

- International Maritime Dangerous Goods Code IGC Doc 41/189

Transport by rail is governed by:

- Règlement Concernant le Transport International Ferroviaire des Marchandises Dangereuses (RID)

Transfer of hydrogen between storage containers should be on concrete or other non-combustible surfaces. Surfaces containing combustible compounds, such as tarmac mush be avoided, due to risk of oxygen condensation and explosion.

Boil-off

State of the art boil off rates for large spherical tanks are below 0.1% /day, whereas they can be closer to or even above 1% / day for small (tens to hundreds of m^3) cylindrical tanks. Whilst boil off can be well-controlled during storage, additional heating events occur during transfer and transportation of the liquid or gas. These can originate from equipment such as pumps and connection to transfer pipework or other storage containers. So-called liquid hydrogen sloshing is a particular concern during transport, accelerating boil off due to the added kinetic energy and increased thermal mixing.

Minimising boil off is critical from both a safety and economical aspect. Boiled off hydrogen is often simply vented to atmosphere, although there is increasing focus on collecting and reusing this vented hydrogen, thus avoiding waste. One concept is to use the boiled off hydrogen in a fuel cell powering a cryo-refrigeration unit to aid insulation of the LH_2 tank.

Transportation - Tanks
Cryogenic storage tanks suitable for transportation
Transfer pipework and pumps
Shutoff valves on transfer lines
Suitably located drip pans
Earthing connections
Steel frame providing protection from mechanical impact to tank and liquid transfer system
Fixing system for tank, avoiding creation of mechanical stress points

Boil-off management systems - bulk transport
Re-liquefaction or venting to atmosphere
Re-storing requires additional equipment such as compressors, heat exchangers, expanders, and gaseous storage tanks

Re-gasification and safety

Re-gasification of liquid hydrogen

Re-gasification of liquid hydrogen can be achieved through simple evaporation (releasing the vapour fraction in the LH_2 tank), combined with some heat exchange to increase its temperature. HX can be with air, water or other fluids, depending on location. Seawater would be appropriate for regasification at terminals. Efforts should be made to recover the cryogenic energy during this heat exchange, but the extent to which this is possible depends very much on co-location and integration with other processes, such as cooling or air-conditioning. Phase change materials such as thermal batteries may be able to capture some of the high grade cold energy and store it for later use.

Safety considerations

Handling and storing liquid hydrogen brings unique safety considerations. These include the usual cryogenic challenges, such as cryogenic burns, asphyxiation as well as oxygen liquefaction/freezing during transfers. Traces of compounds with higher boiling points can cause blockages of equipment and pipework. Loss of vacuum in storage containers' double wall construction can lead to air ingress and its subsequent solidification, potentially cracking the tank walls, risking catastrophic failure of the tank. There also issues specific to LH2. Incomplete ortho-para conversion during production can cause excess heat generation during storage and thus boil-off of gaseous hydrogen. Repeated contraction and expansion of cryogenic vessels can cause material stress and increased hydrogen embrittlement, but this is usually mitigated through appropriate materials choice and controlling the filling rate of tanks. Finally, LH2 is denser than air, and any leaks will therefore pool and create a risk of fire or even explosion, with ventilation having minimal effect. This is in stark contrast to gaseous hydrogen, which quickly dissipates into the atmosphere due to its low density.

Regasification and Safety
Heat exchangers
Pressure gauges/trasnducers
Temperature monitoring
Compressed hydrogen storage or buffer tanks - see factsheet on hydrogen compression, storage and distribution
Mass flow control
Pressure relief valves
Gaseous hydrogen detection
Vent stacks
Passive and active ventilation (ATEX rated)
Oxygen depletion sensors (stationary and on-person)
Regular maintenance and inspection of storage tanks

Standards and codes of practice

Organisation	Standard	Details	Date of Publication
General			
International Organisation for Standardisation	"ISO/TR 15916:2015 Basic considerations for the safety of hydrogen systems"	Provides guidelines for the use of hydrogen in its gaseous and liquid forms as well as its storage in either of these or other forms (hydrides). It identifies the basic safety concerns, hazards and risks, and describes the properties of hydrogen that are relevant to safety.	Edition 2 published 2015 - expected to be replaced by ISO/ DTS 15916 within the coming months.
Liquid Hydrogen Storage Vessels			
Compressed Gas Association	H-3 Standard for Cryogenic Hydrogen Storage (an American National Standard)	Contains the suggested minimum design and performance requirements for shop-fabricated, vacuum-insulated cryogenic tanks (vertical and horizontal) intended for above ground storage of liquid hydrogen.	Published 2024
Liquid Hydrogen Vehicle Fuelling Standards			
International Organisation for Standardisation	ISO 13984:1999	Specifies the characteristics of liquid hydrogen refuelling and dispensing systems on land vehicles of all types in order to reduce the risk of fire and explosion during the refuelling procedure and thus to provide a reasonable level of protection from loss of life and property	Published 1999 - expected to be replaced by ISO/FDIS 13984 in the coming months
International Organisation for Standardisation	ISO 13985:2006	Specifies the construction requirements for refillable fuel tanks for liquid hydrogen used in land vehicles as well as the testing methods required to ensure that a reasonable level of protection from loss of life and property resulting from fire and explosion is provided. It is applicable to fuel tanks intended to be permanently attached to land vehicles.	Published 2006 - expected to be replaced by ISO/DIS 13895 in the coming months

Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Liquid Hydrogen - Road Tankers			
British Standards Institute	BS ISO 1496-3:2019 - Tank containers for liquids, gases, and pressurized dry bulk	Specifies the basic specifications and testing requirements for ISO series 1 tank containers suitable for the carriage of gases, liquids, and solid substances (dry bulk) which can be loaded or unloaded as liquids by gravity or pressure discharge, for international exchange and conveyance by road, rail, and sea, including interchange between these forms of transport.	Published 1029
Liquid Hydrogen Transportation (1/2)			
International Maritime Organisation (IMO)	IGC Doc 41/189 - International Maritime Dangerous Goods (IMDG) code	The IMDG Code was developed as an international code for the maritime transport of dangerous goods in packaged form, in order to enhance and harmonise the safe carriage of dangerous goods and to prevent pollution to the environment. The Code sets out in detail the requirements applicable to each individual substance, material or article, covering matters such as packing, container traffic and stowage, with particular reference to the segregation of incompatible substances.	Introduced in 1965 and made mandatory under the umbrella of SOLAS Convention from January 1st 2004
United Nations Economic Commission for Europe (UNECE)	European Agreement concerning the International Carriage of Dangerous Goods by Road	"The agreement itself is brief and straightforward, and its most relevant article is article 2. This section states that except certain hazardous materials, hazardous materials may, in general, be transported internationally in wheeled vehicles, provided that two sets of conditions be met: 1. Annex A regulates the merchandise involved, notably their packaging and labels. 2. Annex B regulates the construction, equipment, and use of vehicles for the transport of hazardous materials.	Applicable from January 1st 2023

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Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Liquid Hydrogen Transportation (2/2)			
Intergovernmental Organisation for International Carriage by Rail	"Regulation concerning the International Carriage of Dangerous Goods by Rail (RID)"	Governs the safe transport of dangerous goods by rail. It forms Appendix C to the Convention concerning International Carriage by Rail (COTIF) and applies to international and domestic rail transport within the EU and other contracting states. The latest version (2025) includes updates on refrigerated liquefied gases and tank safety provisions.	Applicable from January 1st 2025
Cryogenic Vessels (1/5)			
International Organisation for Standardisation	ISO 20421-1:2019 - Cryogenic vessels — Large transportable vacuum-insulated vessels. Part 1: Design, fabrication, inspection and testing	Specifies requirements for the design, fabrication, inspection and testing of large transportable vacuum-insulated cryogenic vessels of more than 450 l volume, which are permanently (fixed tanks) or not permanently (demountable tanks and portable tanks) attached to a means of transport, for one or more modes of transport.	Edition 2 published 2019 - expected to be replaced by ISO/DIS 20421-1 in the coming months
International Organisation for Standardisation	ISO 20421-2:2017 - Cryogenic vessels — Large transportable vacuum-insulated vessels. Part 2: Operational requirements	Specifies operational requirements for large transportable vacuum-insulated cryogenic vessels. These operational requirements include putting into service, filling, withdrawal, transport within the location, storage, maintenance, periodic inspection and emergency procedures.	Edition 2 published 2017 (reviewed and confirmed in 2022)
International Organisation for Standardisation	ISO 21009-1:2022 - Cryogenic vessels — Static vacuum-insulated vessels - Part 1: Design, fabrication, inspection and tests	Specifies requirements for the design, fabrication, inspection and testing of static vacuum-insulated cryogenic vessels designed for a maximum allowable pressure of more than 0,5 bar.	Edition 2 published 2022

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Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Cryogenic Vessels (2/5)			
International Organisation for Standardisation	ISO 21009-2:2024 - Cryogenic vessels — Static vacuum-insulated vessels - Part 2: Operational requirements	Specifies operational requirements for static vacuum insulated vessels designed for a maximum allowable pressure of more than 50 kPa (0,5 bar). It can also be used as a guideline for vessels designed for a maximum allowable pressure of less than 50 kPa (0,5 bar).	Edition 3 published 2024
International Organisation for Standardisation	ISO 21010:2017 - Cryogenic vessels — Gas/material compatibility	Specifies gas/material compatibility requirements (such as chemical resistance) for cryogenic vessels.	Edition 3 published 2017 (confirmed in 2023)
International Organisation for Standardisation	ISO 21013-1:2021/Amd 1:2024 - Cryogenic vessels — Pressure-relief accessories for cryogenic service - Part 1: Reclosable pressure-relief valves (Amendment 1)	Specifies the requirements for the design, manufacture and testing of pressure relief valves for cryogenic service, i.e. for operation with cryogenic fluids below –10 °C in addition to operation at ambient temperatures from ambient to cryogenic.	Edition 2 published 2024
International Organisation for Standardisation	ISO 21013-2:2025 - Cryogenic vessels — Pressure-relief accessories for cryogenic service - Part 2: Non-reclosable pressure-relief devices	Specifies the requirements for the design, manufacture and testing of non reclosable pressure-relief devices for cryogenic service, i.e. for operation with cryogenic fluids in addition to operation at temperatures from ambient to cryogenic.	Edition 2 published 2025

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Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Cryogenic Vessels (3/5)			
International Organisation for Standardisation	ISO 21013-3:2016 - Cryogenic vessels — Pressure-relief accessories for cryogenic service - Part 3: Sizing and capacity determination	Provides separate calculation methods for determining the required mass flow to be relieved for a number of vacuum-insulated vessels with insulation systems.	Edition 2 published 2016 – expected to be replaced by ISO/DIS 21013-3 in the coming months
International Organisation for Standardisation	ISO 21013-4:2012/Amd 1:2019 - Cryogenic vessels — Pilot operated pressure relief devices - Part 4: Pressure-relief accessories for cryogenic service (Amendment 1)	Specifies the requirements for the design, manufacture and testing of pilot operated pressure relief valves for cryogenic service, i.e. for operation with cryogenic fluids in addition to operation at temperatures from ambient to cryogenic.	Published 2019
International Organisation for Standardisation	ISO 21014:2019 - Cryogenic vessels — Cryogenic insulation performance	Defines practical methods for determining the heat-leak performance of cryogenic vessels. The methods include measurement on both open and closed systems. This document neither specifies the requirement levels for insulation performance nor when the defined methods are applied.	Edition 2 published 2019
International Organisation for Standardisation	ISO 21028-1:2016- Cryogenic vessels — Toughness requirements for materials at cryogenic temperature - Part 1: Temperatures below -80 degrees C	Specifies the toughness requirements of metallic materials for use at a temperature below -80 °C to ensure their suitability for cryogenic vessels - it is not applicable to unalloyed steels and cast materials.	Edition 2 published 2016 – expected to be replaced by ISO/FDIS 21028-1 in the coming months

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Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Cryogenic Vessels (4/5)			
International Organisation for Standardisation	ISO 21028-2:2018 - Cryogenic vessels — Toughness requirements for materials at cryogenic temperature - Part 2: Temperatures between -80 degrees C and -20 degrees C	Specifies the toughness requirements of metallic materials for use at temperatures between −20 °C and −80 °C to ensure their suitability for cryogenic vessels. This document is applicable to fine-grain and low-alloyed steels with specified yield strength ≤460 N/mm^2, aluminium and aluminium alloys, copper and copper alloys and austenitic stainless steels.	Edition 2 published 2018
International Organisation for Standardisation	ISO 21029-1:2018/Amd 1:2019 - Cryogenic vessels — Transportable vacuum insulated vessels of not more than 1000 litres volume - Part 1: Design, fabrication, inspection and tests (Amendment 1)	Specifies requirements for the design, fabrication, type test and initial inspection and test of transportable vacuum-insulated cryogenic pressure vessels of not more than 1000l volume.	Edition 2 published 2019
International Organisation for Standardisation	ISO 21029-2:2015 - Cryogenic vessels — Transportable vacuum insulated vessels of not more than 1000 litres volume - Part 2: Operational requirements	Specifies operational requirements for transportable vacuum insulated cryogenic vessels of not more than 1 000l volume designed to operate above atmospheric pressure. Appropriate parts may be used as a guidance for a vessel design to operate open to the atmosphere.	Edition 2 published 2015

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Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Cryogenic Vessels (5/5)			
British Standards Institute	BS-EN 13458-1: 2002 - Static vacuum insulated vessels	Specifies the fundamental requirements for static vacuum insulated cryogenic vessels designed for a maximum allowable pressure greater than 0,5 bar.	Published 2002
British Standards Institute	BS-EN 13648-1: 2008 - Safety devices for protection against excessive pressure - Safety valves for cryogenic service	Technical specification that specifies the requirements for the design, manufacture, and testing of safety valves for cryogenic service.	Published 2009
British Standards Institute	BS-EN 13648-2: 2002 - Safety devices for protection against excessive pressure - Bursting disc safety devices for cryogenic service	Technical guidance that specifies the design, manufacture, and testing requirements for bursting disc safety devices used in cryogenic service.	Published 2002

Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Codes of Practice			
British Compressed Gas Association	Code of Practice 27: Transportable vacuum insulated containers of not more than 1000 litres volume	Applies to transportable, vacuum insulated, tanks of not more than 1,000 litres water capacity for a number of gases. Provides guidance for the minimum requirements for general safety precautions, design and construction, operation, tank management and filling, transportation, in-service examination, modifications/repairs and records.	Revision 1 published 2004
British Compressed Gas Association	Code of Practice 36: Cryogenic liquid storage at users' premises	Covers the installation of cryogenic liquid storage tanks and associated equipment at customer sites. Tank sizes range from 0 to 125000 litre water capacity.	Revision 2 published 2013
British Compressed Gas Association	Code of Practice 46: The storage of cryogenic flammable fluids	Covers cryogenic flammable liquid storage tanks and associated equipment at customer sites. Tank sizes range from 0 to 125000 litre water capacity. It provides guidance on their design, installation, commissioning and the operation of cryogenic flammable liquid storage installations.	Published 2016
European Industrial Gases Association	DOC 6 / 19: Safety in Storage, Handling and Distribution of Liquid Hydrogen	Guidance for companies directly associated with the installation of liquid hydrogen storage at the user's premises and the distribution of liquid hydrogen by road, rail and sea. This publication applies to the layout, design and operation of fixed storages and the transportation of liquid hydrogen in bulk form by tankers or tank containers, by road, sea and rail, to fixed storages at user's premises.	Published 2019

Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Relevant Regulations (1/2)			
Health and Safety Executive	ATEX - 2014/34/EU	Two EU directives which describe the minimum safety requirements for workplaces and equipment used in explosive atmospheres - ATEX Workplace Directive and the ATEX Equipment Directive	Published in 2014 and applicable from 2016
Health and Safety Executive	Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)	Require employers to control the risks to safety from fire, explosions and substances corrosive to metal	Published 2002
Health and Safety Executive	Control of Major Accident Hazards (COMAH)	Regulations to ensure that businesses take all necessary measures to prevent major accidents involving dangerous substances and limit the consequences to people and the environment of any major accidents which do occur	Published 2015
Health and Safety Executive	Pressure System Safety Regulations 2000 (PSSR)	Aims to prevent serious injury from the hazard of stored energy as a result of the failure of a pressure system or one of its component parts. Before using any qualifying pressure equipment (new or otherwise), a written scheme of examination (WSE) must be in place, and an examination undertaken.	Published 2000

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Standards and codes of practice

Organisation	Standard	Details	Date of Publication
Relevant Regulations (2/2)			
Scottish Government	Planning Controls for Hazardous Substances 2015	Guidance on the planning procedures around hazardous substances consent, relevant applications for planning permission and planning policies.	Published 2015
European Union	Pressure Equipment Directive - 2014/68/EU	Sets out the standards for the design and fabrication of pressure equipment (including steam boilers, pressure vessels, piping, safety calves and other components and assemblies subject to pressure loading) greater than one litre in volume and having a maximum pressure more than 0.5 bar gauge.	Published May 2014
European Union	Transportable Pressure Equipment Directive (TPED) - 2010/35/EU	Addresses the safety requirements and the conformity assessment procedure for transportable pressure equipment used exclusively for the transport of dangerous goods (Class 2) within the EU.	Published 2010

Scottish Enterprise

Highlands and Islands Enterprise
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