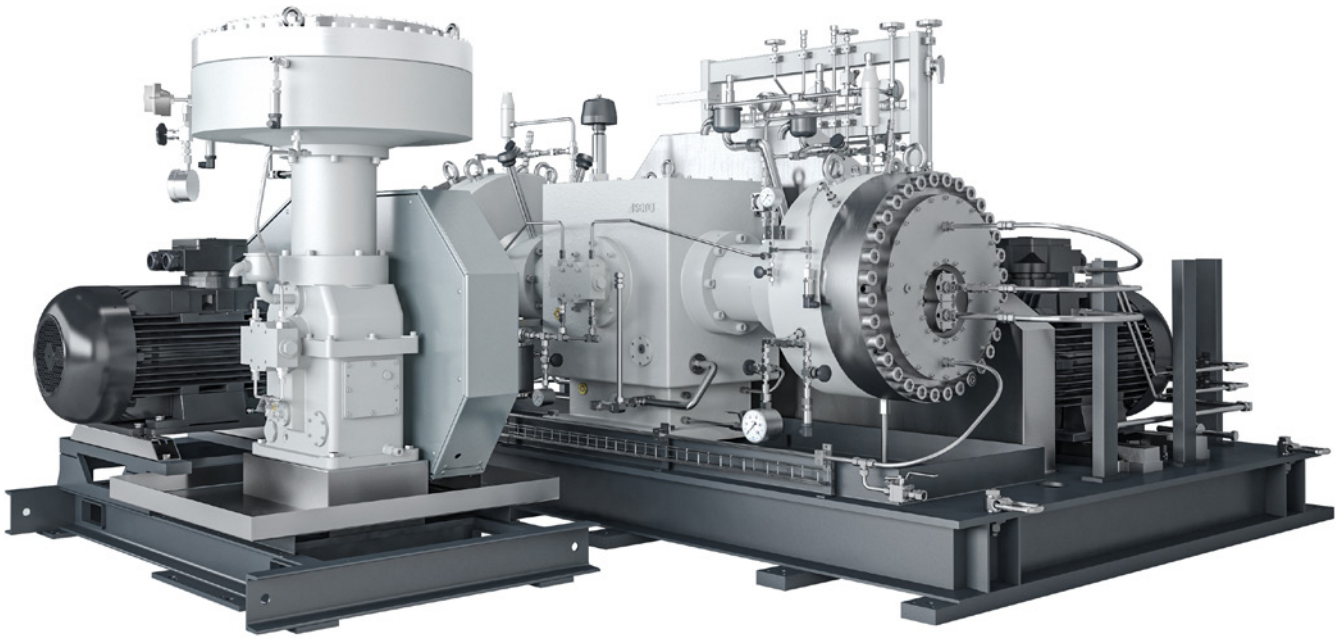
PRODUCT INFORMATION

METAL DIAPHRAGM COMPRESSORS PU series
COMPACT COMPRESSOR SOLUTION CCS

SYSTEM SOLUTIONS FOR THE ENERGY TRANSITION

METAL DIAPHRAGM COMPRESSORS (PU series)

The **sera** metal diaphragm compressors is particularly characterized by its contamination-free and hermetically sealed design. Therefore, hydrogen can be compressed with the **sera** Metal diaphragm compressor (PU series) without concern for people and the environment. In addition to the application for hydrogen, this compression technology is used for almost all technical gases if the downstream processes require a high level of purity.
In addition to individual units, **sera** offers innovative system solutions such as the Compact Compressor Solution (CCS) to make hydrogen usable as a subsystem of power-to-X systems for various areas of application. For example, the hydrogen can be compressed directly from electrolysis. With the **sera** Compact Compressor Solution (CCS), the highly compressed hydrogen is ready for filling into cylinder bundles, trailers and many other applications such as feeding into hydrogen pipelines or natural gas networks. With the **sera** Compact Compressor Solution, hydrogen can be used as energy storage and fluctuations in power generation from wind and solar energy can be balanced out.



ADVANTAGES AT A GLANCE

- Hermetically sealed
- Compression of toxic, flammable, expensive and explosive gases
- Lubricant-free, oil-free compression
- Starting up against the maximum pressure
- No contamination from piston ring and stuffing box packings
- High service intervals and high lifetime
- Easy maintenance
- High corrosion resistance
- Outlet pressure up to 900 bar(a)

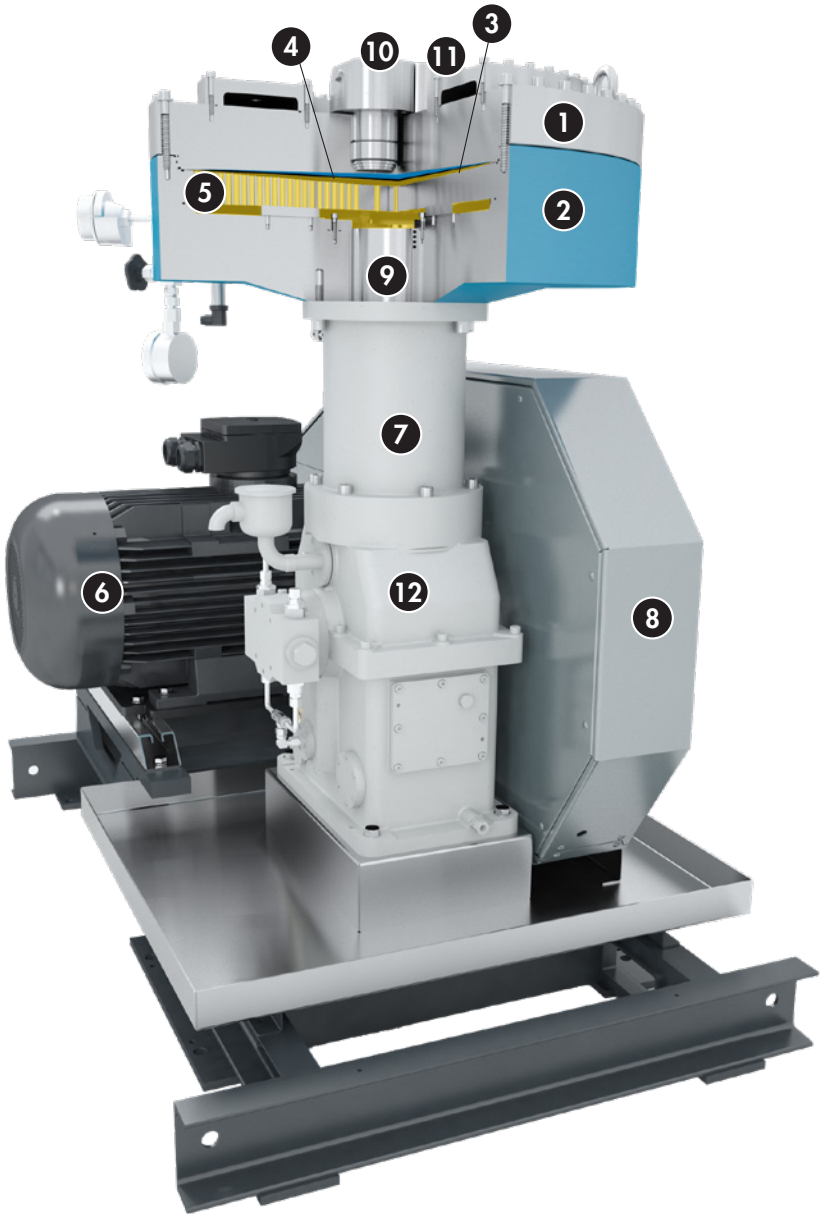
APPLICATIONS

CONSTRUCTION OF METAL DIAPHRAGM COMPRESSOR, PU series

A metallic sandwich diaphragm clamped with static seals is located between the valve head and the upper part of the piston housing. It
separates the gas chamber from the hydraulic drive. This completely prevents contamination of the medium by lubricants and particles. Thanks to this design, **sera** metal diaphragm compressors are hermetically sealed so that toxic and explosive gases can be compressed without any problems.
The oscillating movement of the clamped diaphragm causes the gas chamber to expand and contract cyclically. The gas sucked in via the inlet valve during the downward movement of the diaphragm is compressed during the upward movement and expelled through the pressure valve. The oscillation of the diaphragm is triggered by an oil reservoir, which is pressurized by a piston driven by a crank mechanism. **sera** metal diaphragm compressors comply with the requirements of the Machinery Directive, the ATEX Directive and the Pressure Equipment Directive of the European Union as standard.

In a 2-stage system, the design and mode of operation are identical, but both compressor stages communicate with each other. Stage 1 pre-compresses the gas accordingly and transfers the higher pressure to stage 2.

1. Valve head
2. Piston housing, upper part
3. Multilayer membrane
4. Gas room
5. Perforated plate
6. Electric motor
7. Piston housing, lower part
8. Belt guard
9. Piston
10. Pressure valve
11. Suction valve
12. Drive



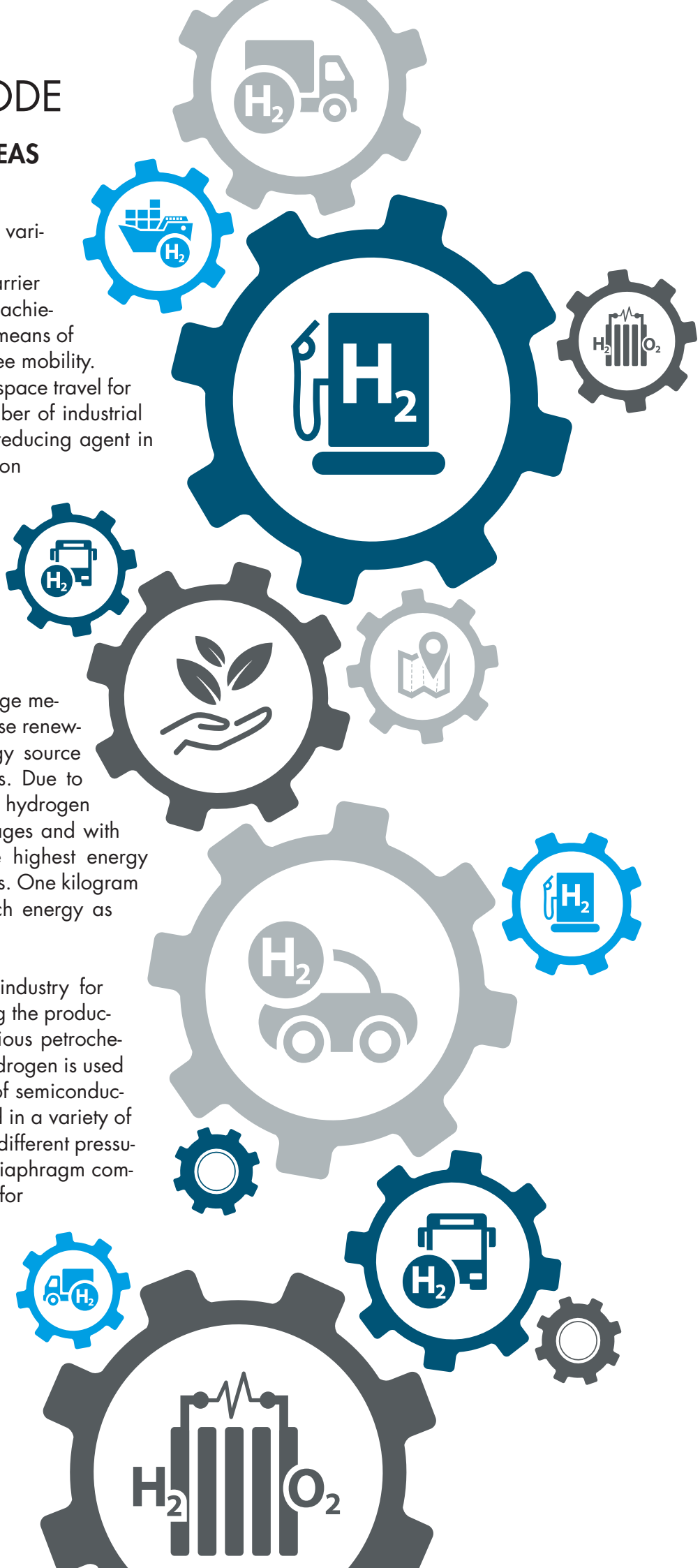
FUNCTIONAL MODE

GENERAL OVERVIEW OF AREAS OF APPLICATION FOR H2

Hydrogen is used in gaseous form in various applications and fields of use.
Hydrogen is a promising energy carrier that can be used to can contribute to achieving climate targets. In vehicles and means of transportation, it enables emission-free mobility.
Hydrogen has already been used in space travel for several decades and in a large number of industrial applications it has been used as a reducing agent in metallurgical processes or in producion in the steel industry already have a long history.

For energy generation hydrogen is used in gas turbines or in gas turbine-fuel cell hybrid plants to generate electricity.
When using solar and wind energy, hydrogen is used as an energy storage medium to store surplus energy from these renewable sources and later as an energy source and to balance out grid fluctuations. Due to its physical and chemical properties, hydrogen has a number of significant advantages and with 33.33 kWh/kg, hydrogen has the highest energy density (in relation to mass) of all fuels. One kilogram of hydrogen contains about as much energy as three liters of petrol.

Hydrogen is used in the chemical industry for various synthesis processes, including the production of ammonia, methanol and various petrochemicals. In the electronics industry, hydrogen is used as a process gas in the production of semiconductors elements. Hydrogen can be used in a variety of ways and often has to be brought to different pressure levels for its use. The **sera** metal diaphragm compressors of the PU series are suitable for this purpose are mainly used in the following application examples.

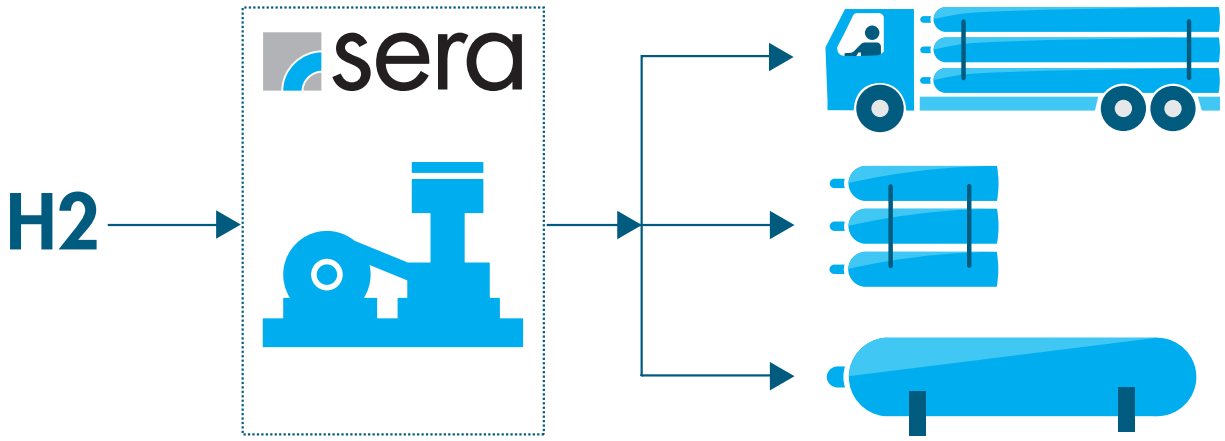


APPLICATIONS

HYDROGEN AS ENERGY STORAGE/ HYDROGEN COMPRESSION AFTER ELECTROLYSIS

Applications for electrolysers can be found where the production of hydrogen makes logistical and energetic sense. For example, in large photovoltaic systems or wind farms. There, the regeneratively generated electricity can be used on site for water electrolysis. The hydrogen produced is usually stored under high pressure so that it can be transported to the consumer. End consumers can be, for example,the mobility sector or steel production in order to reduce CO2 emissions.

Depending on the application, different types of electrolyzers can be used for hydrogen production. The most common applications in conjunction with the **sera** metal membrane compressor are alkaline electrolysis (AEL) with 5-10 bar(a) inlet pressure, PEM electrolysis with inlet pressures between 20-40 bar(a) and AEM electrolysis in the range between 25-35 bar(a). Higher inlet pressures are not a problem for **sera** compressors, but are still very rare due to the current state of development.



For the compression after electrolysis, **sera** compressors of the PU series can be used for different inlet pressures. Here is a selection of possible machines:

Application	Product identification	Inlet pressure bar(a)	Outlet pressure bar(a)	Volume flow Nm^3/h
AEL	AEL-07-050-050	7	50	50
AEL	AEL-07-150-030	7	150	30
AEL	AEL-07-300-015	7	300	15
AEL	AEL-07-500-015	7	500	15
AEL	AEL-07-300-030	7	300	30
AEL	AEL-07-500-030	7	500	30
PEM/AEM	AEM-30-200-010	30	200	10
PEM/AEM	AEM-30-300-025	30	300	25
PEM/AEM	AEM-30-300-050	30	300	50
PEM/AEM	AEM-30-300-100	30	300	100
PEM/AEM	AEM-30-500-050	30	500	50
PEM/AEM	AEM-30-500-100	30	500	100
PEM/AEM	AEM-30-900-003	30	900	3
High pressure-ELY	HEL-70-500-015	50-70	500	15

APPLICATIONS

H2-TRAILER FILLING AND H2-BUNDLE FILLING

To supply customers with hydrogen, it must be filled into trailers and bundles. Here, hydrogen is raised from an inlet pressure level to a final pressure level of 200/300 or 500 bar. **sera** compressor systems can be designed for different pressure levels in order to meet as many different market requirements as possible.

Application	Product identification	Inlet pressure bar(a)	Outlet pressure bar(a)	Volume flow Nm^3/h
Trailer filling	TBF-30-200-010	30	200	10
Trailer filling	TBF-30-300-025	30	300	25
Trailer filling	TBF-30-300-050	30	300	50
Trailer filling	TBF-30-300-100	30	300	100
Trailer filling	TBF-30-500-050	30	500	50
Trailer filling	TBF-30-500-100	30	500	100

H2 TRAILER AND H2 BUNDLE EMPTYING

Many compressors have a limited inlet pressure and therefore cannot completely empty the bundles or trailers filled with hydrogen. As a result, large quantities of hydrogen remain in the bundle or trailer. To completely empty bundles and trailers down to an inlet pressure level of 1-2 bar, **sera** compressors can be used optimally. These compress from one bundle into another and thus increase the pressure level in the second bundle accordingly. This means that no hydrogen is lost or unnecessarily transported back and forth between the gas supply system and the end user. The compressors must be designed according to the application and use of the hydrogen.

APPLICATIONS

H2 COMPRESSION FROM STEAM REFORMER PLANTS (REFORMING GAS AND SYNTHESIS GAS)

Steam reforming is a chemical process in which carbon monoxide reacts with water vapor. This type of hydrogen production has been tried and tested for a long time, so that special steam reforming plants with a capacity of up to 100,000 cubic meters per hour are available today. The oxygen contained in the water causes the fuel to oxidize to hydrogen. The main carbon-containing fuels or energy sources used are natural gas, but methanol, light petrol, biogas or biomass are also used. The water vapor required for the reaction can be supplied from outside or come from the respective source material itself.

The chemical reaction of steam reforming is endothermic, i.e. it consumes heat. It is often supported by a catalyst and the required heat is generated by burning the fuel. For example, concentrated solar thermal energy or waste heat from combustion engines can be used to supply heat from outside. Steam reforming produces a gas mixture whose energy content significantly exceeds that of the fuel used.

Application	Product identification	Inlet pressure bar(a)	Outlet pressure bar(a)	Volume flow Nm^3/h
Steam reforming	DAM-07-050-050	7	50	50
Steam reforming	DAM-07-150-030	7	150	30
Steam reforming	DAM-07-300-015	7	300	15
Steam reforming	DAM-07-500-015	7	500	15
Steam reforming	DAM-07-300-030	7	300	30
Steam reforming	DAM-07-500-030	7	500	30
Steam reforming	DAM-30-200-010	30	200	10
Steam reforming	DAM-30-300-025	30	300	25
Steam reforming	DAM-30-300-050	30	300	50
Steam reforming	DAM-30-300-100	30	300	100
Steam reforming	DAM-30-500-050	30	500	50
Steam reforming	DAM-30-500-100	30	500	100

CIRCULAR GAS COMPRESSORS

Particularly in circulation processes where the gas is circulated several times, **sera** compressors reliably prevent the accumulation of impurities.
As the metal diaphragm compressors can also be operated at high inlet pressures due to their design, cyclic processes with system pressures of up to approx. 100 bar can be realized without any problems.

Application	Product identification	Inlet pressure bar(a)	Outlet pressure bar(a)	Volume flow Nm^3/h
Natural gas desulphurization	PU011	13,8	23,0	5,0
Methanol synthesis	PU045	4,5	6,0	30,0
Sugar production	PU011	15,0	25,0	15,0

APPLICATIONS

CAR REFUELING UP TO 900 BAR FROM 200/300 BAR STORAGE BUNDLES

The **sera** metal diaphragm compressors can be specially designed for the refueling of passenger cars with 700 bar tank pressure from 200/300 bar storage tank bundles, if these are already available for the refueling of trucks or buses.
The advantage is a decoupled compressing into 900 bar storage tanks, required for the refueling of passenger cars independent of the further operation of the filling station for trucks or buses.
Another advantage is the favourable OPEX costs of the single-stage metal diaphragm compressors. In favourable cases, wear parts only need to be replaced every 6,000 car refuelling cycles.

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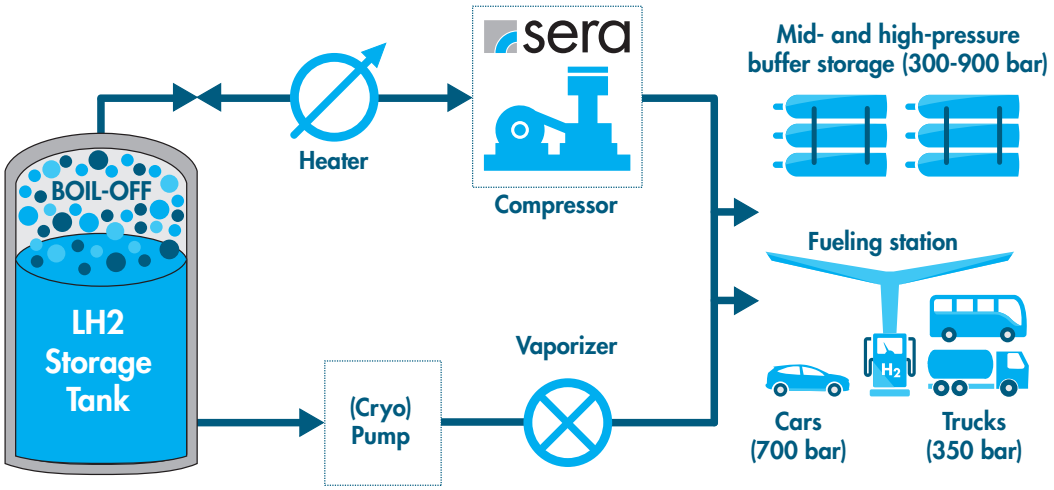
Application	Product identification	Inlet pressure bar(a)	Outlet pressure bar(a)	Volume flow Nm^3/h
Passenger car fill	45000381-200900	200	900	50
Passenger car fill	45000381-200700	200	700	85
Passenger car fill	45000381-200500	200	500	100
Passenger car filll	45000381-150900	150	900	40
Passenger car fill	45000381-150700	150	700	50
Passenger car fill	45000381-150500	150	500	55
Passenger car fill	45000381-100900	100	900	20
Passenger car fill	45000381-100700	100	700	30
Passenger car fill	45000381-100500	100	500	35
Passenger car fill	45000381-030900	30	900	30

APPLICATIONS

BOIL-OFF COMPRESSORS

The boil-off effect occurs when liquid hydrogen vaporizes at higher ambient temperatures. This occurs due to the temperature difference and must be controlled in order to regulate the container pressure and avoid safety risks. The gaseous hydrogen can be compressed with a **sera** compressor and fed into the downstream hydrogen system or compressed in storage tanks for further use.



Application	Product identification	Inlet pressure bar(a)	Outlet pressure bar(a)	Volume flow Nm³/h
Boil-off	BOO-07-050-050	7	50	50
Boil-off	BOO-07-150-030	7	150	30
Boil-off	BOO-07-300-015	7	300	15
Boil-off	BOO-07-500-015	7	500	15
Boil-off	BOO-07-300-030	7	300	30
Boil-off	BOO-07-500-030	7	500	30

FISCHER-TROPSCH SYNTHESIS

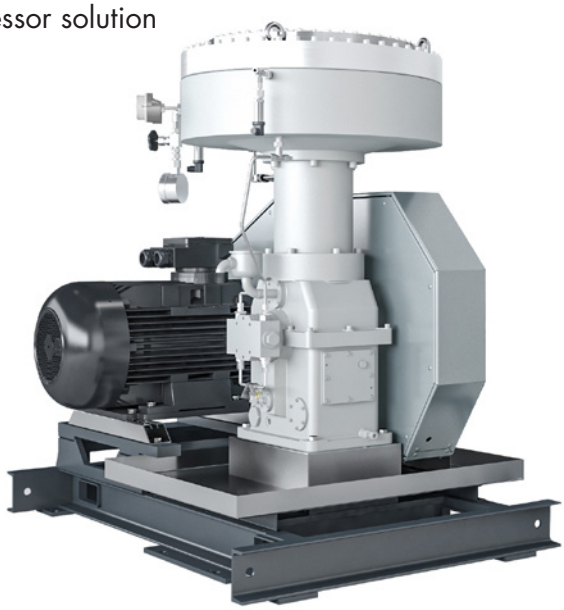
The Fischer-Tropsch synthesis (also Fischer-Tropsch process, FT synthesis for short) is a large-scale heterogenic-catalytic polymerization process for the production of hydrocarbons. In this process, carbon monoxide adsorbed on catalyst surfaces containing carbon or iron is hydrogenated with hydrogen. The reactions take place at temperatures of approx. 150 to 350°C and pressures of 1 to approx. 25 bar. The process includes the production of synthesis gas, its conversion into Fischer-Tropsch products and their further processing. Coal, natural gas, biomass or organic waste are available as raw material sources for synthesis gas production. Due to the large number of possible feedstocks, Fischer-Tropsch synthesis plays a central role in the search for alternatives to natural oil for the production of liquid hydrocarbons.

Application	Product identification	Inlet pressure bar(a)	Outlet pressure bar(a)	Volume flow Nm³/h
FT-Synthesis	PU002	10	15	0,5
FT-Synthesis	PU002	30	35	1,0
FT-Synthesis	PU002	65	70	1,9
FT-Synthesis	PU002	100	105	2,7

METAL DIAPHRAGM COMPRESSORS

sera offers various solutions for compressing hydrogen for different applications.

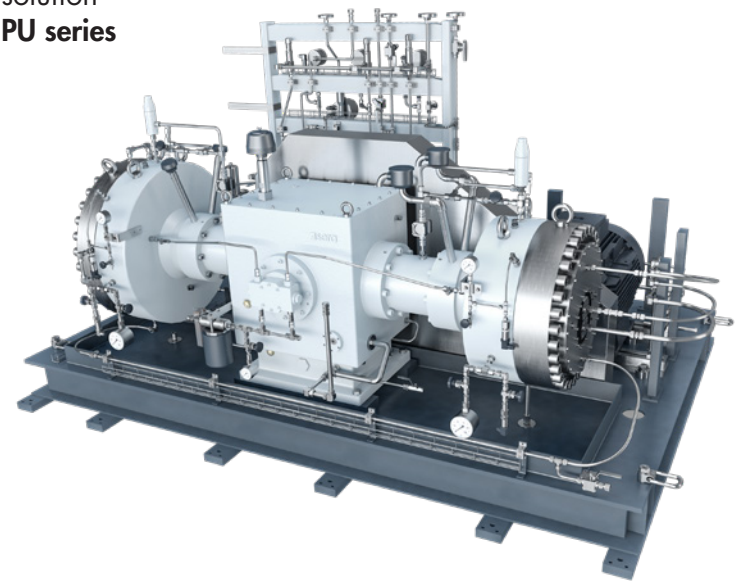
Single-stage compressor solution
PU series



SCOPE OF DELIVERY

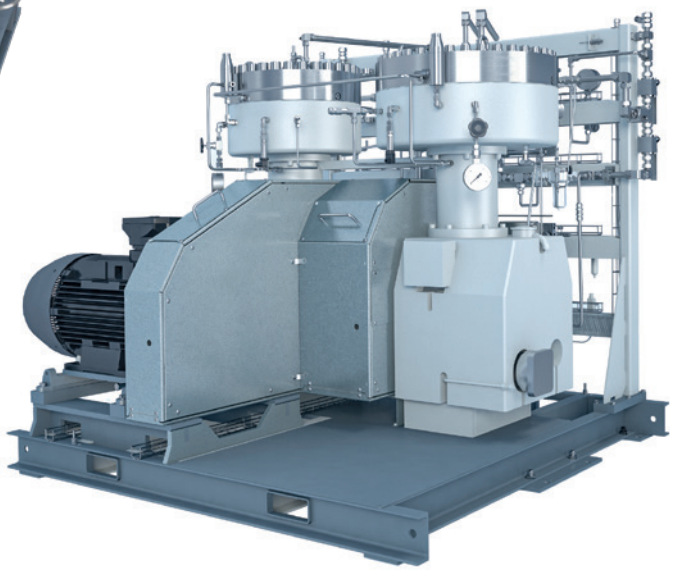
Metal diaphragm compressor PU02 to PU075
1-stage, vertical, water-cooled
Leakage rate: 10^{-3} mbar l/s
ATEX marking: II 3G Ex h IIC T4

Two-stage compressor solution
PU series



SCOPE OF DELIVERY

Metal diaphragm compressor PU02 to PU075
2-stage, vertical or horizontal, water-cooled
Leakage rate: 10^{-3} mbar l/s
ATEX marking: II 3G Ex h IIC T4



METAL DIAPHRAGM COMPRESSORS (OPTIONS)

Winter package for outdoor installation

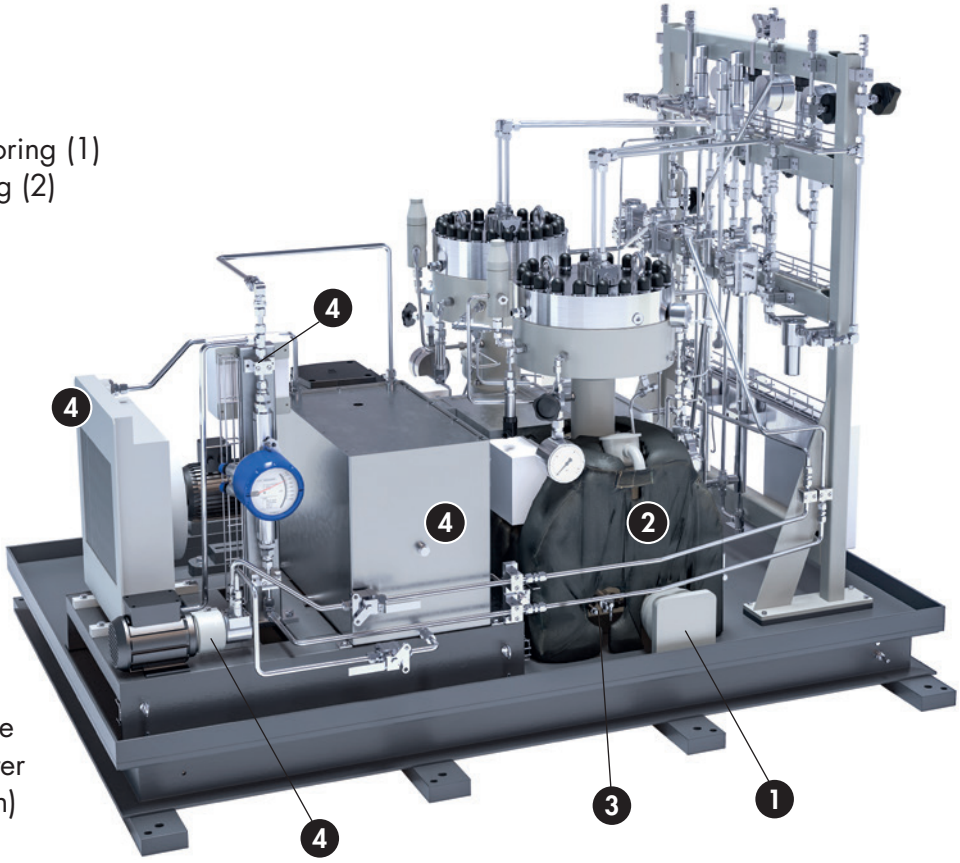
- Liquiphant for oil level monitoring (1)
- Insulation of the drive housing (2)
- Hydraulic oil heater (3)

Cooling unit for valve head and optional oil cooling

- Closed
  Cooling circuit (4)

Delivery rate control

- Regulation of the delivery rate by means of frequency inverter or by-pass (without illustration)



Sound insulation

Sound insulation cover for the compressor with all corresponding fittings, sensors, fans, etc. (5)

COMPACT COMPRESSOR SOLUTION (CCS)

APPLICATION AREAS

- Buffer storage in stationary medium-pressure, high-pressure and cavern storage tanks
- Trailer filling up to 500 bar (a)
- Feed into the natural gas grid
- Feeding into hydrogen pipelines
- Bottle bundle filling up to 500 bar (a)
- Transfer to smaller units

ADVANTAGES AT A GLANCE

- Energy efficient
- Reliable
- Lubricant-free, oil-free compression of hydrogen
- Modular design
- Compact
- Flexibly expandable

SCOPE OF DELIVERY

- Complete compressor technology integrated in one system container (subdivided into Ex zone II (compressor room) and Non-Ex zone (switch cabinet room))
- Equipped with all necessary mechanical and electrical safety devices
- Gas flow control technology with all control fittings
- Lighting and ventilation of the system container
- Ambient temperatures from -20°C to +40°C
- CE conformity

COMPACT COMPRESSOR SOLUTION (CCS), CONSTRUCTION

With Compact Compressor Solution from **sera**, innovative system solutions can be implemented to convert renewable electricity into hydrogen and then use it in various applications. The direct use of green hydrogen in mobility is just as possible as buffering in storage facilities and feeding it directly into the natural gas grid or hydrogen pipelines. Compact Compressor Solution plants as electricity storage systems can help to balance out the increasing fluctuations in electricity generation from wind and solar energy or prevent electricity from being fed directly into the grid at times of particularly high generation.

COMPACT COMPRESSOR SOLUTION (CCS), POWER RANGES

BUILDING SIZES *)		PTG 50	PTG 100	PTG 150	PTG 200
Delivery rate	Nm^3/h	50	100	150	200
Delivery rate	kg/h	4,5	9	13,5	18
Electrolysis output	kW	250	500	750	1000
Inlet pressure 1)	bar(a)	30	30	30	30
Outlet pressure 2)	bar(a)	500	500	500	500

*) Deviating delivery rates must be requested individually with the specific application.
1) Special solutions up to 1 bar(a) inlet pressure must be requested individually in the specific application.
2) Other outlet pressures possible; standard versions with outlet pressures of 300 bar(a) and 500 bar(a) available.

AUSFÜHRUNGEN

PTG Container, 10 ft.

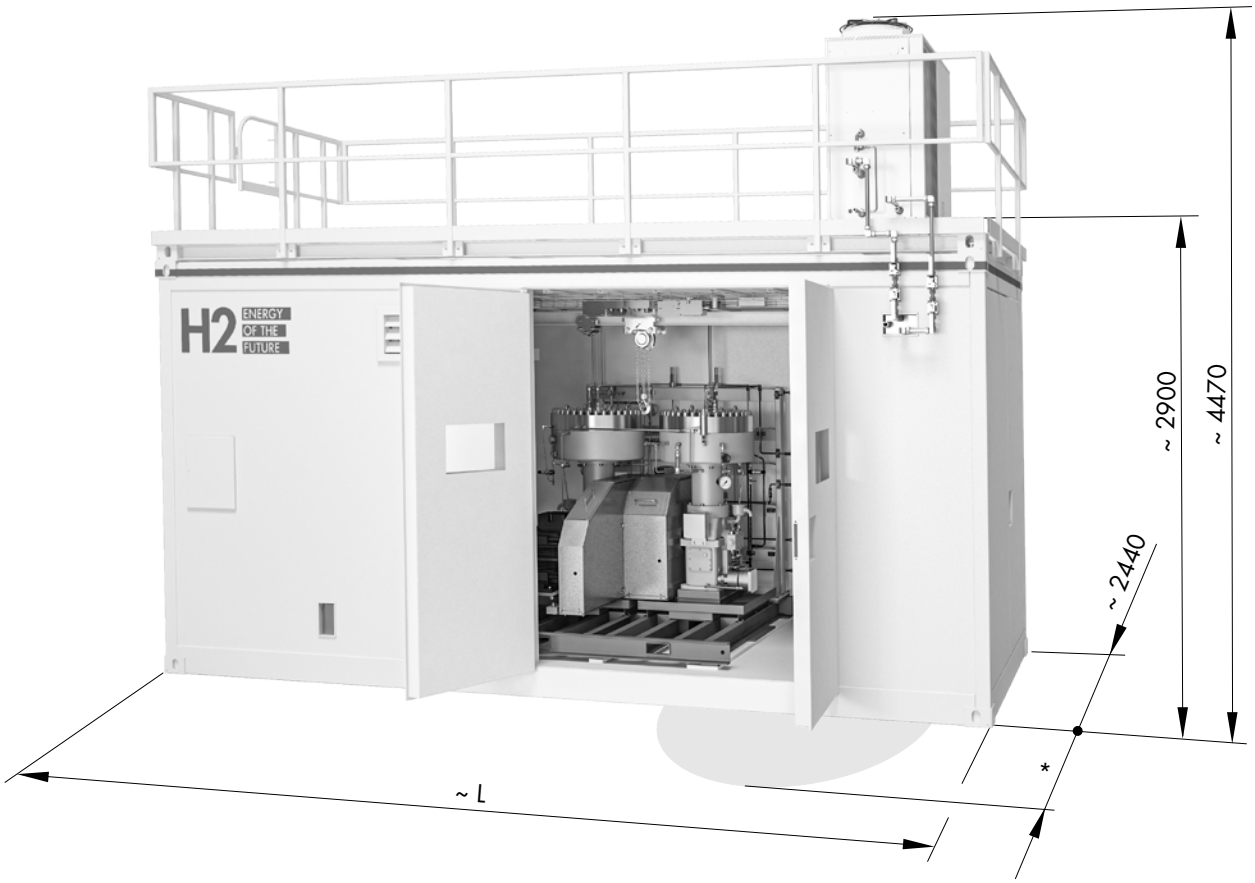
PTG Container, 15 ft.

PTG Container, 20 ft.

OPTIONS

- Flow rate control by frequency inverter or bypass
- Filling device for trailer refueling
- Larger flow rates and special dimensions
- Container housing in various sizes (3- and 4-door)
- Individual enclosure
- Indoor installation
- Remote connection
- Closed cooling water circuit
- Switch and load cabinet with fail-safe PLC for controlling the container system
- Other specific customer requirements can be offered as an option

COMPACT COMPRESSOR SOLUTION (CCS), DIMENSIONS



Dimensions in mm

* Door opening approx. 1050 mm to 1150 mm. Doors can be positioned on all sides.

BUILDING SIZES	CONTAINER (ft)	L (mm)	
		without control	with control unit
PTG 50	10	3000	–
PTG 50	15	–	4500
PTG 100	10	3000	–
PTG 100	15	4500	–
PTG 100	20	–	6060
PTG 150	15	4500	–
PTG 150	20	–	6060
PTG 200	20	–	6060

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