

## VALVES FOR HYDROGEN PROCESSES





# PERFORMING IN DEMANDING APPLICATIONS

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.

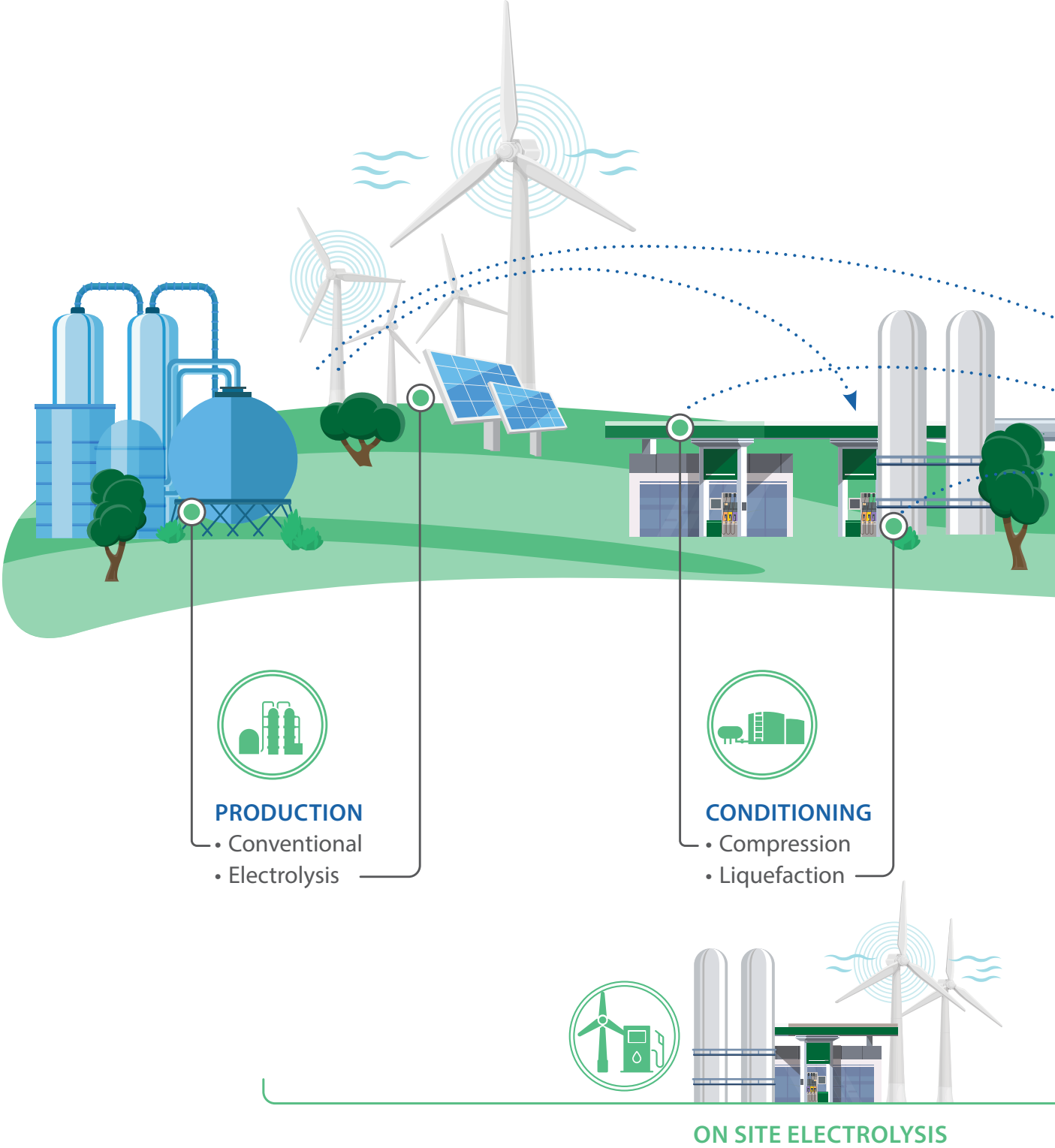
With the understanding of the challenges of modern Hydrogen system designers, we are closely cooperating with our customers to develop optimal solutions within the required safety, quality, and regulations.

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# THE HYDROGEN SUPPLY CHAIN





### Green H<sub>2</sub>



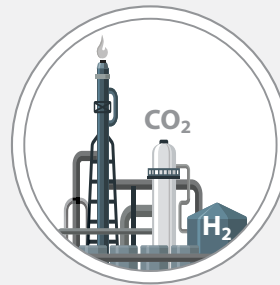
Green/Renueable energy.  
Electrolysis process.  
Zero carbon footprint.

### Blue H<sub>2</sub>

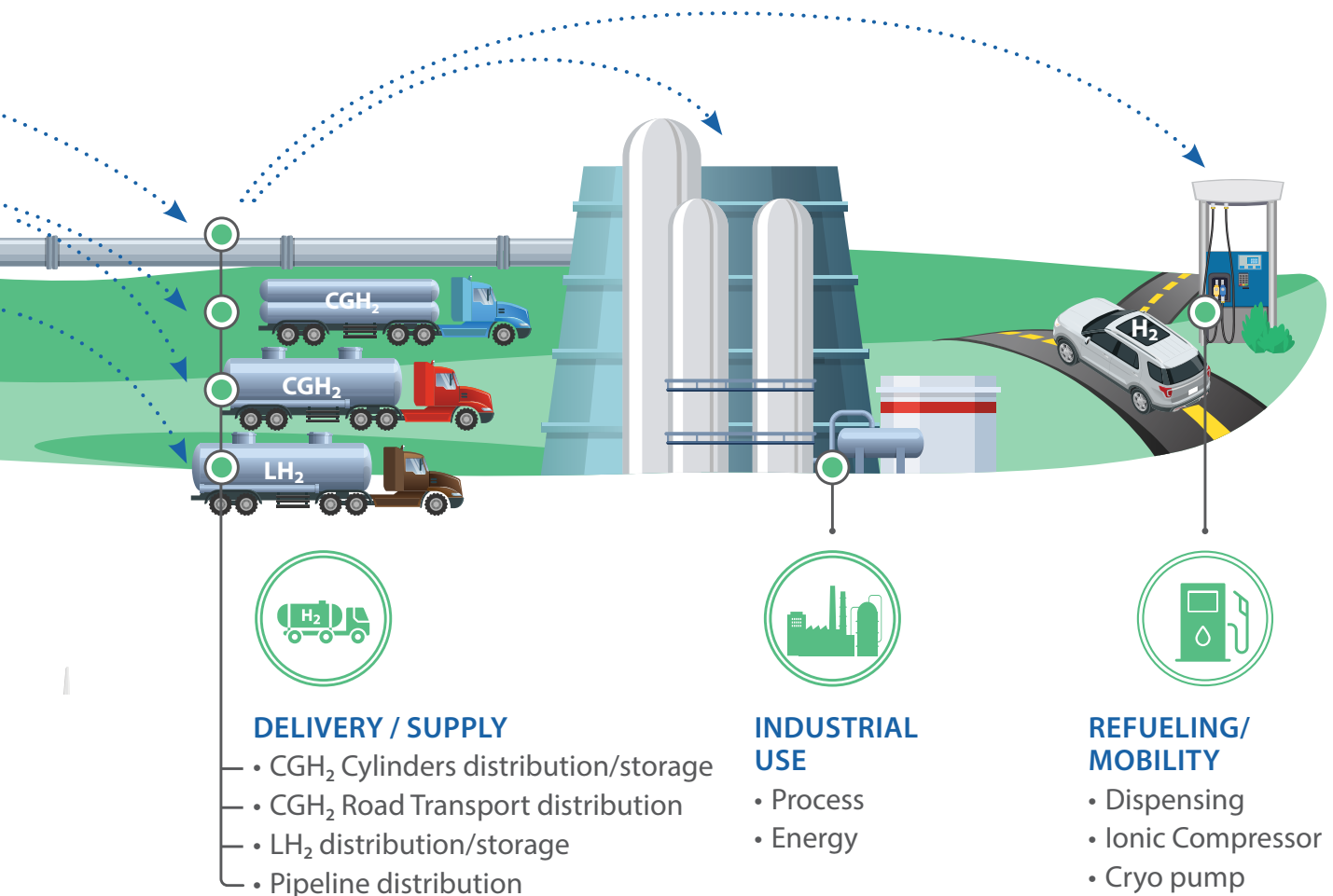


Carbon based energy with  
carbon capturing, utilization  
or underground storage.

### Grey H<sub>2</sub>



Carbon based energy.  
Legacy process.



# 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

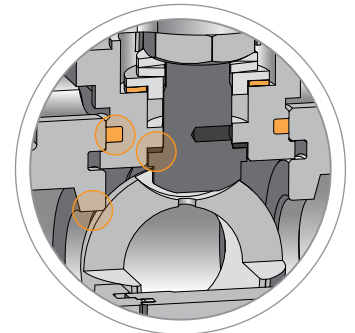
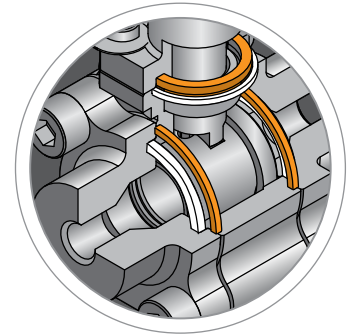
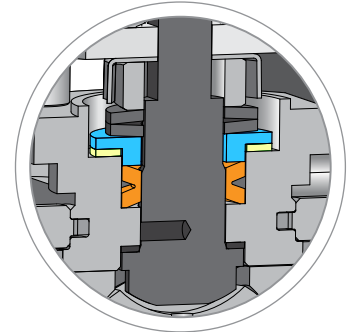
A variety of implemented mechanism provides extended in-line sealing capabilities such as:

- Bidirectional sealing
- High Pressure full  $\Delta p$  sealing
- High & low pressure sealing
- Others

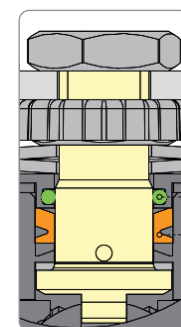
### Hydrogen service cleaning

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



O-ring  
HermetiX

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.







PRODUCTION

# CONVENTIONAL

- 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<sub>2</sub> 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)												MWP (ANSI Class)																					
								1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16
								High Pressure	Trunnion	3 Piece	See High Pressure	⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	2500/1500						2500/1500						2500/1500													
High Pressure	Floating	3 Piece	See High Pressure	⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	2500/1500						2500/1500						2500/1500																					
Industrial Use	Trunnion	3 Piece	See Industrial	⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	900/600/300/150						900/600/300/150																											
		2 Piece		⊗ ○	⊕ ⊕	⊕ ⊕	600/300/150						600/300/150																												
	Floating	3 Piece		⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	900/600/400/300/150						900/600/400/300/150																											
		2/1 Piece		⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	300/150/PN40/PN16						300/150/PN40/PN16																											
		DS/DBB		⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	600/300/150/PN16						600/300/150/PN16																											
		Multiport/Diverter		⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	600/300/150						600/300/150																											
		Control		Control	See Control	⊗ ⊙ ○	⊕ ⊕	⊕ ⊕	⊕ ⊕	900/400/300/150/PN40/PN16																															

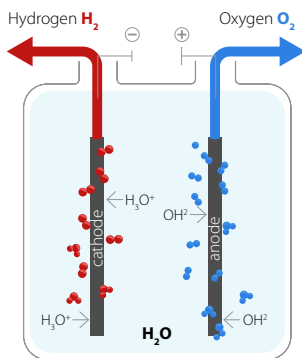


# ELECTROLYSIS

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<sub>2</sub> to produce Hydrogen as part of transforming excessive CO<sub>2</sub> to clean energy.

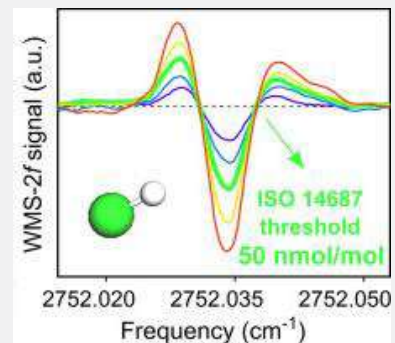


PEM Alkaline Solid Oxide



## 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<sub>2</sub> 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





PRODUCTION

# ELECTROLYSIS

**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<sub>2</sub> gas embrittlement:** Non-critical - use St. St.  
**Cleaning level:** Cleaned for H<sub>2</sub> 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)												MWP (ANSI Class)				
									¼	⅜	½	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14	16
Industrial Use	Floating	3 Piece	<input checked="" type="checkbox"/>	See Industrial	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	900/600/400/300/150												Hatched			
		2/1 Piece	<input checked="" type="checkbox"/>	See Industrial	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	300/150/PN40/PN16																
		DS/DBB	<input checked="" type="checkbox"/>	See Industrial	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	600/300/150/PN16																
		Multiport/ Diverter	<input checked="" type="checkbox"/>	See Control	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	600/300/150												Hatched			
		Control	<input checked="" type="checkbox"/>	See Control	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	900/400/300/150/PN40/PN16															



# HYDROGEN COMPRESSION & FIXED STORAGE

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<sub>2</sub> Gas Embrittlement

- H<sub>2</sub> 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<sub>2</sub> 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<sub>2</sub> valves need to be hard (fatigue): trim materials are key HABONIM's know - how!

# HYDROGEN COMPRESSION & FIXED STORAGE

- 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<sub>2</sub> stem seal
- Fire Safe:** API 607; ISO 10497
- HE - H<sub>2</sub> gas embrittlement:** Very critical - use Hydrogen service valves
- Cleaning level:** Cleaned for H<sub>2</sub> service

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)											
									1/4	3/8	1/2	9/16	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16							
													1,034 bar (15,000 psi)				550 bar (8,000 psi)				500 bar (7,250 psi)				2500 (Δp up to 255 bar/3700 psi)				900				400
High Pressure	Floating	Threaded body	OC	H29	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																								
			OC	H25	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																									
			OC	H24	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																									
		OC	H28	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																										
		OC	H47	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>																										



# LIQUEFIED HYDROGEN (LH<sub>2</sub>)



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<sub>2</sub>) 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<sub>2</sub> storage and transportation.

Habonim valves are in use for LH<sub>2</sub> 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<sub>2</sub> is almost 5 times larger than that of 1 liter (or Gallon respectively) of H<sub>2</sub> gas at 200 bar (~3,000 psi) pressure and more than double the energy of 1 liter (or Gallon respectively) of H<sub>2</sub> gas at 500 bar (~7,250 psi)

# LIQUEFIED HYDROGEN (LH<sub>2</sub>)

- 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<sub>2</sub> stem seal
- Fire Safe:** API 607; ISO 10497
- HE - H<sub>2</sub> 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  
 Ordering Code

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



# CYLINDER DISTRIBUTION (CGH<sub>2</sub>)

## Cylinder filling

Use ball valves for systems exclusively used for H<sub>2</sub>.

## Compressor output to storage tank

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



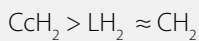
## H<sub>2</sub> Storage alternative technologies:

- CH<sub>2</sub> - Compressed HIGH PRESSURE H<sub>2</sub> 350/700 bar
- LH<sub>2</sub> - LIQUID H<sub>2</sub>
- CcH<sub>2</sub> - LIQUID CHEMICAL H<sub>2</sub>

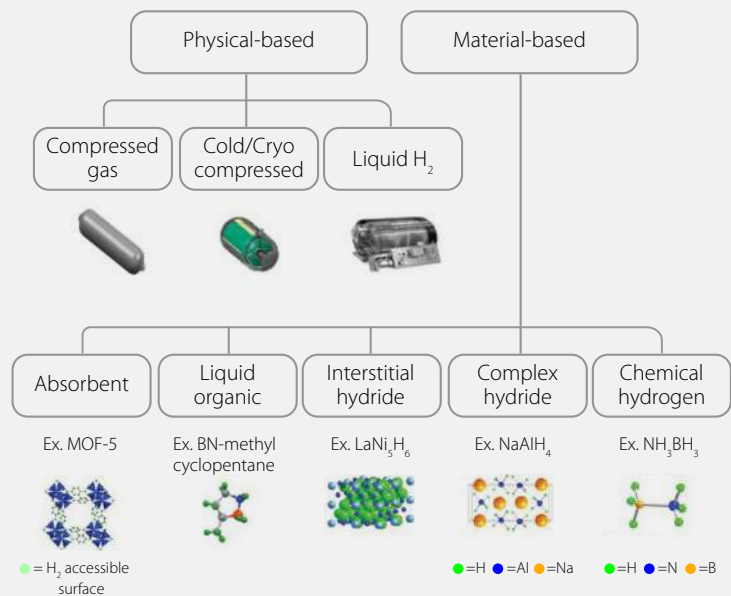
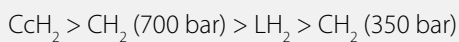
## Considerations:

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

## Energy / Gravimetric capacity:



## Volumetric density:







# CYLINDER DISTRIBUTION (CGH<sub>2</sub>)

- 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<sub>2</sub> stem seal
- Fire Safe:** API 607; ISO 10497
- HE - H<sub>2</sub> gas embrittlement:** Very critical - use Hydrogen service valves
- Cleaning level:** Cleaned for H<sub>2</sub> service

⊗ 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)						
									1/4	3/8	1/2	9/16	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16
									High Pressure	Floating	Threaded body	⊙	H29	⊗	⊙	⊙	⊕	⏏	1,034 bar (15,000 psi)							
		Threaded body	⊙	H25	⊗	⊙	⊙	⊕	⏏	550 bar (8,000 psi)																
		Threaded body	⊙	H24	⊗	⊙	⊙	⊕	⏏	500 bar (7,250 psi)																
		3 Piece	⊙	H28	⊗	⊙	⊙	⊕	⊕	□			900		2500 (Δp up to 255 bar/3700 psi)											
		3 Piece	⊙	H47	⊗	⊙	⊙	⊕	⊕	□			900		400											





# ROAD/RAIL/SHIPPING TRANSPORT (CGH<sub>2</sub>)

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](http://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<sub>2</sub>)

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 <sub>2</sub> stem seal
Fire Safe:	API 607; ISO 10497
HE - H <sub>2</sub> 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)												MWP (ANSI Class)										
									1/4	3/8	1/2	9/16	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16					
High Pressure	Floating	Threaded body	Threaded body	☉	H29	☒	☉	☉	☉	☉	☉	700 bar (10,000 psi)																			
				☉	H25	☒	☉	☉	☉	☉	550bar (8,000 psi)																				
				☉	H24	☒	☉	☉	☉	☐	500 bar (7,250 psi)																				





# PIPING DISTRIBUTION (CGH<sub>2</sub>)

## 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<sub>2</sub>)

**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<sub>2</sub> 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)															
								MWP (ANSI Class)															
								¼	⅜	½	¾	1	1¼	1½	2	2½	3	4	6	8	10	12	14
Floating	Trunnion	3 Piece	⊙	93	⊗	⊙ ⊙	⊕ ⊕ ⊕ ⊕	900								600							
		2 Piece	⊙	83	⊗		⊕ ⊕ ⊕ ⊕	900								600							
	Floating	3 Piece	⊙	47	⊗	⊙ ⊙	⊕ ⊕ ⊕ ⊕	900				400				600							
		3 Piece	⊙	26	⊗	○	⊕ ⊕ ⊕ ⊕	900								600							
		DS/DBB	⊙	47DS	⊗	⊙	⊕ ⊕ ⊕ ⊕	900								600							
		Multiport/ 3 Piece	⊙	61		⊙ ⊙	⊕ ⊕ ⊕ ⊕	900				300				600							
			⊙	62		⊙ ⊙	⊕ ⊕ ⊕ ⊕	900				300				600							
		Diverter/ 3 Piece	⊙	D47	⊗	⊙ ⊙	⊕ ⊕ ⊕ ⊕	900				300				600							
		Side-Entry/ 3 Piece	⊙	S47	⊗	⊙ ⊙	⊕ ⊕ ⊕ ⊕	900				300				600							
		3 Piece	⊙	47	⊗	⊙ ⊙	⊕ ⊕ ⊕ ⊕	900								400				600			



# HYDROGEN IN INDUSTRIAL PROCESSES

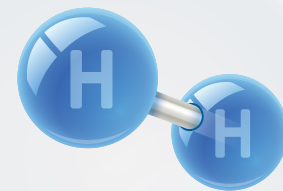
Hydrogen is used in diverse industries and processes. Hydrocracking in petroleum refining, many chemicals' productions and reactions, food ingredients manufacturing, and many more.

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](http://www.wikipedia.com)



HYDROGEN  
 $H_2$



INDUSTRIAL  
USE

# HYDROGEN IN INDUSTRIAL PROCESSES

- 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<sub>2</sub> gas embrittlement:** Non-critical - use St. St.
- Cleaning level:** Cleaned for high purity H<sub>2</sub> use

Total HermetiX™ | **Port**  Standard Port  Full Port  Tube Size  
 Ordering Code | **End Connections**  Threaded  Cone & Thread  Flanged  Welded

	Category	Ball Valve	Design Type	OC	Series	TH	Port	End Con.	Valve Size (Inches)											MWP (ANSI Class)						
									1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16	
Temp.: -60°C - +260°C (-76°F +500 °F)	High Pressure	Floating	3 Piece	<input checked="" type="checkbox"/>	See High Pressure	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	2500/1500																
	Industrial Use		3 Piece	<input checked="" type="checkbox"/>	See Industrial	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							900/600/300/150										
			2 Piece	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>							600/300/150												
			3 Piece	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	900/600/400/300/150																		
			2/1 Piece	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	300/150/PN40/PN16																		
			DS/DBB	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	600/300/150/PN16																		
			Multiport/ Diverter	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	600/300/150																		
			Control	<input checked="" type="checkbox"/>		See Control	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	900/400/300/150/PN40/PN16																





INDUSTRIAL  
USE

# ENERGY SOURCE

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.

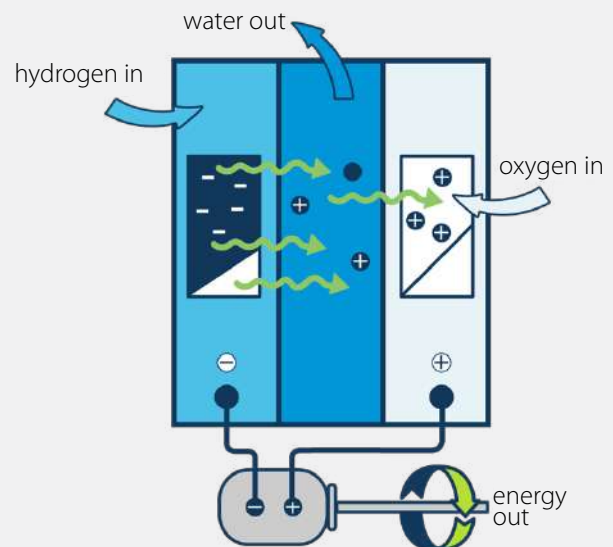


## Hydrogen Fuel Cell

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)





INDUSTRIAL  
USE

# ENERGY SOURCE

- Piping style:** Medium 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<sub>2</sub> stem seal
- Fire Safe:** API 607; ISO 10497
- HE - H<sub>2</sub> gas embrittlement:** Critical - use Hydrogen service valves
- Cleaning level:** Cleaned for high purity H<sub>2</sub> 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)								MWP (ANSI Class)							
								1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14
Trunnion	3 Piece	⊖	93	⊗	⊙	⊙	⊗ □	600								600							
	2 Piece	⊖	83	⊗			⊕ ⊗	600								600							
Floating	3 Piece	⊖	47	⊗	⊙	⊙	⊕ ⊗ □	900				400				600							
	3 Piece	⊖	26	⊗	⊙		⊗	600				600				600							
	DS/DBB	⊖	47DS	⊗	⊙		⊕ ⊗ □	600				600											
	Multiport/ 3 Piece	⊖	61		⊙	⊙	⊕ ⊗ □	600				300				600							
		⊖	62		⊙	⊙	⊕ ⊗ □	600				300				600							
	Diverter/ 3 Piece	⊖	D47	⊗	⊙	⊙	⊕ ⊗ □	600				300				600							
	Side-Entry/ 3 Piece	⊖	S47	⊗	⊙	⊙	⊕ ⊗ □	600				300				600							
	3 Piece	⊖	47	⊗	⊙	⊙	⊕ ⊗ □	900				400				600							

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



# DISPENSING - CGH<sub>2</sub>

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 <sub>2</sub>	700-750 bar (10,000-11,000 psi)	1,034 bar (15,000 psi)
Industrial machinery & trucks	CH <sub>2</sub>	500-550 bar (7,250-8,000 psi)	600-700 bar (8,700-10,000 psi)
Trucks	CH <sub>2</sub>	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



REFUELING/  
MOBILITY

# DISPENSING - CGH<sub>2</sub>

- 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<sub>2</sub> stem seal
- Fire Safe:** API 607; ISO 10497
- HE - H<sub>2</sub> gas embrittlement:** Critical
- Cleaning level:** Cleaned for high purity H<sub>2</sub> use
- Certification:** 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)							
									1/4	3/8	1/2	9/16	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14	16
									High Pressure	Trunnion	Threaded body	⊙	H99		⊙ ⊙	⊕ ⊕		1,034 bar (15,000 psi)								
	Floating	Threaded body	⊙	H25	⊗	⊙ ⊙	⊕ ⊕		550 bar (8,000 psi)																	

Relevant HABONIM Series: H99/H25



# PRODUCTION-STORAGE-FUELING-USE (CGH<sub>2</sub>)

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.

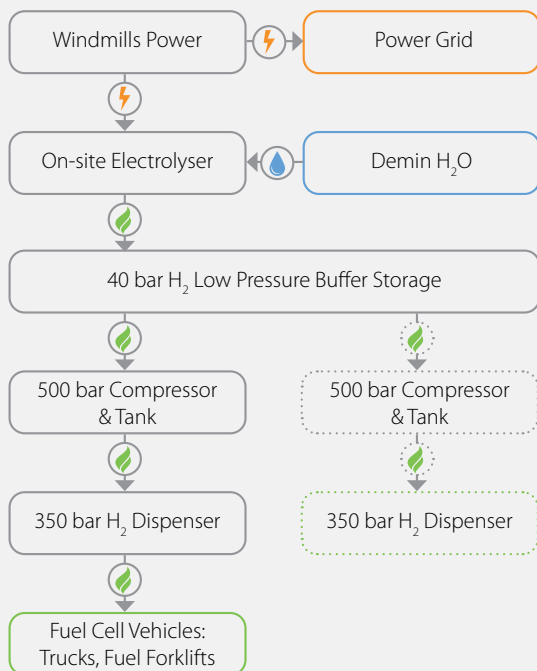


A system like this can be built to fuel a variety of vehicle types with few working pressures.

Such local systems can be integrated with the local power grid and local H<sub>2</sub> or Natural gas pipe systems allowing bi-directional electricity and hydrogen flow.



## 20 MW power to H<sub>2</sub> self-generation, self-consumption fueling and H<sub>2</sub> surplus selling



# PRODUCTION-STORAGE-FUELING-USE (CGH<sub>2</sub>)

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 <sub>2</sub> stem seal
Fire Safe:	API 607; ISO 10497
HE - H <sub>2</sub> gas embrittlement:	Critical
Cleaning level:	Cleaned for high purity H <sub>2</sub> 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)					
									1/4	3/8	1/2	9/16	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	6	8	10	12	14
High Pressure	Trunnion	Threaded body	<input checked="" type="checkbox"/>	H99		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1,034 bar (15,000 psi)											Hatched area				
			<input checked="" type="checkbox"/>	H29	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	1,034 bar (15,000 psi) with TPED / TPE - 700 bar (10,000 psi)																
	Floating	Threaded body	<input checked="" type="checkbox"/>	H25	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	550 bar (8,000 psi)																









VP0007634 CAT- Hydrogen Processes ver01\_170124

## 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



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