Hydrogen compressor H2H2p

The new environmentally friendly way to compress - the thermal compressor
Compressing without electricity

Thermal compressor for filling hydrogen trailers at the Visp site, Valais, Switzerland

Product description

The hydrogen compressor H2H2p (Heat to H2 pressure), also known as thermal compressor, fulfills its compression task by using heat instead of electricity. The core element is the use of special metal hydrides. Here, the property of absorption and desorption of hydrogen atoms from a metal structure is utilized. Absorption, or more precisely chemisorption, takes place at low pressure (e.g. the discharge pressure of an electrolysis process) when a container filled with a special metal alloy is filled. After complete absorption (maximum hydrogen absorption by the metallic structure), the system is heated by adding heat (e.g. waste heat) until the desired pressure is reached. This depends on the temperature level of the heat used. Hydrogen is desorbed and can be discharged at increased pressure. For the next adsorption step, the container is cooled down to starting conditions.

In order to achieve a continuous volume flow, up to four containers with metal hydride are operated in parallel, cyclically offset. The entire compression unit, including the control system, is located in a commercially available container. Depending on the type of heat (steam, flue gas, thermal oil, hot water, heat pump, etc.), the heating unit with possible heat recovery is housed in another container.

Depending on the available temperature level, the required heat and the desired discharge pressure, the compressor can also be designed in two stages to meet the requirements. Messer offers standardized industrial compressors with pressures of up to 380 bar for the industrial market.

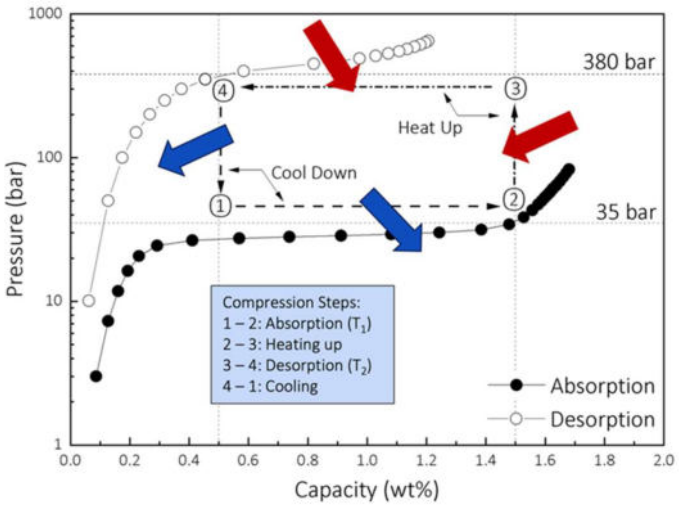
Metal hydrides can be used to build both very compact hydrogen storage tanks and hydrogen compressors that compress the hydrogen without moving parts due to thermodynamics and material properties.

The combination of metal hydride storage and compressor allows the hydrogen to be adsorbed directly from an electrolysis process (storage function) and then fed directly to the application in compressed form as required. The main advantage is that no hydrogen has to be stored separately, which represents a major safety gain. Storage takes place at only 10 to 35 bar, depending on the hydrogen source.

Functional principle

The H2H2p hydrogen compressor is based on a resource-saving and sustainable, innovative technology: metal hydride hydrogen compression. The hydrogen supplied is chemically adsorbed atomically on the structure of a special powdered metal alloy. A metal hydride is formed from the alloy. A pressure equilibrium is established between the solid and gaseous phases. When the metal is fully loaded, flow is stopped. In the next step, heat supply increases the pressure, which is determined by the temperature level, and releases the bounded hydrogen from the metal hydride. Once the desired pressure has been reached, the outlet is opened and hydrogen flows out. Further heat is added to maintain pressure equilibrium and continue the desorption process. At the end of the cycle, the original metal alloy remains in the container.

The property of hydrogen absorption and desorption on a special metal alloy can thus be used to compress the useful gas hydrogen.



Typical compaction cycle for metal hydride technology

Thermochemical process cycle:

1. hydrogen is absorbed at low temperature
2. system is heated up until equilibrium at the final pressure
3. hydrogen is desorbed at elevated temperature
4. the system is cooled to the original temperature

Compression takes place in batches. Several metal hydride containers are therefore used in parallel to ensure a continuous supply. The use of additional geometric hydrogen storage tanks may also be necessary in individual cases, depending on the task at hand.

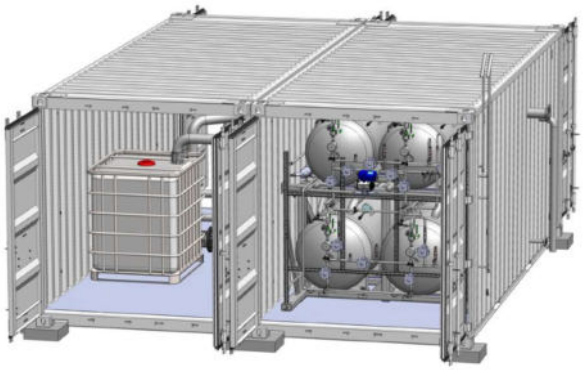
Individually customizable

The compression unit can be scaled as required. The function is not dependent on the geometric shape of the metal hydride container. This means that any supplied hydrogen flow can be processed. It does not matter at what pressure and temperature it is supplied or at what pressure it is to be compressed. Like the conventional compressor, the thermal compressor works with a compression ratio (inlet to outlet pressure). This allows individual tasks to be solved.

Messer offers a standard size with a one- or two-stage design that can cover a wide range of industrial applications.

All components are tested for their intended use and, where required, have the relevant certifications. This means that delivery times can be shortened and components can be used uniformly, making the investment more attractive.

One and the same compressor unit can generate different pressures if required. Simply change the temperature of the heat supply and you get a different pressure. No conversion is required.



Modular design for easy configuration and expansion

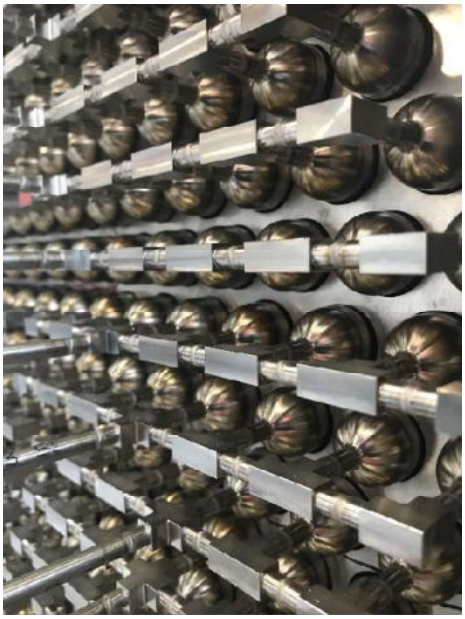
Both the compression unit and the heating system can each be installed on a skid or in their own container. This enables installation in existing premises and expansion of the output by connecting additional units.

If the structural conditions are unfavorable, the H2H2p compressor can be adapted to the local conditions.

Heating system can also be selected as required and connected to the compression unit on a modular basis. This means that different heat sources can be used, regardless of the medium.

The technology

In addition to electrolysis, hydrogen can also be supplied by a gas supply company such as Messer. This can make economic sense for smaller quantities or as an interim solution until an electrolysis system is installed, possibly with its own renewable electricity generation.



Stacks filled with metal hydride in a compaction unit

The H2H2p hydrogen compressor uses only sophisticated, high-quality materials that fully comply with all legal, normative and material requirements for hydrogen.

The entire technology is installed in a weatherproof and robust, commercially available container. The container is designed to allow easy access to the internal components from both ends.

The hydrogen storage system is characterized by its compactness, excellent safety properties, high density and long service life. The materials used in the storage system are non-toxic and easy to handle. They are processed and containerized in application-specific optimized pressure vessels, so-called stacks. These stacks comply with the relevant regulations and standards and are subjected to a strict quality inspection before leaving the factory. An important consequence of the design decisions is that there is no ATEX zone around the stacks, which facilitates many projects and applications.

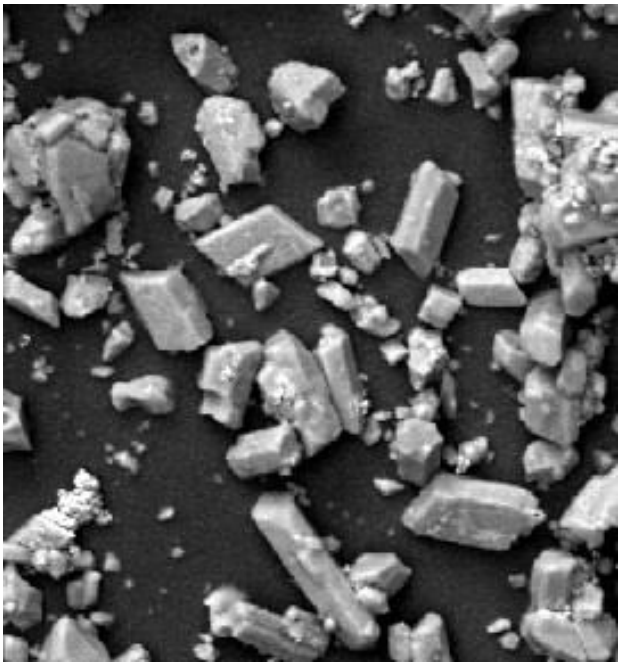
The design of the system is based on strict quality requirements. H2H2p hydrogen compressor is supplied with a certificate of conformity. CE conformity refers to the following directives:

-ATEX Directive 2014/34/EU
-Machinery Directive 2006/42/EC
-Pressure Equipment Directive 2014/68/EU
-Low Voltage Directive 2014/35/EU

Compliance with other specific and local regulations and standards can be checked when the order is placed.

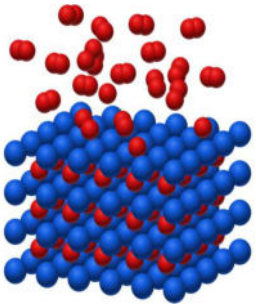
The metal hydride

The core component of the hydrogen compressor is the metal hydride. Metal hydrides are metals that can store hydrogen in the interstitial spaces, thereby increasing the hydrogen density up to twice the density of liquid hydrogen and approx. 4 times the density of hydrogen at 700 bar. This process can be compared to a dry sponge. If the temperature is then increased, the pressure in the metal hydride rises and the hydrogen is released again. Metal hydrides can be used to build hydrogen compressors that compress hydrogen without moving parts due to thermodynamics and material properties. All available types of heat and waste heat with a temperature level between 50 and 200 °C, depending on the desired pressure application, serve as heat sources. Pressures of up to 1000 bar can be realized with this principle.



Microscopic image of a metal hydride

The lattice structure of metal hydrides is based on dense spherical packings of metal atoms. The spaces in between are filled with hydrogen atoms and embedded in them. This creates a solid solution in which the metal structure remains unchanged.



Hydrogen entering the lattice of the solid carrier material

During hydrogen intercalation, hydrogen molecules adsorbed on the metal surface are first split into hydrogen atoms, which are then incorporated into the lattice.

Model variants

Parameter		HyCo 10-220	HyCo 10-380	HyCo 30-220	HyCo 30-380	HyCo 30-2205	HyCo 30-380S
Inlet pressure	(barg)	10 - 30	10 - 30	30 - 70	30 - 70	30 - 70	30 - 70
Outlet pressure	(barg)	50 - 220	50 - 380	50 - 220	50 - 380	50 - 220	50 - 380
Capacity	(kg_{H2}/h)	30	30	30	30	30	30
Stages	#	2	2	2	2	1	1
Cooling temperature	(°C)[1]	< 20	< 20	< 20	< 20	< 20	< 15
Heating temperature	(°C)[2]	> 160	> 177	> 135	> 165	> 180	> 205
Comment						no constant flow	

[1] Temperature of the coolant provided by the user (maximum)

[2] Temperature of the heating fluid provided by the user (minimum)

The thermal hydrogen compressor is available in 6 standard configurations and can be supplied with the following options:

Fully equipped container: The system can be supplied as a fully integrated system in a 20ft ISO container. The container is fully equipped with ventilation, gas detector, vent lines, etc. It is recommended for installation in particularly exposed environments.
Integrated air compressor: If no compressed air is available at the installation site, an air compressor can be integrated.
Lightning protection for containers: A standard lightning protection system is offered as an option when the container version of the product is selected.
Fire and smoke detectors: A standard setup is offered as an option when the containerized version of the product is selected.

Interpretation

For the correct selection of the hydrogen compressor H2H2p, parameters of the available hydrogen such as volume flow, temperature and pressure as well as the desired delivery pressure are required. In addition, the type of heat source used, the available heat flow and its temperature level must be known.

Electrical power is still required on site to supply the control unit and individual measuring instruments.

Compressed air is required to control the valves.

To set up the containers, only strip foundations are required to ensure level positioning of the containers on uneven and soft surfaces. Otherwise, the container can be set up without any further construction work.

Service and advice

We are happy to support and advise you in the planning and installation of the hydrogen compressor or supply that is right for you. In addition to supplying hardware components, Messer can also carry out the complete installation and provide a reliable hydrogen supply.

Our almost one hundred years of qualified experience in the hydrogen sector in a wide variety of industrial sectors is available to our customers. Messer can actively and professionally support you in your projects.

Advantages at a glance

No moving parts >>> No wearing parts, no spare parts required, no service intervals, no service costs

Low maintenance

Noiseless compression >>> Can be installed anywhere (even in residential areas), no building with sound insulation required

No vibrations >>> No damping required

Utilization of waste heat as energy drive >>> Higher energy efficiency compared to conventional compression, lower operating costs

Individually customizable >>> Can be designed for an individual task, no compressor steps

Can be used for different pressure tasks >>> Same compressor can deliver different pressures

Second life possible >>> If the task is completed, the compressor can be used in another project with a different pressure

Modularly expandable >>> The compressor can be expanded modularly as it grows

Network-compatible >>> All data can be used electronically, telemetry, remote control

Environmentally friendly >>> Elimination of electricity and the use of waste heat twice reduces the burden on the environment

Weather-resistant >>> Robust container design, no vulnerability

Can be integrated into existing energy concepts >>> Available, unused heat can be used

Highest safety standard >>> Hundred years of experience in the hydrogen sector, use of sophisticated components

Higher economic efficiency in the overall view >>> Total investment (system, protective measures, construction measures) lower than conventional compaction with significantly lower operating costs

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