ENERGYN

EXTREME TECHNOLOGY

Core technology of Energyn

High Pressure Technology

Diffusion Bonding Technology

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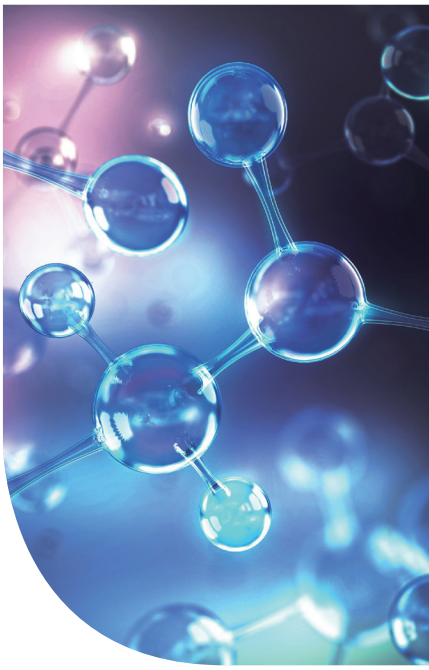
The Future of **H2,**

The Future of **Energy,**

The Future of **Energyn.**



Company History

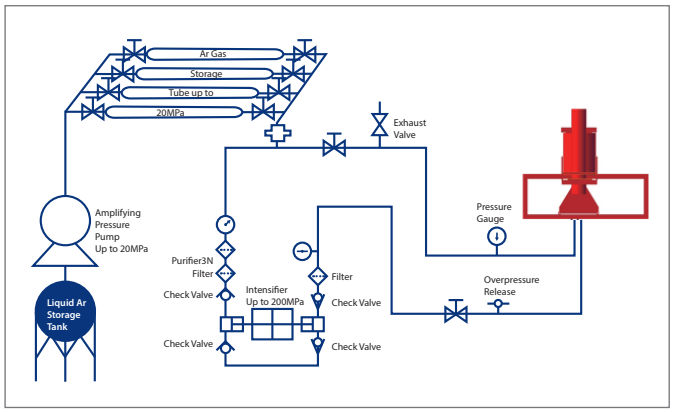
2020. 00 Jointly developed type 1 wire wound H2 storage pressure vessel with KGS, RIST, and KITECH
2019. 05 Planned ASME U and U3 code renewal for the next 3 years
2019. 11 Exported WIP system up to 250℃ with the rapid cooling option to the USA
2019. 05 HOT PRESS Delivery (EHP300-500HV)
2019. 03 Introduced the first Spark Plasma Sintering Furnace in domestic
2018. 12 Supplied WIP system up to 200MPa ID450
2018. 10 Completed development of PLASMA GUN Cathode / Anode
2018. 10 Received ASME / KGS joint certification 99MPa hydrogen station PCHE manufacture and shipment
2018. 08 Manufactured and supplied 600MPa cold isostatic / hydrostatic press
2018. 06 Produced and supplied Korea's first satellite-mounted aerospace SiC structure 1000 pi
2018. 04 Manufactured and delivered the world's largest 3600mm Length Hot Press
2017. 11 Installation of ID1600 Vacuum Heat Treatment Equipment
2017. 11 Exported High Vacuum Diffusion Bonding Equipment
2017. 06 Hydrogen Heat Treatment Furnace Installation
2017. 05 PCHE heat exchangers manufactured for sale, 1000Bar pressure
2017. 04 High Vacuum Brazing Equipment (Inner Diameter 800x1900H Vertical Type)
2017. 04 Delivered 3,000bar, Φ800 x 1,200 CIP
2017. 02 Moved to a new factory
2016. 06 ASME U&U3 Certified for High-Pressure Vessel
2016. 03 Delivered 1m X 1m Diffusion Bonding Vacuum Hot Press
2015. 12 Delivered medium-sized HIP
2015. 08 Exported Dry-type CIP delivered to overseas
2015. 06 Developed and delivered a rectangular H2 furnace
2015. 03 Developed 'Chamber Integrated Vacuum Hot Press' (patent)
2014. 07 Installed 3,000℃ diffusion bonding hot press and started bonding service
2014. 07 Developed HPP (High-Pressure Processing for Food)
2013. 12 High Throughput Warm Isostatic Press (WIP) developed
2013. 11 Developed Vacuum Chamber/Press Frame Integrated Hot Press (patent)
2013. 07 Developed Induction heated SiC CVI (Chemical Vapor Infiltration) equipment
2013. 06 Delivered HIP for Carbon Composite for defense application
2012. 12 Delivered 25,000 tons Hybrid CIP (patent)
2012. 03 Received ISO9001, ISO14001 Certification
2012. 01 Installed Big scale servo-controlled wire-winding machine
2011. 08 Delivered High Temp. Gas Pressure Sintering (GPS, 2000C, 10MPa) Furnace
2011. 06 Delivered Laboratory Hot Isostatic Press (HIP) to KITECH National Institute
2011. 04 New FRP technology (patented), PV Panel cooling technology(patented)
2011. 02 Established ENERGYN

High Pressure Technology

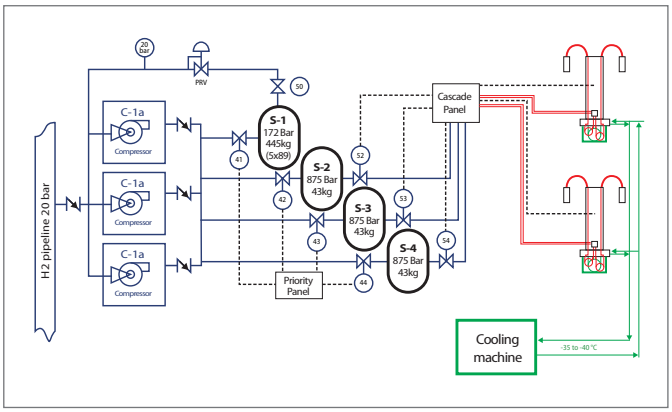
High Pressure Technology of Energyn

Energyn is one of most leading manufacturers of high-pressure vessel designed, constructed, and qualified up to 700MPa by its own wire-wound technology through ASME. And this technology has a similar construction structure as H2 filling station with an even much lower operating pressure range of 120MPa. All the designs of compressions, storages, and valves for H2 industries that Energyn proposed are started from these experiences and fundamentals

Design and construction high pressure vessel and frames



Schematic drawing of Energyn HIP



Schematic drawing of H2 filling station

Energyn Hot Isostaic Press

- Working pressure : 200MPa
- Max. Pressure : 200MPa
- Pressure media : Inert gases

Energyn HIP system

HIP Applications

- Casting Densification
- Powder Metallurgy & MIM
- Additive Manufacturing & 3D Printing
- Cladding & Diffusion Bonding
- Intermetallics
- Composites & Ceramics

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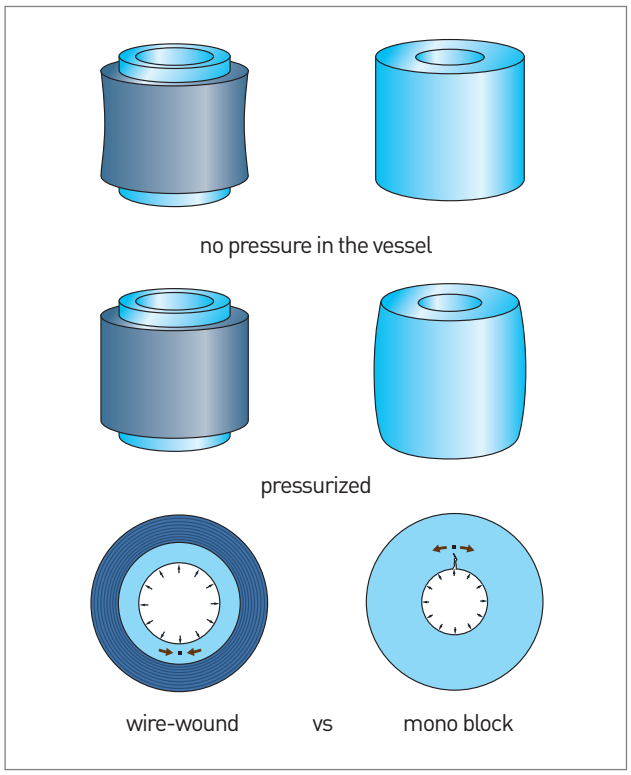
Core Technology of Energyn

Wire-Wound Technology

The wire wound technology is only one technology ASME permits for high-pressure vessel manufacturing technology over 68.9MPa. Energyn has wire-wound technology and applying it for high-pressure vessel manufacturing processes in real. The LBB (Leak before burst) warrants a safe operating environment and the longest durability for the pressure vessel

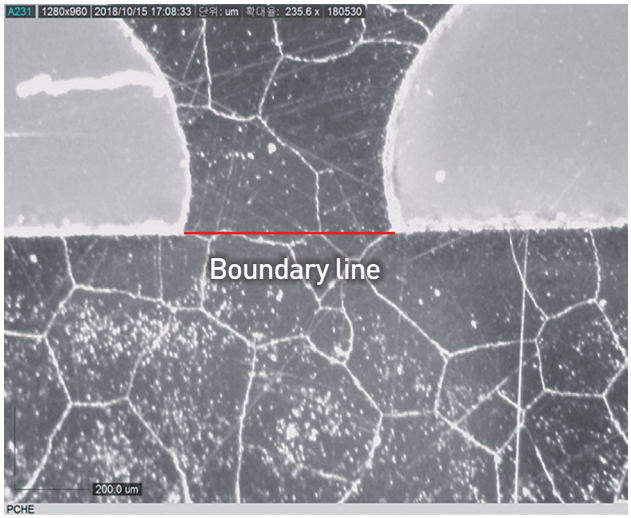


Wire wound vessel vs Mono block vessel

Wire Wound technology

- Extremely high static and fatigue strength under cyclic pressure load
- No stress-concentration points (see threaded type for comparison)
- Crack propagation eliminated
- Light Weight & Compact Structure

Diffusion Bonding Technology



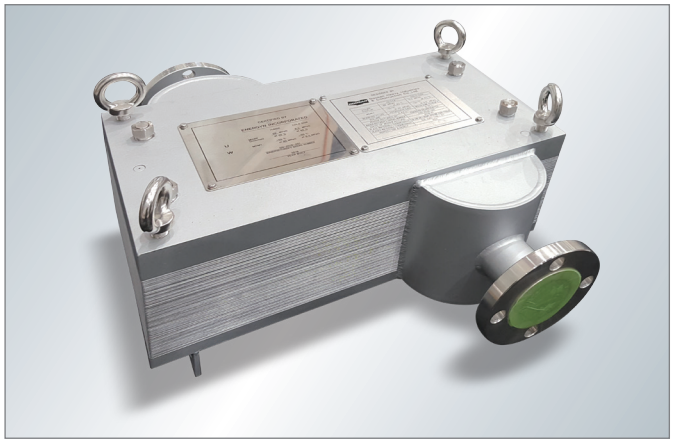
Microscope picture of diffusion bonded plates

Diffusion Bonding Technology

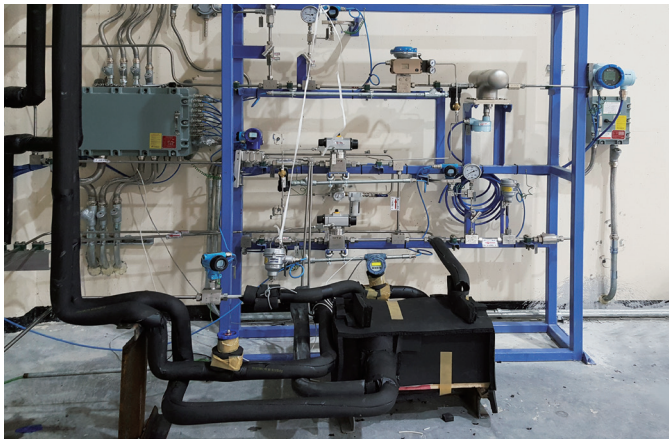
- Bonding or Welding between similar or dissimilar solid materials
- Transient Liquid Phase (TLP) diffusion bonding without inserting an interlayer
- Targeting to achieve its material properties
- Closing interfacial voids with grain diffuse
- Bonding between surface-to-surface not linear area
- Optimized solution for high pressure and wide operating temperature application unit

Printed Circuit Heat Exchanger for Pre-cooler of H2 station

By incorporating diffusion bonding with micro-channel technology, Energyn can manufacture a unit that is up to 85% smaller and lighter than traditional technologies such as shell and tube heat exchangers. This reduction in unit size can lead to significant savings in structural costs due to the elimination of excess pipework, frames, and associated equipment.



H2 station Pre-cooler PCHE joint qualified by ASME and KGS



PCHE verification test in real operation environment of H2 filling station

SPECIFICATION OF PRE_COOLER HEAT EXCHANGER

Specification									
Fluid		Unit	Stream 1			Stream 2			
			BRINE			H2			
Flow Rate	Total	kg/hr	4,887			H2			
	Vap. In/Out	kg/hr	0	/	0	76	/	76	
	Liq. In/Out	kg/hr	4,887	/	4,887	0	/	0	
Density	Vap. In/Out	kg/hr	-	/	-	38.350	/	47.014	
	Liq. In/Out	kg/hr	943.250	/	928.470	-	/	-	
Viscosity	Vap. In/Out	cP	-	/	-	0.011	/	0.011	
	Liq. In/Out	cP	7.932	/	5.244	-	/	-	
Thermal Conductivity	Vap. In/Out	W/m-C	-	/	-	0.268	/	0.257	
	Liq. In/Out	W/m-C	0.125	/	0.123	-	/	-	
Specific Heat	Vap. In/Out	kj/kg-C	-	/	-	15.507	/	16.670	
	Liq. In/Out	kj/kg-C	1.609	/	1.630	-	/	-	
Operating Temperature		℃	-45	/	-35.6	35.0	/	-40.0	
Inlet pressure		barg	3.5	875					
Allowable DP / Cal. DP		bar	1.00	/	0.32	1.00	/	0.21	
Heat Load		kW	32						
Fouling Resistance		m2K/W	N/A	N/A					
Thermal Design Result									
LMTD / MTD		℃	21.9	11.4					
Required UA / Actual UA		W/C	1.46	2.98					
Geometry Information									
Design Pressure		barg	FV	/	10	FV	/	1,000	
Design Temperature		℃	-70/70			-70/70			
No. of Layer		-	72			36			
Plate I.D		-	P15			P15			
Heat Transfer Areas		m^2	10.37			4.59			
ID		-	N1	/	N2	N3	/	N4	
Rating		ASME	-	/	-	-	/	-	
Dia.		inch	1-1/2"	/	1-1/2"	1-1/8"	/	1-1/8"	
Type & Face		-	THREAD	/	THREAD	THREAD	/	THREAD	
Header Type		-	N/A	/	N/A	N/A	/	N/A	
Recommended Stainer Size		40 Mesh	Con	80 Mesh	/	Basket			

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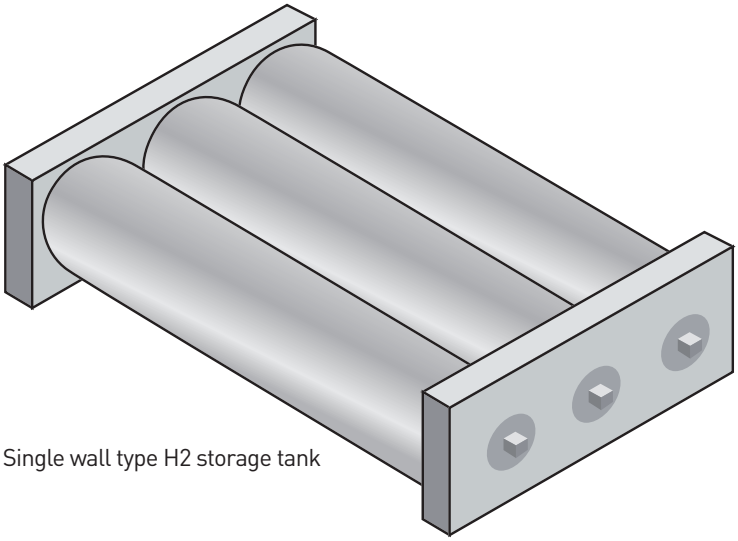
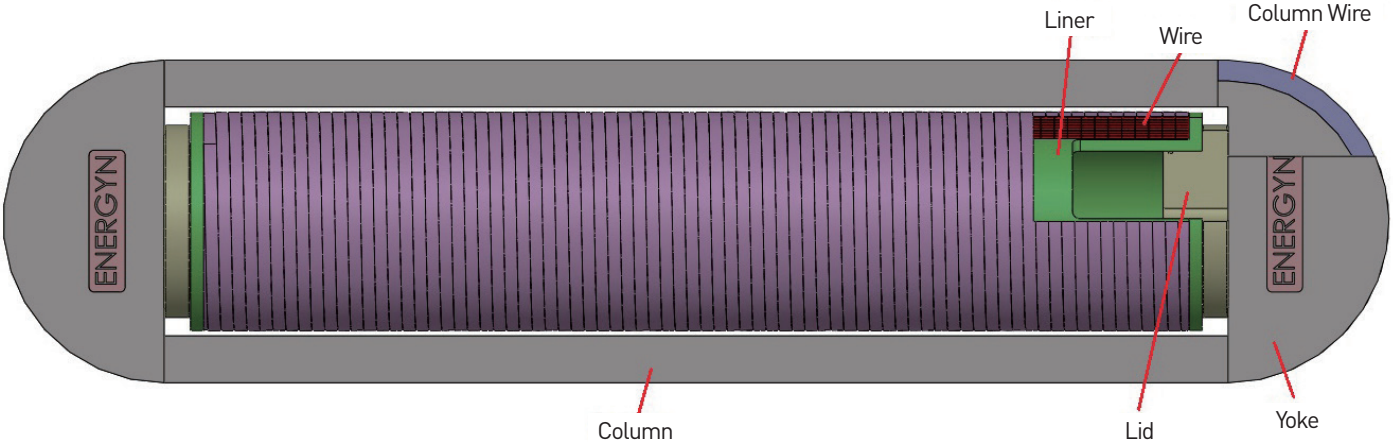
Type 1 Wire-Wound H2 storage tank

One of the most difficult issues when decide the installation site of H2 filling station is opposition against explosion risks by neighborhood downtown. This is resulted in why almost H2 filling stations in the world were still being constructing in a far distance from the convenient living area. Type 1 wire wound H2 storage tank eliminates this anxiety through never exploded since it had been used as only one technology for high-pressure vessel application fields



Single wall type H2 storage tank



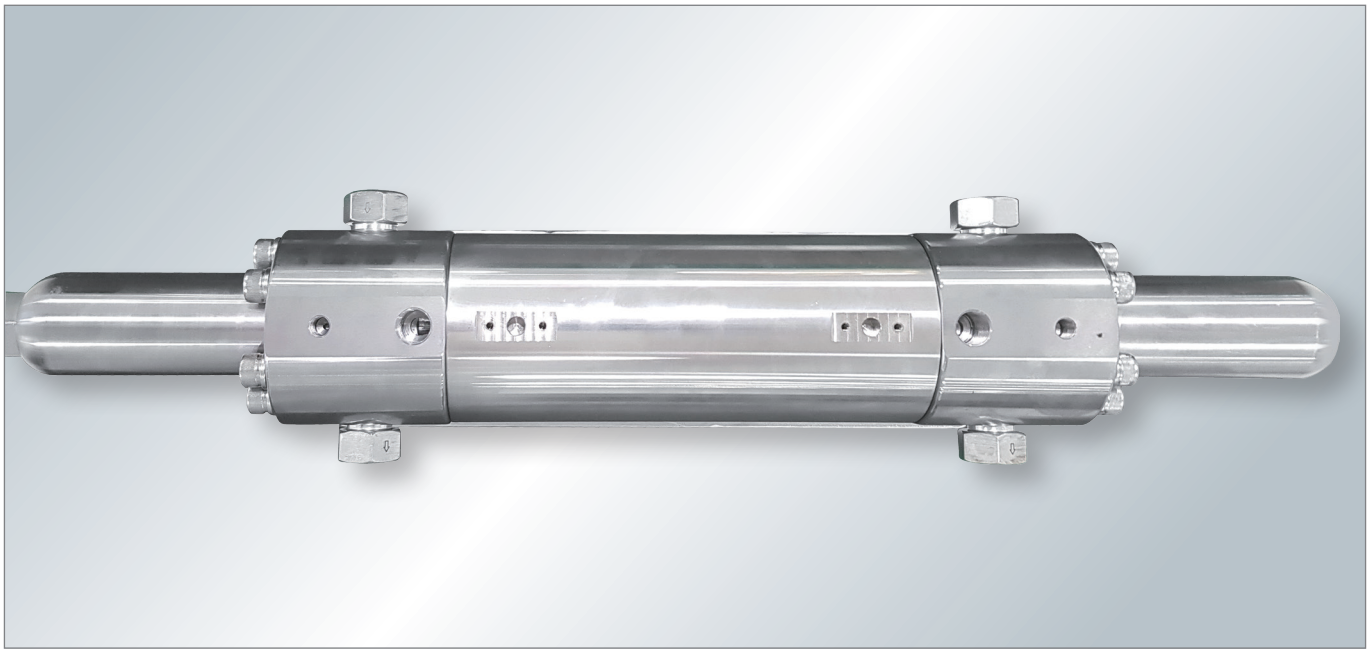
Type 1 Wire-Wound H2 storage tank and frame.

Specification of Type 1 Wire Wound H2 storage high pressure vessel

Description	Unit	Specification	Qualification
Design pressure	MPa	125	KGS AC111/ ASME Sec.VIII Div.3
Working Pressure	MPa	100	
Volume	m3	1	
Pressure test	cycles	100K	-
Wire-wound Certification	100Mpa & m3	1	ASME Sec.VIII Div.3
Wire Yield Strength	MPa	1,450	ASTM A931
Wire fatigue limit	MPa	705	ASTM E466

Burst tester for Hydrogen components:

Hot isostatic press withstanding 200MPa is completed by high pressure safety valves, check valves and compression pumps. Energyn has enough experience to design and manufacture all of related products for last 20 years. All the materials are selected, designed and manufactured considering H2 brittleness characteristics and qualified under ASME SEC Ⅷ DIV.3.



1000MPa Pressure booster pump

Check valves up to 1000MPa

Check valves up to 1000MPa

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