

REFERENCE CASE

Transporting hydrogen

safely and cost-effectively



Hydrogen is a beacon of hope in the energy transition. Hexagon Purus, a global player in hydrogen and electromobility, offers Type 4 high-pressure cylinders to transport hydrogen in a safe, environmentally friendly manner.

The benefits

- extremely lightweight
- non-corroding
- fatigue-resistant
- durable

The new European Climate Law requires Europe to become climate neutral by 2050. Emissions must be reduced at least 55% from 1990 levels by 2030. These targets cannot be achieved without hydrogen. They require special technologies and innovations – and companies to tackle this challenge. Hexagon Purus is a case in point: It is the world's leading player in hydrogen storage, having made a name for itself with innovative storage solutions. Hexagon Purus has been part of Norway's Hexagon Composites ASA, the world's leading supplier of high-pressure composite cylinders for compressed gases, since 2016.

Hydrogen transport options

Countries around the world can only become hydrogen nations if the hydrogen is also transported – after all, production and end-use locations are often far apart from each other. This generally takes three forms.

First, hydrogen can be transported as liquefied gas. However, this requires considerable energy because the gas condenses only at temperatures below minus 252 degrees Celsius. Other disadvantages include strict storage requirements and the requisite complex infrastructure that only makes economic sense to build for large quantities of liquid hydrogen.

The second option is to chemically bond the hydrogen to base materials such as nitrogen to generate ammonia, or liquid organic hydrogen carriers (LOHCs). Once bonded to the substrate, these base materials offer favorable properties such as high energy density.

They make them ideal choices for transporting large quantities of hydrogen over long distances by ship or other transport modes, but both options are less ideal or have very limited utility in mobility applications.

The third option is to transport it as a compressed gas. There are barely any hydrogen pipelines, so the most efficient transport method is by truck with pressurized cylinders. For decades, Type 1 steel containers have been used to transport hydrogen to industrial customers. However, they have serious disadvantages, not least the heavy weight of the cylinders themselves. Type 2 cylinders, on the other hand, are made of steel and have a wrap of carbon or fiberglass- composite material that reinforces the cylinders and reduces the weight compared to Type 1.

Type 3 containers have an aluminum liner and are fully wrapped with carbon fiber composite, which significantly reduces the weight even more. The liner in Type 4 cylinders is made of a polymer plastic. They are the lightest cylinders.



Type 4 high-pressure composite cylinders offer several advantages

Hexagon Purus GmbH maintains a global market-leading presence with its Type 4 high-pressure composite cylinders and systems. The company pioneered the introduction of Type 4 technology in hydrogen transport in 2012. Today, all major gas distributors are among the clients. Hexagon Purus has developed cylinders and systems for hydrogen distribution for pressures of 250, 300, 380, 500 and 635 bar.



A Type 4 cylinder weighs about 75% less than a Type 1 cylinder. This has a big impact on the payload; after all, the total permissible weight for trucks is 40 metric tons in most of the EU countries. For example, transporting 500 kilograms of hydrogen in Type 2 cylinders in a 30 ft container brings you close to the total permissible weight of 40 metric tons, after including the chassis and tractor. "Our Type 4 cylinders make it possible to transport over twice the volume of hydrogen on a truck: We can transport over 1150 kilograms of hydrogen at a pressure rating of 381 bar in a 45 ft container – with a total vehicle weight of 33 metric tons," said Jan Michael Geck, Project Manager at Hexagon Purus for distribution systems. In Europe, a new EN 17339 standard allowing higher payloads and pressures has been in place since this year. Hexagon Purus is therefore developing systems for transporting 1,400 to 1,500 kilograms of compressed hydrogen at pressures 500 and 635 bar. To be sure, Type 4 systems require a larger upfront investment than Type 1 steel systems. "However, between the lower weight and the ability to transport significantly more hydrogen with one truck, the operational costs are much lower," added Felix Grass, Sales Director Europe Hydrogen Distribution at Hexagon Purus. "The total cost of ownership (TCO) is unbeatable with a Type 4 solution in the vast majority of applications." Another advantage is the very high long-term stability of Type 4 cylinders. Requalification tests at 300 and

381 bar show that the cylinders exhibit no signs of material fatigue, even after 50,000 cycles – which is a multiple of the standard specification. In other words, Hexagon Purus manufactures the cylinders for non-limited lifetimes. Hexagon Purus Type 4 cylinders also excel in their corrosion resistance: Only the metal bosses that are used to mount the cylinders and connect them to the tubing are made of stainless steel, so the cylinders are extremely resistant to corrosion and virtually made for harsh climates or sea transport. “We manufacture our modules in sizes ranging from 10 to 45 feet and offer flexible solutions for our customers,” said Geck.

Partnership with Everfuel: One-stop shop

These advantages also won over Everfuel. The Danish company approached Hexagon Purus looking for a transport solution between its hydrogen production facilities and refueling stations. Engaged in a collaborative process with the customer, Hexagon Purus developed a 45 ft container that is tailored to the customer’s specific requirements. „It incorporates technical ideas that increase efficiency when filling and emptying the container,” said Geck. Hexagon Purus does not compromise on the safety of dangerous goods containers. The containers are subjected to various simulated and real load tests during development and homologation.



The Type 4 composite cylinders have to pass around 15 highly demanding mechanical, chemical and thermal load tests during homologation. After successful approval, each finished distribution system is leak-tested and inspected and approved by a notifying body prior to shipment.

Hexagon Purus relies on a wide variety of safety features that build on one another. This also includes safety against fire. “If there is a fire, our fire protection system will ensure that TPRDs (temperature pressure relief devices) blow off the gas in a controlled manner, thus preventing the cylinders from bursting,” said Geck.



Hexagon Purus acquires Wystrach

Hexagon Purus and Wystrach – Europe’s leader in high-pressure systems for compressed gases – will work together in the hydrogen domain in the future. The merger combines both companies’ unparalleled expertise and capacities; the companies intend to further expand their leading position together.