BOYSEN
GROUP

Less need for space – more range:

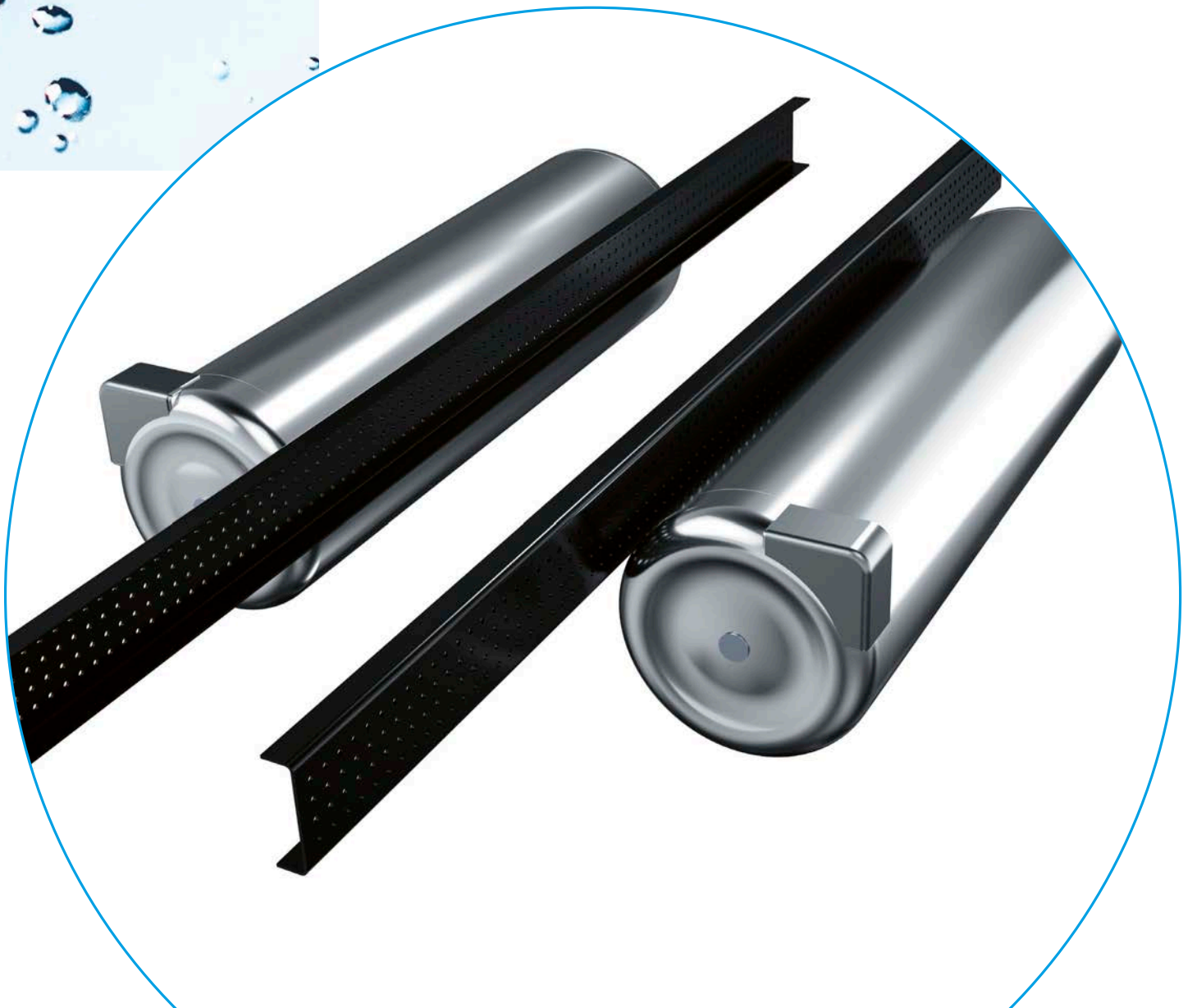
LH2 storage system for heavy duty vehicles

We bring the future to the road

The fuel cell electrical vehicle (FCEV) operated with hydrogen provides enormous potential when it comes to operating heavy duty vehicles both economically and ecologically.

Because liquid hydrogen (LH2) can be stored in much higher amounts by maintaining the same tank volume than compressed gaseous hydrogen (CGH2), the Boysen Group has started the proof of concept of a LH2 storage system for mobile applications already at the end of 2020. The first prototypes are being tested at the moment.

OUR NEXT GOAL: At the beginning of 2023, the new LH2 storage system is supposed to be certified by the Federal Motor Transport Authority and being put on the road in test vehicles. Furthermore, the system is intended to go into production in 2027.



Comparison between compressed gaseous hydrogen and liquid hydrogen

The only mass production solutions for FCEV in field today are CHG2 storage systems (high-pressure vessels with 350 bar for HDV's and 700 bar for passenger cars).

Disadvantages of CGH2 storage systems:

- less storage mass of the hydrogen in gaseous state
- enormous requirements concerning the containers' compressive strength

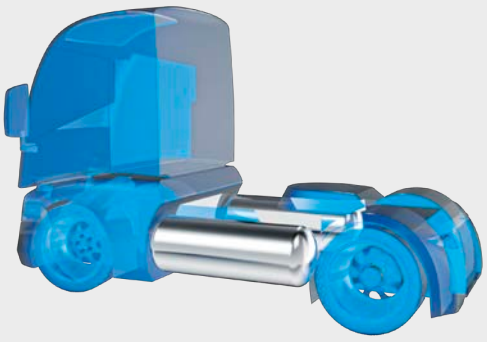
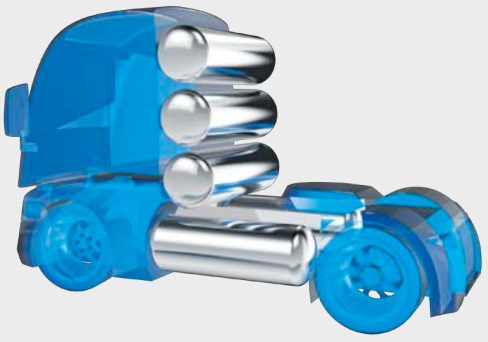
For some kind of applications, the technology provides quite a suitable solution because of the recent infrastructure.

Because of the higher density of liquid hydrogen, 2.7 times the amount can be transported with the same storage volume.

Advantages of LH2 storage systems:

- higher range
- higher payload
- more transport volumes

Therefore, the corresponding infrastructure has to be pressed ahead at full speed.

	LH2 storage system (16 bar)	CGH2 storage system (350 bar)
Density	70 g/l	24 g/l
H2 mass / vehicle	approx. 97 kg	approx. 45 kg
Range / vehicle	approx. 1.210 km	approx. 560 km
Tanks / vehicle	2 x frame mounted	2 x frame mounted and 3 x behind driver´s cab
Packaging / Application		

Challenges

The storage of liquid hydrogen takes place at a temperature of -253 C° and a pressure of 4 to 16 bar. Keeping hydrogen at this level of temperature as long as possible without active cooling is a big challenge for the insulation. Therefore, the heat input has to be reduced to minimum.

The storage system developed by Boysen essentially consists of an outer and an inner tank. The inner tank is designed as pressure vessel and accommodates the liquid hydrogen. In order to store as much hydrogen as possible, a minimal gap between the inner and the outer tank has to be accomplished. This can be achieved by a high insulation quality through a high vacuum in the gap combined with a so-called multi-layer-insulation (MLI). To keep the heat input low, the inner tank should have literally no connection to the outer tank. Practically spoken, this means that the bearing concept has to both accom-modate the corresponding mechanical load and is characterized by the lowest possible thermal conductivity.

In the event that the pressure within the tank rises and hydrogen has to be released, Boysen develops currently an appropriate-safety system. The key technology behind the system is a hydrogen catalyst with a passive air mixture which converts hydrogen into water by oxidation.

Meanwhile Boysen has tested the first prototype on a multi axis shaker concerning the mechanical load induced by road load. The quality of the insulation was determined through appropriate thermal loss tests.

Our mission:

our own hydrogen center

Because we believe in the enormous potential of the hydrogen technology, we develop and manufacture not only corresponding systems and components but we will also set another decisive milestone: Following our conviction we will start building in 2022 our own "Boysen Hydrogen Center" in the Black Forest next to our plant in Simmersfeld. Therefore, we will invest approx. 50 million euros.

Key services and development areas:

- Production of green hydrogen by means of photovoltaic and wind power
- Filling station for hydrogen (gaseous, liquid)
- Basic development (e.g. bi-polar plate, membrane, coating/catalytic converter)
- Product development (e.g. fuel cell, electrolysis)

A short portrait of the Boysen Group

Core business of the Boysen Group with its headquarters in Altensteig (Baden-Württemberg) is the development and production of top-class exhaust systems and exhaust components for motorcars, commercial vehicles and off-highway applications. Beside of its three main customers Audi, BMW and Mercedes-Benz, the specialist in terms of exhaust technology works for the German car manufacturers Volkswagen and Porsche, the English brands Bentley and Rolls-Royce, the commercial vehicle manufacturers Daimler and MAN as well as Krauss-Maffei Wegmann, mtu, Voith and others in the field of off-highway applications.

In the course of technological transformation within the automotive industry Boysen does not only rely on innovative exhaust technologies but also on new product groups that can be used in any vehicle – regardless of the propulsion concept. Another important element of it's future strategy as a foundation company is the field of energy technology, whereas topics like hydrogen, fuel cells and stationary energy storages are relevant above all.

The Boysen Group recently employs approx. 5.300 people at 25 plants globally. Besides the development sites in Altensteig and Nagold Boysen has production sites in Altensteig, Simmersfeld, Heubach, Salching, Ingolstadt, Plauen and Achim as well as in France, Egypt, South Africa, India, China, Mexiko, Serbia, Romania and in the USA.

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