HYDROGEN TAKES CENTRE STAGE

Molly Cooper investigates the factors involved in the transition to storing hydrogen as an industrial fuel

TODAY, THE majority of hydrogen is used by the refining and chemical industries. Hydrogen is a versatile and clean-burning fuel that has the potential to play a significant role in the global energy transition. Unlike fossil fuels, hydrogen produces no greenhouse gas emissions when it is burned, making it an attractive alternative for reducing carbon emissions and mitigating climate change.

Hydrogen can be produced from a variety of sources, including water, natural gas, and renewable energy sources such as wind and solar power. When hydrogen is produced using renewable energy sources, it is often referred to as green hydrogen, as it has a minimal environmental impact. 'Producing hydrogen from natural gas, renewable natural gas (RNG) or renewable energy using fuel cell technology can reduce carbon emissions,' says Peter Gerstl, director of hydrogen sales (EMEA) at Chart Industries.

According to an article by the World Economic Forum, demand for industrial hydrogen use has tripled since 1975 and its potential as an energy transition fuel could see demand grow exponentially. The demand for hydrogen reached 94 million tonnes in 2021, containing energy equal to about 2.5% of global final energy consumption, up from a pre-pandemic total of 91 million tonnes in 2019.

Although, it is great to see so many companies becoming involved in decarbonisation and the switch to cleaner fuels there are many elements involved in the transition to hydrogen including, storage, transportation, digitalisation and safety.

STORING ENERGY

'Even though demand and price related concerns appear to be the key parameters to build a viable business model for hydrogen storage, they will most likely be accompanied by other challenges,' says Bora Aydin, business development manager at Walter Tosto.

TWI Technologies explains that hydrogen can be difficult to store due to its low volumetric energy density. It is the lightest and simplest of all elements, being lighter than helium, and so is easily lost into the atmosphere. The safety and stability of storage should be counted, and aspects such as embrittlement and flammability ought to be taken into account. 'Hydrogen is a much smaller molecule than natural gas, and components which are tight under natural gas services might be leaking in hydrogen service,' says Gerstl. So, ventilation and adequate leak prevention measures are vital. Specialised materials need to be selected when building hydrogen storage facilities.

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Walter Tosto has patented an internal coating system for long-term hydrogen storage tanks at high pressure and at large volumes. It proposes various technical and economical solutions for national and international projects related to large scale hydrogen storage.

Walter Tosto has mechanical test campaigns to certify some metals for high-pressure large volume storage tanks. 'We are currently participating in a working group dedicated to updating and improving the standard at national level both for material selection and for long-term storage tank design,' explains Aydin. This innovative storage tank design also includes rapid detection of any leaks or losses and a possible accumulation system for the leak.

'The energy sector will need a mix of different storage technologies to meet short term variations between supply and demand and longer-term imbalances,' says Aydin. There are currently short-term solutions available, but nothing long term yet. As hydrogen is a key element in the move to decarbonisation, this is an issue the industry needs to tackle.

DIGITALISING THE SUPPLY CHAIN

Industrial connectivity company, Weidmüller is at the forefront of bringing digitalised processes to the hydrogen transportation and storage chain. 'Fully automated processes are important in every phase of hydrogen production, and we also see the same for storage and transportation,' says Cengiz Oguzoglu, global business development manager of hydrogen at Weidmüller. As Weidmüller supplies products that are used all throughout the hydrogen supply chain, the company has conducted extensive research into what the industry needs on all sides.

Weidmüller supports the production of hydrogen by standardising electrical installations. The Industrial Analytics solution from Weidmüller uses automated machine learning software with for application-oriented AI applications and helps companies detect and classify anomalies. Industrial Analytics helps companies reliably predict the quality of their hydrogen products, based on recordings of sensors, conditions and process data. Digitalisation of hydrogen tank maintenance processes allows for safer storage, less downtime and increase in profits. 'Through predictive maintenance, you can plan service intervals in a targeted manner as and when required,' explains Oguzoglu.

LNG & LIQUID HYDROGEN

Cryogenics company, Chart Industries, has been producing hydrogen equipment for over 50 years, proving that hydrogen is not new; the industry is just working

HYDROGEN BY 2030

Ocior Energy, incorporated in Abu Dhabi, develops, constructs, owns and operates green hydrogen and ammonia assets in India, Middle East and North Africa. The mission of the company is to deploy 4 GW of green hydrogen capacity by 2030. The green hydrogen produced will be converted to derivatives such as green ammonia, based on offtake requirements. There are already several projects underway to make green hydrogen replace both the natural gas and coal for domestic use and power generation. 'The challenges to this are government policies, safety, technology, production costs, and enabling infrastructure. However, these obstacles are expected to be overcome in the medium term as we march towards a sustainable future,' says Bakul Pant, CCO at Ocior.

Ocior's optimised green ammonia plant design may include a combination of one or more of electricity storage, hydrogen storage and ammonia storage in well-engineered proportions.

on new ways it can be used. 'We sit in the middle of the hydrogen value chain. We provide liquefaction technology and all required specialised equipment to those who are producing hydrogen, together with hydrogen transports (trailers and ISO containers) and liquid hydrogen storage tanks of any size,' says Gerstl. Chart is using the technologies developed for liquefaction, storage and transportation of LNG as the basis for developing global liquid hydrogen supply chains.

Liquefaction processes were developed in the middle of the previous century. There are multiple proven processes that are being further optimised for larger capacity liquefaction facilities, higher efficiencies and/or lower power consumption during the process. The globalisation of liquid hydrogen will require large-scale transportation systems, similar to those used with LNG. Companies like Chart are using their extensive LNG knowledge and applying that to hydrogen. 'For example, liquid export and import terminals, bunkering systems, and cryogenic transport trailers and ISO containers for road, sea and rail,' explains Gerstl.

All the way along the value chain, there are examples of increased demand for natural gas leading to developments in the capacity and capability of LNG equipment. As both LNG and liquid hydrogen are stored and transported in insulated vessels, many of those developments are directly transferable, and means, in theory, the hydrogen infrastructure can similarly be expanded.

But LNG is not a climate-neutral carrier and in order to hit green targets, governments are looking at importing clean fuels such as hydrogen and ammonia. At first glance, repurposing LNG infrastructure seems the best option due to speed of delivery and construction costs. However, there are challenges with this.

Most LNG storage tanks and pipelines are not currently suitable store hydrogen. Different rules apply to existing infrastructure for hydrogen rather than LNG, including permitting, licencing and commissioning of these tanks and pipelines. Transporting hydrogen to a terminal will require rebuilding the fossil fuel infrastructure, resulting in equipment being abandoned rather than repurposed. This is because the gases and liquids do not have similar properties in terms of flammability, toxicity and temperature. Much of the fossil fuel infrastructure, such as piping, compressors and safety equipment, will require replacing to be used safely with pure hydrogen.

However, there are currently many projects in Germany and globally to construct new import terminals for ammonia and hydrogen, such as RWE in Brunsbuttel and Wilhelmshaven. It is not yet known how much of these will be repurposing LNG infrastructure.

TRANSPORTING FUEL

One aspect of hydrogen production and storage that is often neglected is the transportation of the fuel. Ammonia is the most common method of transporting hydrogen. It is already transported on a large scale every year and is currently the cheapest option for transporting hydrogen in comparison to liquefied natural gas.

Transportation and storage infrastructure for this are already in place, and the industry has measures in place to mitigate risks. Ammonia is toxic to humans and animals, even at low concentrations, so any leak will have a negative impact. It is corrosive to certain materials, which must be factored in when choosing a vessel, but adequate regulations are already in place.

However, the cracking process to return ammonia back to hydrogen leads to a 13%-34% energy loss, and a loss of profit.

Hydrogenious uses the hydrogenation method, chemically binding the hydrogen to an LOHC. 'Our LOHC (Liquid Organic Hydrogen Carrier) technology enables the storage and transport of hydrogen in a particularly safe, simple and efficient way – at high storage densities, under ambient conditions and in conventional liquid fuel infrastructure,' explains Toralf Pohl, CCO at Hydrogenious LOHC Technologies.

This method allows hydrogen to be transported by tanker, barge, train or road tanker, using the existing infrastructure for liquid fuels to enable long-distance transport even to remote areas. 'At the off-take end, we release the hydrogen from the LOHC in our ReleasePlant in an endothermic catalytic process called dehydrogenation. The LOHC is not consumed during this process, but can be reused many hundreds of times to store and transport hydrogen, and is also recyclable,' explains Pohl.

The Chiyoda Corporation uses a similar hydrogenation method to transport

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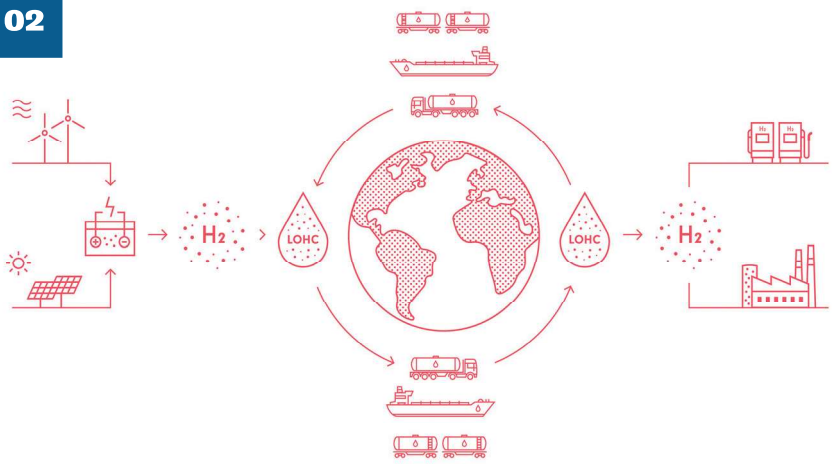

hydrogen across the world. 'By causing a chemical reaction between toluene and hydrogen, methylcyclohexane (MCH) is formed, and this liquid reduces the hydrogen to about 1/500th the volume of gaseous hydrogen,' says Masashi Nagai, deputy general manager for Chiyoda's Hydrogen Business Department. 'This makes it possible to transport large volumes of hydrogen at ambient temperature and normal pressure. We call this MCH SPERA Hydrogen.'

Hydrogenious is currently exploring large-volume supply chains, with its LOHC technology, from the UAE to Europe with partners like ADNOC, JERA Americas and Uniper. By scaling up transport capacity, companies such as Hydrogenious and the Chiyoda Corporation are contributing towards a successful global energy transition.

THE FUTURE OF HYDROGEN

Hydrogen presents long-term potential in many sectors beyond existing industrial applications. 'With the growing demand and various applications of hydrogen around the world, the need for hydrogen storage is likely to rise proportionally,' says Aydin.

'Despite all the advantages of hydrogen storage as well as the opportunities that it may bring, keeping and preserving hydrogen for later transportation or consumption requires innovative solutions,' says Aydin. In the last month alone, Evos Hamberg has announced it will establish a blue hydrogen hub in Hamburg, while Onyx Power plans to build a hydrogen plant in the Port of Rotterdam.

Not only storage but transportation. Exolum is investing in H2Vector to provide energy solutions that support decarbonisation. Hydrogenious is continuously building upon technology to transport and store hydrogen in a safe and efficient way.

The industry must keep up the momentum with its green plans and call for government and policies to follow suit. 'There is still a lot to be done in terms of regulation, both in the individual countries and at EU level,' explains Pohl. 'First and foremost, the legislators need to create clarity for all stakeholders as quickly as possible. At the same time, technological openness must be maintained and approval procedures accelerated to speed up the energy transition and the decarbonisation of industry.' As an industry we must keep working together to create and improve on the solutions surrounding hydrogen to ease the energy transition into a cleaner, safer, future.

For more information:

www.chartindustries.com
www.chiyodacorp.com
www.exolum.com
www.hydrogenious.net
www.ociorenergy.com
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01 Weidmüller hydrogen rendering diagram
02 The LOHC Circle by Hydrogenious
03 Andrés Suárez, global strategy, innovation lead at Exolum

CASE STUDY: GREEN HYDROGEN, THE ENERGY FOR A DECARBONISED FUTURE

Andrés Suárez, global strategy and innovation lead at Exolum provides insight into Exolum's current hydrogen projects

Hydrogen is the most abundant element on the planet. People have been using it as a raw material for a long time. However, in order to be used, it must be produced. This is the key to this new energy vector, which is presented as one of the alternatives to fossil fuels in sectors that are difficult to electrify, such as aviation, maritime or heavy transport and highly temperature-intensive industrial processes. These all are essential to the bigger goal of the fight against climate change and decarbonisation.

As part of Exolum's diversification strategy, green hydrogen and its derivatives play a leading role for both industrial and mobility purposes. The company is working to provide storage and transportation services for green hydrogen and to support the development of hydrogen hubs. That's all while positioning Exolum at national and international ports, where it has facilities to promote the establishment and growth of new supply chains. These are aimed at the receipt, storage and dispatch of new products, such as green ammonia or ethanol.

With the aim of promoting the use of hydrogen for mobility purposes, Exolum is building a network of supply points, hydrogen refuelling stations, for heavy transport by lorry and bus. This includes the first integrated plant for the production and dispatch of green hydrogen for mobility purposes in the Madrid region, Spain: Green Hydrogenares.

Exolum's involvement with hydrogen covers other areas as well, such as business entrepreneurship and research. In this regard, the company has recently completed an investment operation in the Spanish start-up H2Vector, which aims to provide energy solutions to enable the decarbonisation and electrification of society, based on renewable hydrogen. The investment in H2Vector is part of an ambitious Open Innovation plan through which Exolum seeks to establish strategic agreements that will enable it to incorporate new technologies and new talent in the company's business development areas.

Exolum participates in research with a view to developing technologies to enable an efficient and sustainable use

of its current infrastructure in the future. This includes the storage and transport of green hydrogen in liquid form through its combination with organic carriers or liquid organic hydrogen carriers (LOHC).

These initiatives are a testament to Exolum's commitment to developing new solutions that boost an energy transition towards decarbonisation. Green hydrogen is becoming an essential new energy vector to achieve the climate commitments of the Paris Agreement and the zero-emissions goals demanded by the climate crisis.