HYDROGEN

H_2

VALVES FOR HYDROGEN PROCESSES

HABONIM
An ITT Company

PERFORMING IN DEMANDING APPLICATIONS

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We are leading the emerging Hydrogen-as-a-full process valve market with our unique full range of ball valves and actuators, covering the entire value chain of this new realm.

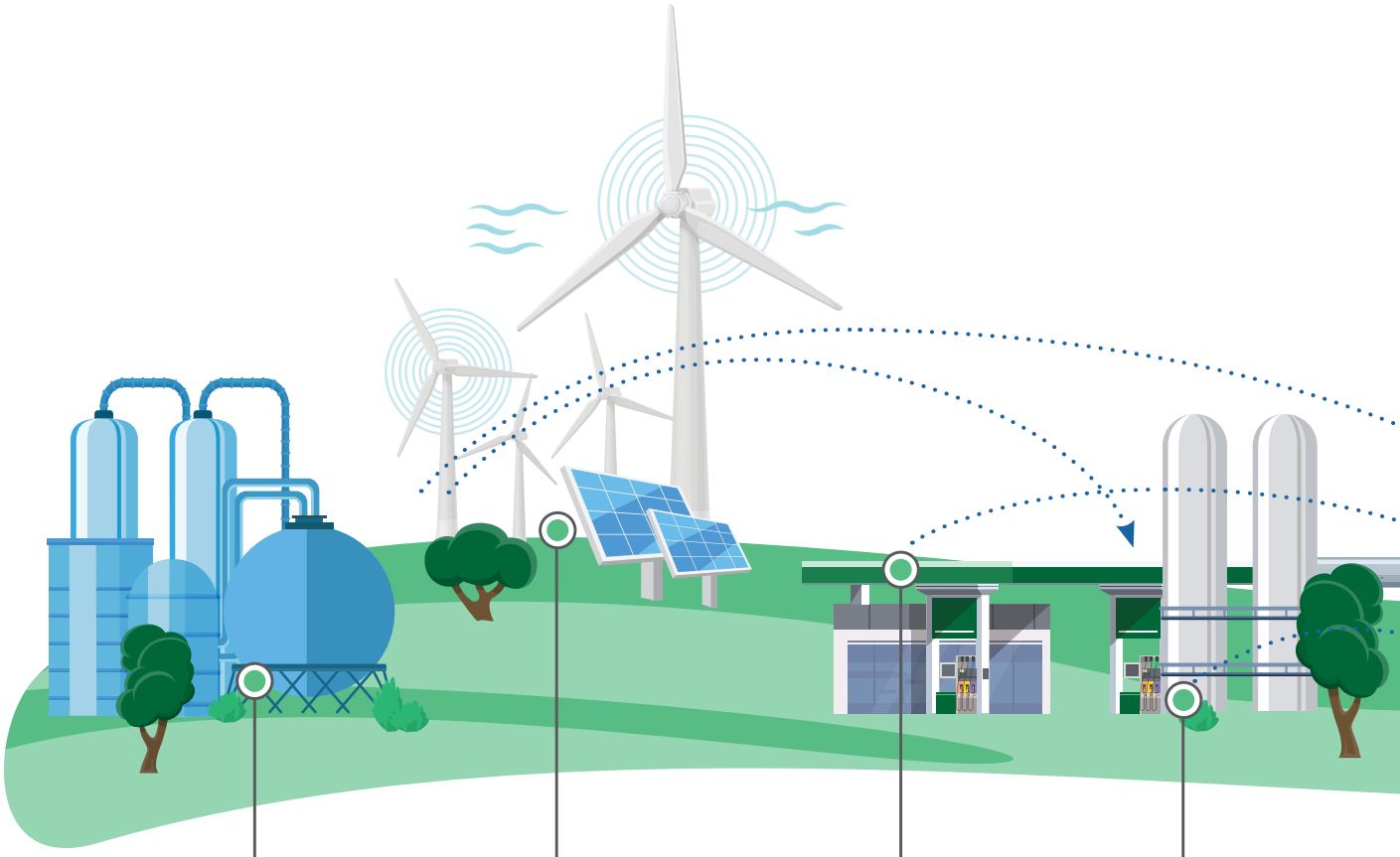
With Ultra-High-Pressure, High-Cycle Hydrogen valves, designs that support the most advanced standards, and a full set of product type approval and safety certifications, our Hydrogen valve product offer is the natural choice for Hydrogen system designers and manufacturers.

Our experience in successfully supplying hydrogen service valves and automated-valves, stretches for over a decade with a wide install base in hydrogen applications, ranging from Liquid- Hydrogen, Ultra-High-Pressure Hydrogen, to industrial grade Hydrogen and all in between.

With the understanding of the challenges of modern Hydrogen system designers, we are closely cooperating with our customers to develop optimal solutions within the required safety, quality, and regulations.

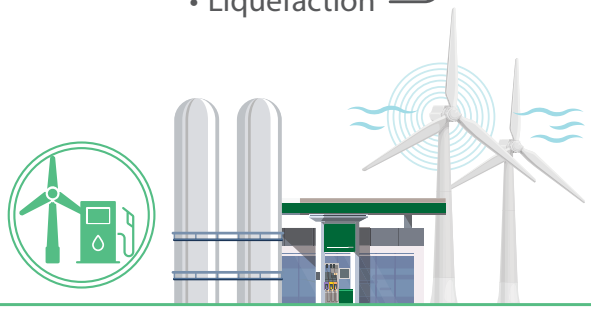
Table of contents

THE HYDROGEN SUPPLY CHAIN



PRODUCTION
- Conventional
- Electrolysis

CONDITIONING
- Compression
- Liquefaction



ON SITE ELECTROLYSIS

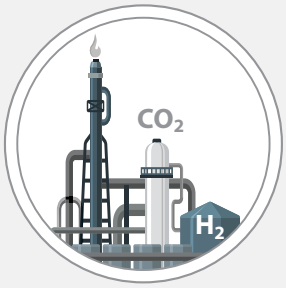
Green H_2

Green/Renuable energy.
Electrolysis process.
Zero carbon footprint.

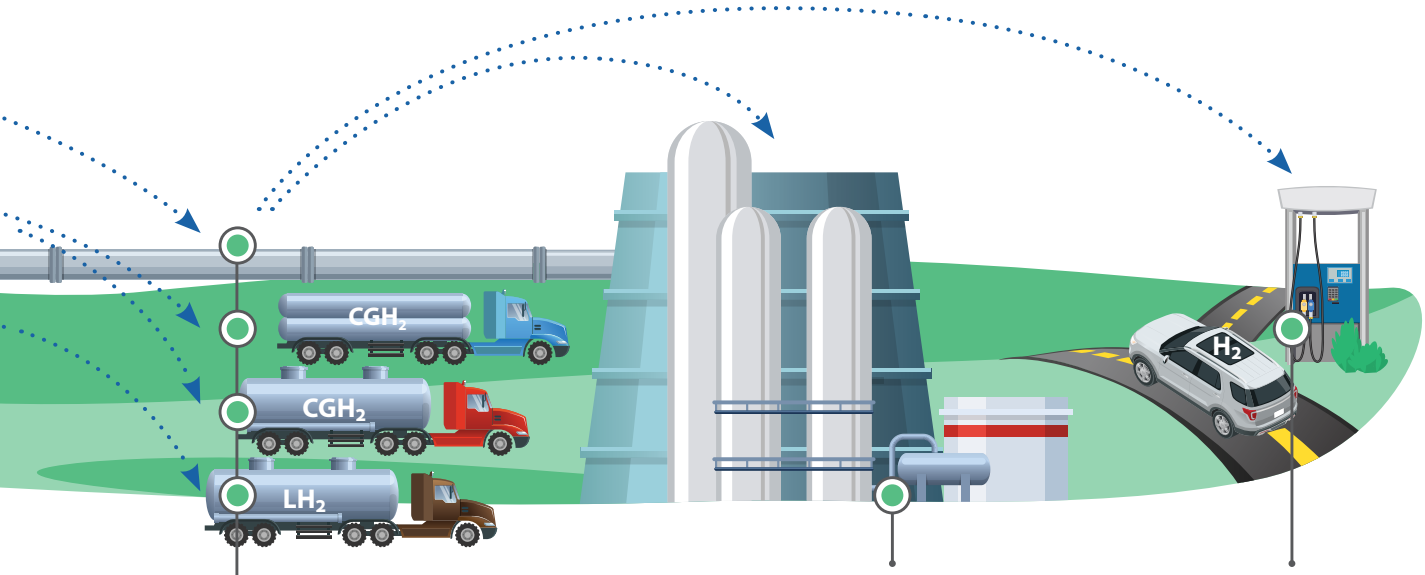
Blue H_2

Carbon based energy with carbon capturing, utilization or underground storage.

Grey H_2



Carbon based energy.
Legacy process.



DELIVERY / SUPPLY

- CGH_2 Cylinders distribution/storage
- CGH_2 Road Transport distribution
- LH_2 distribution/storage
- Pipeline distribution

INDUSTRIAL USE

- Process
- Energy

REFUELING/ MOBILITY

- Dispensing
- Ionic Compressor
- Cryo pump

HYDROGEN SERVICE PROCESS VALVES

Habonim's Hydrogen Service process valves are designed, tested, and certified to provide the compatibility required in the hydrogen supply chain, end-to-end. The valves design, materials selection, and certification process are made specifically to support the Hydrogen-as-a-full eco-system with process grade valves with the highest quality, durability, and safety.

With decades of proven safe and long-lasting use in hydrogen applications, Habonim Hydrogen- service ball valves deliver un-matched integrity and overall best cost of ownership for Hydrogen systems from manufacturing and storing to re-fueling and transportation applications.

TPED / TPE

ISO 19880-3

Ultra-High & High-Pressure valves

- Work pressure: up to 1,034 bar (15,000 psi) Applies to road, rail and inland waterways in EU.
- Working temp.: -40°C to +260°C (-40°F to +500°F).
- Tube / Pipe size: ¼" to 1-½" (DN8 to DN40).
- Total HermetiX™ Integrity Package.
- Double stem packing for Hydrogen use.
- PEEK seat.
- HNBR O-rings .

Standards & Certifications

See details per series and standards.

- Transportable Pressure Equipment Directive - TPED / TPE (ISO 23826) - series H24, H25, H29.
- Hydrogen Fueling - ISO 19880-3 - series H25, H99
- Safety - ATEX IIC, SIL.
- Fugitive Emissions - ISO 15848-1 & API 641.
- Fire Safe – ISO 10497 & API 607.

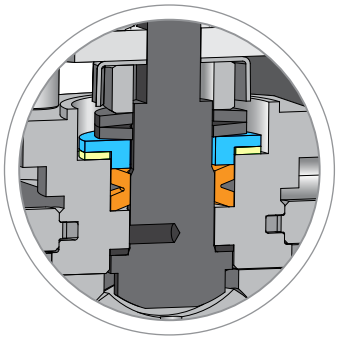
Industrial valves

The full range of Habonim valves is offered for Hydrogen use up to class #2500, PN420 (6,000 psi).

HYDROGEN SERVICE PROCESS VALVES

Registered EU Design
015025978-0001

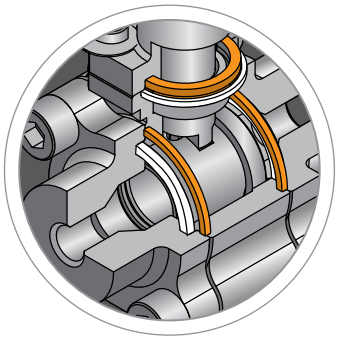
Total HermetiX™ Integrity Package



As a standard, most of HABONIM valves are equipped with the Total HermetiX Integrity Package comprised of three main elements and a superior inline sealing mechanisms in some of them:

Zero fugitive-emission no maintenance stem sealing

- HermetiX™ stem sealing design with zero fugitive emission sealing capability.
- Tested or certified according to ISO 15848-1 and API 641 standards.
- Tested for up to 500,000 cycles of operation.

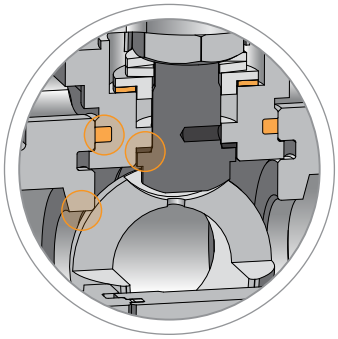


Double body sealing

- Body-to-ends & body-to-bonnet double sealing for superior sealing.
- Selection of sealing materials for diverse applications.
- Fugitive emission prevention.

Fire Safe

- According to API 607 & ISO 10497 - where applicable.
- Type-tested and certified by leading certification bodies for marine service – for some valve series.
- Clean Fire Safe construction guarantees no graphite contamination of the media flow.



Superior In-line sealing

A variety of implemented mechanism provides extended in-line sealing capabilities such as:

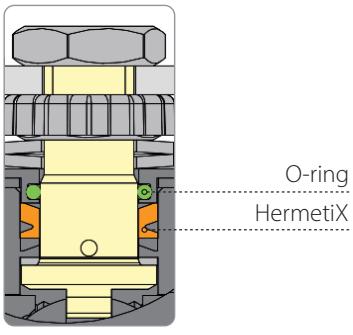
- Bidirectional sealing
- High Pressure full Δp sealing
- High & low pressure sealing
- Others

Hydrogen service cleaning

Process of cleaning, assembling and packing that refers to international standards in partial or in full:

- ASTM A380
- CGA G 4.1
- EN 12300

Hydrogen Double Stem Packing



Double stem sealing

CONVENTIONAL

PRODUCTION

The most popular hydrogen production legacy process is based on Steam Reforming of Natural Gas, or a similar process that uses a reaction of hydrocarbons with water.

Hydrogen produced by steam reforming is classified as 'gray hydrogen' when waste carbon dioxide is released into the atmosphere and as 'blue hydrogen' when the majority of carbon dioxide is captured, stored geologically, or reused within a carbon dioxide non-emitting process.

Typically, steam reforming systems, or steam methane reforming (SMR) systems are similar in construction to refining or industrial gases production systems with quite a large size piping system for a mixture of low and high pressures.

All Habonim Valves are ISO 15848-1 & API 641 Certified

Fugitive Emissions ISO 15848-1 & API 641

Hydrogen is the smallest molecule, lighter than air, and is a very flammable gas. Therefore, hazardous prevention means are required:

- Forced ventilation out of system closed spaces.
- Prevention of fugitive emissions by using certified emission prevention valves.

CONVENTIONAL

PRODUCTION

Piping style:	Low/High Pressure - Industrial use
Pressure range:	Up to 414 bar; 6,000 psi; class #2500
Piping diameters:	1/2" to 10"; DN15 to DN250
Connections styles:	Welded; Threaded
Fugitive emission:	API 641; ISO 15848-1
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Non-critical - use St. St.
Cleaning level:	Industrial level

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temp.: -60°C - +260°C (-76°F +500 °F)	Category	Ball Valve	Design Type	Series	TH	Port	End Con.	Valve Size (Inches) ¼	⅜	½	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16	MWP (ANSI Class)
	High Pressure	Trunnion	3 Piece	See High Pressure											2500/1500										
		Floating	3 Piece	See High Pressure											2500/1500										
	Industrial Use	Trunnion	3 Piece	See Industrial											900/600/300/150										
			2 Piece												600/300/150										
		Floating	3 Piece												900/600/400/300/150										
			2/1 Piece												300/150/PN40/PN16										
			DS/DBB												600/300/150/PN16										
			Multiport/ Diverter												600/300/150										
	Control		Control	See Control											900/400/300/150/PN40/PN16										

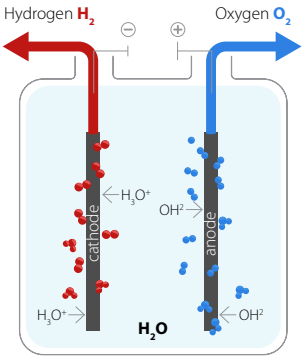
ELECTROLYSIS

PRODUCTION

Green Hydrogen production is mainly based on utilizing clean energy to produce hydrogen from water using electrolysis.

PEM - Polymer electrolyte membrane electrolysis is the electrolysis of water in a cell equipped with a solid polymer electrolyte.

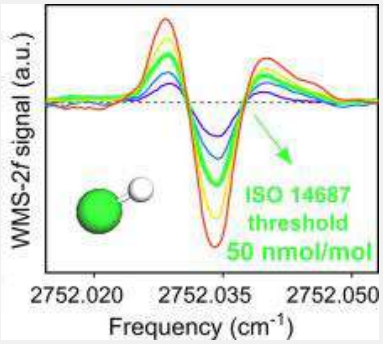
SOEC - Solid Oxide Electrolyzer Cell is the electrolysis of water in a cell using a solid oxide, or ceramic, electrolyte.
Some technologies allow using CO_2 to produce Hydrogen as part of transforming excessive CO_2 to clean energy.



PEM Alkaline Solid Oxide

Hydrogen Purity & Clean Valves

- Fuel Cells efficiency is damaged by Hydrogen impurities
- ISO 14687-2 defines Hydrogen purity > 99.97% :
  - sulphurs (< 4 nmol/mol); halogenates (< 50 nmol/mol, picture)
  - or carbon monoxide (< 200 nmol/mol)
- Valve production with no grease & particles
- O_2 cleaning grants clean internals at commissioning



HABONIM Hydrogen service cleaning

Process of cleaning, assembling and packing that refers to international standards in partial or in full:

- ASTM A380
- CGA G 4.1
- EN 12300

ELECTROLYSIS

PRODUCTION

Piping style:	Low Pressures - High Purity
Pressure range:	Up to 725 psi; 50 bar; class #300
Piping diameters:	1/2" to 6"; DN15 to DN150
Connections styles:	Welded; Flanged
Fugitive emission:	API 641; ISO 15848-1
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Non-critical - use St. St.
Cleaning level:	Cleaned for H_2 service

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temp.: -60°C - +260°C (-76°F +500 °F)	Category	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches) ¼	⅜	½	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16	MWP (ANSI Class)
	Industrial Use	Floating	3 Piece	OC	See Industrial	TH	Port	End Con.																		900/600/400/300/150
			2/1 Piece	OC		TH	Port	End Con.																		300/150/PN40/PN16
			DS/DBB	OC		TH	Port	End Con.																		600/300/150/PN16
			Multiport/ Diverter	OC		TH	Port	End Con.																		600/300/150
			Control	OC	See Control	TH	Port	End Con.																		900/400/300/150/PN40/PN16

HYDROGEN COMPRESSION & FIXED STORAGE

CONDITIONING

The most common way to store hydrogen in stationary storage is as a compressed gas.
Gas compression and High-pressure large bulk storage are used in a variety of technologies and scales.

HGE: H_2 Gas Embrittlement

- H_2 molecule diffuses into metal surface
- P & T variations create cracks by fatigue
- Crack propagation = HGE
- HGE risk increases with P/decreases with polishing-coating
- Rule of thumb: materials HRC < 32 are not affected by HE

Habonim H_2 Valve Materials non-susceptible to HGE

- Body: SS316L shell; A479 (forged bar, not cast) for HP valves
- Embrittlement risk is proportional to hardness
- Trim (ball & stem) in HP H_2 valves need to be hard (fatigue): trim materials are key HABONIM's know - how!

HYDROGEN COMPRESSION & FIXED STORAGE

CONDITIONING

Piping style:	High Pressures
Pressure range:	300 to 1,034 bar; 4,300 to 15,000 psi; Class #2,500; #3,500
Piping diameters:	1/2" to 2"; DN15 to DN50
Connections styles:	Coned & Threaded; Welded
Fugitive emission:	API 641; ISO 15848-1; With special HP H_2 stem seal
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Very critical - use Hydrogen service valves
Cleaning level:	Cleaned for H_2 service

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

									Valve Size (Inches)																	MWP (ANSI Class)
Temp.: -40°C - +260°C (-40°F +500 °F)	Category	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	¼	⅜	½	9/16	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16
	High Pressure	Floating	Threaded body	OC	H29	TH	Port	End Con.	1,034 bar (15,000 psi)																	
				OC	H25	TH	Port	End Con.	550 bar (8,000 psi)																	
				OC	H24	TH	Port	End Con.	500 bar (7,250 psi)																	
			3 Piece	OC	H28	TH	Port	End Con.					2500					2500 (Δp up to 255 bar/3700 psi)									
			3 Piece	OC	H47	TH	Port	End Con.					900					400									

LIQUEFIED HYDROGEN (LH_2)

CONDITIONING

Hydrogen in a liquid form is much more efficient for storing large quantities, or when there is a need for storing a lot of energy using Hydrogen.

Legacy uses of Liquid Hydrogen (LH_2) are rocket-fuel, laboratories, and some others, yet the emerging market of Hydrogen as a fuel for commercial transportation and energy storage is expanding the use of LH_2 storage and transportation.

Habonim valves are in use for LH_2 applications for many years in the aerospace and rocket launch market, storage tanks, and testing systems.

Our technology is optimized to accommodate the very low cryogenic temperatures while providing high sealing levels and low emissions in manual and automated valves.

The energy stored in 1 liter (or Gallon) of LH_2 is almost 5 times larger than that of 1 liter (or Gallon respectively) of H_2 gas at 200 bar (~3,000 psi) pressure and more than double the energy of 1 liter (or Gallon respectively) of H_2 gas at 500 bar (~7,250 psi)

LIQUEFIED HYDROGEN (LH_2)

CONDITIONING

Piping style:	Low Pressures; Double wall vacuumed piping
Pressure range:	Up to 725 psi; up to 50 bar; up to Class #300
Piping diameters:	1/2" to 4"; DN15 to DN100
Connections styles:	Welded, Flanged
Fugitive emission:	API 641; ISO 15848-1; With special HP H_2 stem seal
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Not critical
Cleaning level:	Cleaned for Hydrogen use (covers also Cryogenic use)

Quick Selection Table

™Total Hermetix | **:Port** Standard Port | Full Port | Tube Size | **:End Connections** Threaded | Flanged | Welded

OC Ordering Code

Temperature: Cryogenic Down to -269°C (-452°F)	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches) ¼	⅜	½	¾	1	1¼	1½	2	2½	3	4	6	8	10	12 — MWP (ASME Class / DIN PN)
	Trunnion Mounted Ball	Top Entry	OC	C52	TH	Tube Size	Tube Size			300				300								
		3 Piece	OC	C91	TH	Standard Port	Tube Size										150					
			OC	C92	TH	Standard Port	Tube Size										300					
			OC	C93	TH	Standard Port	Tube Size										600					
			OC	C94	TH	Standard Port	Tube Size										900					
			OC	C95	TH	Standard Port	Tube Size										1500					
			OC	C96	TH	Standard Port	Tube Size										2500					
		2 Piece	OC	C81	TH	Full Port	Tube Size										150					
			OC	C82	TH	Full Port	Tube Size										300					
			OC	C83	TH	Full Port	Tube Size										600					
	Floating Ball	3 Piece	OC	C47	TH	Standard Port	Threaded	600								300						
			OC	C47-BD	TH	Standard Port	Threaded	300								150						
			OC	C26	TH	Full Port	Threaded								600							
			OC	C28	TH	Standard Port	Threaded	2500 (Δp up to 103bar/1494 psi)														
		Diverter 3 Pcs.	OC	DC47	TH	Standard Port	Threaded			600												
		Multiport 3 Pcs.	OC	C61		Standard Port	Threaded	600								300						
		Multiport 3 Pcs.	OC	C62		Standard Port	Threaded	600								300						
		1 Piece	OC	C31	TH	Standard Port				150												
			OC	C32	TH	Standard Port				300												
		1 Piece 2 Piece	OC	C73	TH	Full Port	Tube Size			150												
			OC	C74	TH	Full Port	Tube Size			300												
			OC	C77	TH	Full Port	Tube Size										PN16					
			OC	C78	TH	Full Port	Tube Size			PN40												

ASME Class			150		300		600	900	1500		2500		6000	
Pressure Bar	* -1	0	16	20	40	50	100	150	200	250	350	420	700	1000
Pressure psi	* -14	0	230	290	580	750	1500	2250	3000	3750	5000	6000	10000	15000

Vacuum 10^{-6} Tor *

CYLINDER DISTRIBUTION (CGH_2)

DELIVERY

Cylinder filling

Use ball valves for systems exclusively used for H_2.

Compressor output to storage tank

- Ball valves up to DN50, welded
- Pressure 200 to 700 bar

H_2 Storage alternative technologies:

- CH_2 - Compressed HIGH PRESSURE H_2 350/700 bar
- LH_2 - LIQUID H_2
- CcH_2 - LIQUID CHEMICAL H_2

Considerations:

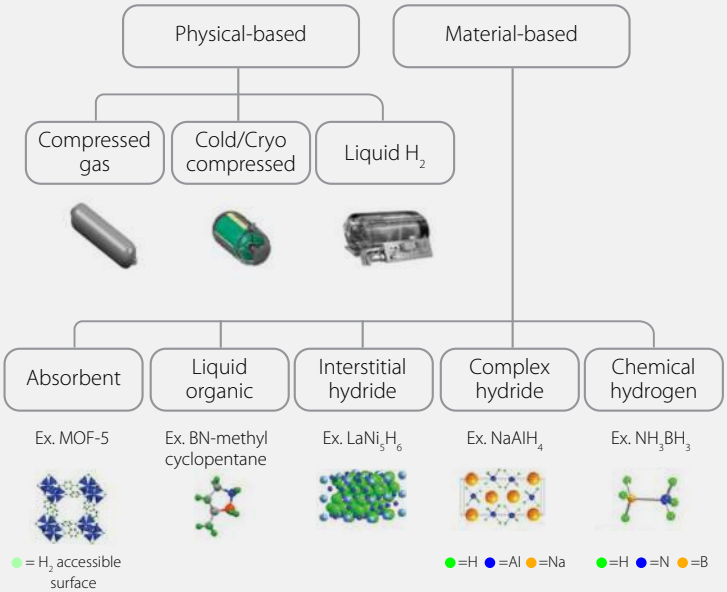
- Safety
- Energy balance (OPEX)
- Infrastructure (CAPEX)

Energy / Gravimetric capacity:

$CcH_2 > LH_2 \approx CH_2$

Volumetric density:

$CcH_2 > CH_2$ (700 bar) > $LH_2 > CH_2$ (350 bar)



CYLINDER DISTRIBUTION (CGH_2)

DELIVERY

Piping style:	High Cycle - High Pressure - High Purity
Pressure range:	300 to 1,034 bar; 4,300 to 15,000 psi; Class #2,500; #3,500
Piping diameters:	1/2" to 2"; DN15 to DN50
Connections styles:	Coned & Threaded; Welded
Fugitive emission:	API 641; ISO 15848-1; With special HP H_2 stem seal
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Very critical - use Hydrogen service valves
Cleaning level:	Cleaned for H_2 service

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

										Valve Size (Inches)																	MWP (ANSI Class)
Temp.: -40°C - +260°C (-40°F +500 °F)	Category	Ball Valve	Design Type	OC	Series	TH	Port		End Con.					¼	⅜	½	9/16	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16
	High Pressure	Floating	Threaded body		H29									1,034 bar (15,000 psi)															
					H25									550 bar (8,000 psi)															
					H24									500 bar (7,250 psi)															
			3 Piece		H28													900				2500 (Δp up to 255 bar/3700 psi)							
			3 Piece		H47													900				400							

DELIVERY

ROAD/RAIL/SHIPPING TRANSPORT (CGH_2)

Cylinder Bundles are built on truck-trailers, MEGC / ISO containers, etc., and their filling systems.

Working pressures as per the cylinder technologies, mainly Fiberglass and composite materials:

- 500 bar (7,000 psi)
- 700 bar (10,000 psi)
- Certified for transportation: TPED (EUROPE) / TPE (UK) & ISO 23826

ISO 23826:2021 Gas cylinders - ball valves - specification and testing

Specifies design, type testing, marking, manufacturing tests and examinations requirements for ball valves used as:

- Closures of refillable transportable gas cylinders, pressure drums and tubes.
- Main valves for cylinder bundles.
- Valves for cargo transport units [e.g. trailers, battery vehicles, multi-element gas containers (MEGCs)].

Which convey compressed gases, liquefied gases and dissolved gases. Source: www.iso.org

Test Highlights:

- 2,000 Cycles test under 1.2 times the maximal working pressure.
- Inline and Atmospheric leak test at -40°C (-40°F), -20°C (-4°F), 65°C (149°F) & ambient:
- Under 1.2 times the maximal working pressure.
- Under low pressure.
- Cycle of high and low pressure.
- Sealing tested with Hydrogen media.
- Burst test under 2.25 times the maximal working pressure, with water.
- Flame impingement test.
- Excessive torque test.

ROAD/RAIL/SHIPPING TRANSPORT (CGH_2)

DELIVERY

Piping style:	High/Ultra-High Pressure - High Purity - transportation
Pressure range:	7,250 to 10,000 psi; 500 to 700 bar
Piping diameters:	Up to 1"; up to DN25
Connections styles:	Coned & Threaded
Fugitive emission:	API 641; ISO 15848-1; With special HP H_2 stem seal
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Critical - use Hydrogen service valves
Cleaning level:	Cleaned for Hydrogen service
Specific Standards & Regulations	TPED π / TPE ρ (UK) (mandatory in EU), ISO 23826

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temperature: -40°C - +260°C (-40 °F ÷ +500 °F)	Category	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches) ¼	3/8	½	9/16	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16	MWP (ANSI Class)
	High Pressure	Floating	Threaded body	OC	H29	TH	Port	End Con.	700 bar (10,000 psi)																	
			Threaded body	OC	H25	TH	Port	End Con.	550bar (8,000 psi)																	
			Threaded body	OC	H24	TH	Port	End Con.	500 bar (7,250 psi)																	

PIPING DISTRIBUTION (CGH_2)

DELIVERY

Local Hydrogen Distribution

There are two main use cases for pipes transferring Hydrogen. Local distribution of Hydrogen is the first and is a growing one, transforming available energy into hydrogen and utilizing the hydrogen as an energy source elsewhere is becoming more popular. As an outcome, piping systems for the distribution of hydrogen in relative proximity is expanding. Either as a local network in industrial areas, or to connect a hydrogen manufacturing site to hydrogen consumption points, as sometimes the hydrogen is manufactured as a side product of an existing facility and is consumed as energy in other facilities located elsewhere.

Mixing Hydrogen into Natural Gas Feedstock

Mixing hydrogen into a Natural Gas supply is another use, injecting up to 15% hydrogen volume into a Natural Gas system has a negligible impact on the system and its efficiency and allows for a reduction in the total carbon signature of such a system equivalently. A common implementation is basically injecting hydrogen into a Natural Gas piping system and allowing all downstream users to enjoy the carbon footprint reduction. Both use cases have no special requirements from the piping system and medium pressure hydrogen-use valves are in service.

PIPING DISTRIBUTION (CGH_2)

DELIVERY

Piping style:	Medium Pressures - Industrial use
Pressure range:	50 to 90 bar; 700 to 1,300 psi; class #600
Piping diameters:	2" to 12"; DN50 to DN300
Connections styles:	Welded
Fugitive emission:	API 641; ISO 15848-1
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Critical - use Hydrogen service valves
Cleaning level:	Industrial level
Specific Standards & Regulations	ASME B31.12; Eventually EN 10204 3.2

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temp.: -60°C - +260°C (-76°F +500 °F)	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches) ¼	⅜	½	¾	1	1¼	1½	2	2½	3	4	MWP (ANSI Class) 6	8	10	12	14	16
	Trunnion	3 Piece	OC	93	TH	Port	End Con.												600					
		2 Piece	OC	83	TH														600					
	Floating	3 Piece	OC	47	TH	Port	End Con.										900		400					
		3 Piece	OC	26	TH														600					
		DS/DBB	OC	47DS	TH												600							
		Multiport/ 3 Piece	OC	61													600		300					
			OC	62																				
		Diverter/ 3 Piece	OC	D47	TH												600		300					
		Side-Entry/ 3 Piece	OC	S47	TH																			
		3 Piece	OC	47	TH												900		400					

HYDROGEN IN INDUSTRIAL PROCESSES

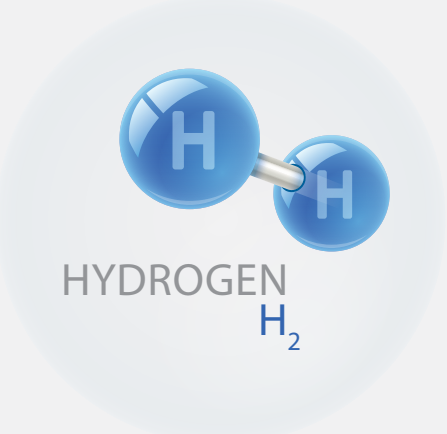
INDUSTRIAL USE

Hydrogen is used in diverse industries and processes. Hydrocracking in petroleum refining, many chemicals' productions and reactions, food ingredients manufacturing, and many more.

These legacy applications and others like rocket fueling, laboratories, and research have diverse tubing and piping systems in use, for low, medium, and high pressures and require industrial standards and certifications to accommodate this flammable highly volatile gas.

Hydrogen is the chemical element with the symbol H and atomic number 1. Hydrogen is the lightest element. At standard conditions, hydrogen is a gas of diatomic molecules having the formula H_2. It is colorless, odorless, tasteless, non-toxic, and highly combustible.

Hydrogen is the most abundant chemical substance in the universe, constituting roughly 75% of all normal matter. Most of the hydrogen on Earth exists in molecular forms such as water and organic compounds. For the most common isotope of hydrogen (symbol 1H) each atom has one proton, one electron, and no neutrons. Source: www.wikipedia.com



HYDROGEN IN INDUSTRIAL PROCESSES

INDUSTRIAL USE

Piping style:	Low/High Pressure - Industrial use
Pressure range:	Up to 6,000 psi; up to 414 bar; up to class #2500
Piping diameters:	1/2" to 10"; DN15 to DN250
Connections styles:	Welded; Threaded
Fugitive emission:	API 641; ISO 15848-1
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Non-critical - use St. St.
Cleaning level:	Cleaned for high purity H_2 use

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temp.: -60°C - +260°C (-76°F +500 °F)	Category	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches) ¼ ⅜ ½ ¾ 1 1¼ 1½ 2 2½ 3 4 6 8 10 12 14 16 — MWP (ANSI Class)
	High Pressure	Floating	3 Piece	OC	See High Pressure	TH	Port	End Con.	2500/1500
	Industrial Use		3 Piece	OC	See Industrial	TH	Port	End Con.	900/600/300/150
			2 Piece	OC		TH		End Con.	600/300/150
			3 Piece	OC		TH	Port	End Con.	900/600/400/300/150
			2/1 Piece	OC		TH	Port	End Con.	300/150/PN40/PN16
			DS/DBB	OC		TH	Port	End Con.	600/300/150/PN16
			Multiport/ Diverter	OC		TH	Port	End Con.	600/300/150
			Control	OC	See Control	TH	Port	End Con.	900/400/300/150/PN40/PN16

ENERGY SOURCE

INDUSTRIAL USE

Hydrogen and especially green or blue hydrogen that are manufactured by an environmentally clean process are ideal to be used as a storage for access energy later to be transformed back to energy, (mainly electricity) in a clean process mainly based on fuel-cell technology.

More than one technology is developed to allow the large-scale and efficient transformation of hydrogen to electricity or heat, all with the purpose of utilizing the stored energy in a clean way.

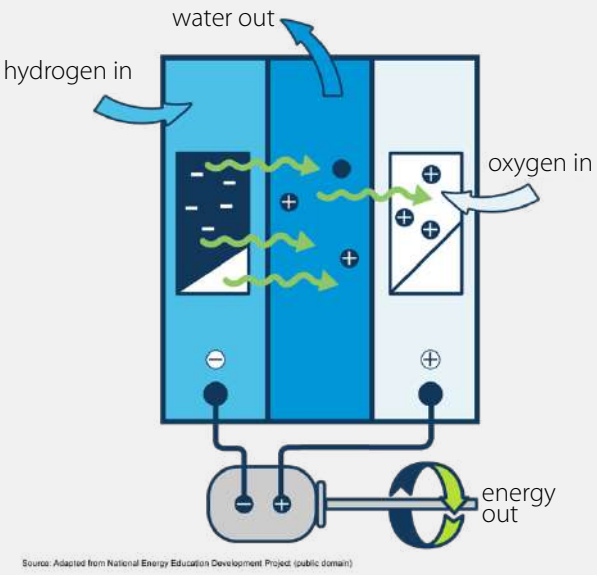
These processes have the stored hydrogen feedstock on one end and the transforming device that turns it into energy on the other. These processes usually are done locally at low to medium pressures and have a small to medium piping size in use. Cost-effectiveness is a major key factor in such systems designs as they are distributed near the end use points of the energy, hence relatively small scale with a challenging ROI and low maintenance requirements.

Hydrogen Fuel Cell

A fuel cell is an electrochemical cell that converts the chemical energy of hydrogen and oxygen (usually) into electricity through a pair of redox reactions. Fuel cells are different from most batteries in requiring a continuous source of fuel and oxygen to sustain the chemical reaction, yet can produce electricity continuously for as long as hydrogen fuel and oxygen are supplied.

Fuel cell energetic efficiency can reach 80-90% and is used in mobile devices like cars, trucks, space vehicles, and more or in stationary power generation facilities.

Individual fuel cells produce relatively small electrical potentials, about 0.7 volts, so cells are "stacked", or placed in series, to create sufficient voltage. Stationary fuel cells power plants becomes bigger all the time, reaching capacity of close to 80 MW already. Source: wikipedia.org



Source: Adapted from National Energy Education Development Project (public domain)

ENERGY SOURCE

INDUSTRIAL USE

Piping style:	Meduim Pressures - Industrial use
Pressure range:	700 to 1,300 psi; 50 to 90 bar; class #600
Piping diameters:	1/4" to 10"; DN8 to DN250
Connections styles:	Coned & Threaded; Welded
Fugitive emission:	API 641; ISO 15848-1; With special HP H_2 stem seal
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Critical - use Hydrogen service valves
Cleaning level:	Cleaned for high purity H_2 use

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temp.: -60°C - +260°C (-76°F +500 °F)

Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches) / MWP (ANSI Class)
Trunnion	3 Piece	OC	93	TH	Standard, Full	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 2½ 3 4 6 8 10 12 14 16 — 600
Trunnion	2 Piece	OC	83	TH		Threaded, Cone & Thread	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 2½ 3 4 6 8 10 12 14 16 — 600
Floating	3 Piece	OC	47	TH	Standard, Full	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 900 — 400
Floating	3 Piece	OC	26	TH	Full	Cone & Thread	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 600
Floating	DS/DBB	OC	47DS	TH	Standard	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 600
Floating	Multiport/ 3 Piece	OC	61		Standard, Full	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 600 — 300
Floating	Multiport/ 3 Piece	OC	62		Standard, Full	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 600 — 300
Floating	Diverter/ 3 Piece	OC	D47	TH	Standard, Full	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 600 — 300
Floating	Side-Entry/ 3 Piece	OC	S47	TH	Standard, Full	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 600 — 300
Floating	3 Piece	OC	47	TH	Standard, Full	Threaded, Cone & Thread, Welded	¼ ⅜ ½ ¾ 1 1¼ 1½ 2 — 900 — 400

Relevant HABONIM Series: H93/H83/H47/H26/47DS/H61/H61/D47/S47/H47

DISPENSING - CGH_2

REFUELING/
MOBILITY

Hydrogen-powered vehicles are basically electrical motored vehicles of all sorts that use a fuel cell to continuously transform hydrogen to electricity, such vehicles have a hydrogen tank onboard and need to be refueled like any petrol or gas vehicle.

The available space and physical constraints of each vehicle impact the volume of the onboard hydrogen tank. In order of allowing the required traveling distance before refueling, different hydrogen gas pressures are used in different types of vehicles.

The onboard hydrogen tank working pressure defines the fueling stations and dispensing systems working pressures to go up to 1,034 bar (15,000 psi).

Standards like ISO 19880 Gaseous hydrogen — Fuelling stations — Part 3: Valves define the requirements and certification of the valve to be used in those high-pressure hydrogen fueling stations.

Vehicle Type	Full	Onboard tank pressure	Dispensing & Fuel station systems pressure
Cars	CH_2	700-750 bar (10,000-11,000 psi)	1,034 bar (15,000 psi)
Industrial machinery & trucks	CH_2	500-550 bar (7,250-8,000 psi)	600-700 bar (8,700-10,000 psi)
Trucks	CH_2	300-350 bar (4,350-5,000 psi)	450-550 bar (6,500-8,000 psi)

ISO 19880-3:2018, Gaseous hydrogen - Fuelling stations - Part 3: Valves

This international standard specifies the requirements and test methods for valves designed and manufactured for gaseous hydrogen stations, specifies the safety performance requirements, and proof of design type-test methods for components to be used in hydrogen stations.
The standard specifies a list of stringent testing in the purpose of validating the valve design is suitable for high-cycle outdoor safe use under very high pressures with hydrogen media.

Some of the tests are:

100,000 Cycles
Under Pressure

-40°C
Under Pressure Cycles
+ Full Δp cycles

+85°C
Under Pressure Cycles
+ Full Δp cycles

Pressure Tests
valve rating x 2.5

DISPENSING - CGH_2

REFUELING/
MOBILITY

Piping style:	High/Ultra-High Pressure - High Purity - transportation
Pressure range:	550 bar / 1,034 bar, 8,000 psi / 15,000 psi
Piping diameters:	1/4" to 1-1 /2"; DN8 to DN40
Connections styles:	Coned & Threaded
Fugitive emission:	API 641; ISO 15848-1; With special HP H_2 stem seal
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Critical
Cleaning level:	Cleaned for high purity H_2 use
Certification:	ISO 19880-3

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

OC Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temp.: -40°C - +260°C (-40°F +500°F)	Category	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches) ¼	⅜	½	9/16	¾	1	1¼	1½	2	2½	3	MWP (ANSI Class) 4	6	8	10	12	14	16
	High Pressure	Trunnion	Threaded body	OC	H99				1,034 bar (15,000 psi)																
		Floating		OC	H25	TH			550 bar (8,000 psi)																

Relevant HABONIM Series: H99/H25

PRODUCTION-STORAGE-FUELING-USE (CGH_2)

ON SITE
ELECTROLYSIS

On-site end-to-end renewable energy supply systems are becoming more and more popular.

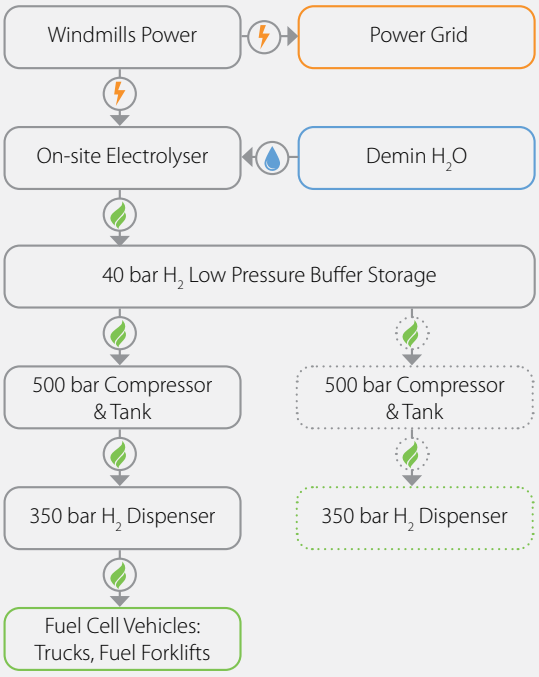
Such a typical system comprises of:

- Renewable energy generation devices like a wind turbine, solar panel system, or others.
- Hydrogen electrolysis device to turn the access renewable electricity into hydrogen.
- Low-pressure hydrogen tank or storage.
- Hydrogen compression system.
- High-pressure hydrogen tank or storage.
- Dispensing system.

A system like this can be built to fuel a variety of vehicle types with few working pressures.

Such local systems can be integrated with the local power grid and local H_2 or Natural gas pipe systems allowing bi-directional electricity and hydrogen flow.

20 MW power to H_2 self-generation, self-consumption fueling and H_2 surplus selling



PRODUCTION-STORAGE-FUELING-USE (CGH_2)

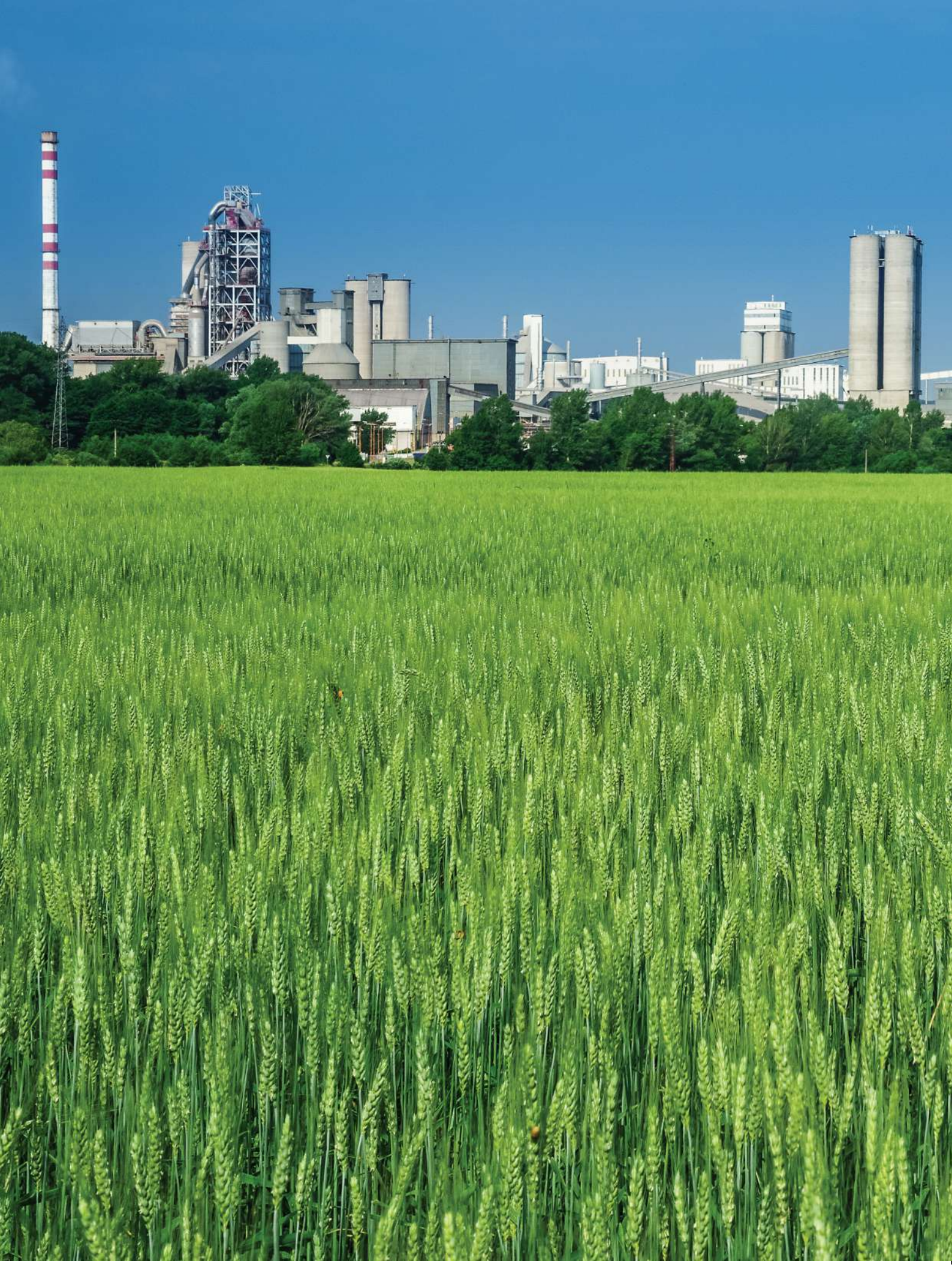
ON SITE ELECTROLYSIS

Piping style:	High/Ultra-High Pressure - High Purity - transportation
Pressure range:	550 bar - 1,034 bar, 8,000 psi - 15,000 psi
Piping diameters:	1/4" to 1-1 /2"; DN8 to DN40
Connections styles:	Coned & Threaded
Fugitive emission:	API 641; ISO 15848-1; With special HP H_2 stem seal
Fire Safe:	API 607; ISO 10497
HE - H_2 gas embrittlement:	Critical
Cleaning level:	Cleaned for high purity H_2 use
Specific Standards & Regulations:	ISO 19880-3

Total HermetiX™ | **Port** Standard Port Full Port Tube Size

Ordering Code | **End Connections** Threaded Cone & Thread Flanged Welded

Temp.: -40°C - +260°C (-40°F +500 °F)	Category	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches)	MWP (ANSI Class)
									¼ ⅜ ½ 9/16 ¾ 1 1¼ 1½ 2 2½ 3 4 6 8 10 12 14 16	
	High Pressure	Trunnion	Threaded body	OC	H99				1,034 bar (15,000 psi)	
		Floating		OC	H29	TH			1,034 bar (15,000 psi) with TPED / TPE - 700 bar (10,000 psi)	
				OC	H25	TH			550 bar (8,000 psi)	



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About Habonim

Ball Valves & Actuators for the most demanding, challenging and hazardous applications are our passion and profession for the last 70 years.

We believe in designing, manufacturing and supplying control and shutoff components and solutions that improves the overall safety, integrity and sustainability of the systems they are installed in.

Designed, manufactured and tested according to the highest standards, our products allow us to partner within systems that flow and control varied gases and liquids in diverse markets especially where extreme temperatures and pressures are involved, hazardous materials are used and system performances are critical.

We are leading in cryogenic ball valve-based control solutions, emergency shutoff and specially designed solutions.

Believing that supplying and developing the most effective, safe and reliable products for the global leaders in the LNG and Gas distribution market continually challenges us to improve our capabilities and products.

Best coping with our prestigious customers' most challenging requirements technically, operationally and commercially is our promise fulfilled for decades.

Performing in Demanding Applications

HABONIM
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