CIHT Dubai Online Seminar – Bulletin

Speaker

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About the Event

This seminar provided a history of two elemental gases Hydrogen and Helium and their use within the transport industry. Both are well known as lifting gases in airships particularly during the early part of the 20th Century, and in the 1920s and 1930s passenger airships were common. Given the current considerations around the sustainability of air transport, one of the questions of the seminar was "Will there be a return of the airship in the near future?". The answer is that this is highly unlikely, however both hydrogen and helium will form a part of future sustainable transportation strategies.

In addition, both gases have a planned use in the aviation industry, and both are likely to have a future use for road transport vehicles (Hydrogen vehicles using hydrogen directly, and helium within the manufacturing process, particularly in its use as an inert atmosphere during microchip manufacturing, and within the welding industry). The speaker provided predictions about how the transport industry will change moving towards 2050 and the fossil fuel transition.

Helium is an elemental gas which is currently completely dependent on the natural gas industry for its production. Even if oil and gas production were to continue at current rates the production of helium is expected to decline due to dwindling reserves. With decreasing demand for oil and gas, helium will become even less available, and this is problematic for many high-tech industries. Helium is critically important, and has limited supply. For example, helium is the basis for superconducting magnets which are used in MRI machines in hospitals. It is also envisaged that helium will be an important part of the cooling system for future nuclear fission reactors.

Post covid, due to supply chain issues, microchips for the automotive industry were in short supply, producing challenges for the car industries supply chain. As helium supply declines, cross-sector manufacturing challenges are likely to be experienced, particularly in microchip manufacturing. Potential solutions to this require technological changes, either to use other gases, or other processes, or to develop technologies to extract helium directly from the atmosphere where it is available at relatively low concentrations.

Hydrogen is also an elemental gas. To date the vast majority of hydrogen used on earth has been created from the fossil fuel industry including coal. More recently the use of electrolysis to split hydrogen from water generates a future sustainable fuel with great potential. This is so-called green hydrogen, around which there is a growing interest. Hydrogen is, however, feared by consumers due to its historic use in airships, particularly the Hindenburg disaster. Hydrogen is highly flammable, and therefore it has associated safety risks. Early trials with light passenger vehicles have not attracted many users. However, for heavier vehicles hydrogen is seen as a strong contender for the sustainable future.

The seminar touched on a review of the history of helium and hydrogen. The history of helium starts with its discovery in 1895 by William Ramsay. However, at the time relatively limited amounts of helium were available to scientists. But in 1903 during prospecting for natural gas in Dexter, Kansas, a natural gas was identified that would not burn. This was named "wind gas" and later the reason for not burning was identified as its high concentration of helium. At that time helium had no commercial use, and so this discovery was largely ignored.

Later, during World War I, a book was published in Germany titled "applied chemistry in aviation" and contained a short discussion of the advantages of use of helium as a balloon filling gas in comparison to hydrogen as it is not flammable. One airship did not combust when shot by the British with incendiary bullets leading the British to believe that Germany had managed to develop helium airships. This led to a global search for sources of natural gas containing helium and the development of cryo technology for the separation of helium. The processing of helium was not sufficiently rapid for helium airships to take part in World War I, but the military investment which continued after the war supported the growth of this industry.

Airship disasters in the 1920s and 1930s including the USS Akron, USS Macon and the LZ 129 Hindenburg among others raised concerns about the safety of airships, and the development of fixed wing aircraft with the advent of World War II completed the collapse of the rigid airship for military purposes. However, the investment that took place into the industry made the extraction of helium significantly cheaper. This then led to its use in diving as a breathing mixture from 1939, and its use in magnesium welding for the production of fixed wing aircraft during World War II. In the 1950s with the development of cryogenic technology and the potential of helium in quantum mechanics (now particularly quantum computing), and with the use of helium in purging rockets during the space race, there was a vision of the potential high-tech future of helium. The US government started stockpiling huge quantities of helium in the 1960s. In 1980s and 90s helium industry was privatised, and US government started selling US helium reserve. This led to shortages in helium supply which have occurred regularly since 2004.

Given the importance of helium in high-tech industries including chip manufacturing the future lack of availability of helium is concerning. The development of technologies that preserve and recycle helium is essential, alongside moving towards technologies that can work by other gases or processes.

The history of hydrogen starts with its discovery in 1766. Very shortly after this in 1783 hydrogen was used as a lifting gas in the first passenger balloon. The first hydrogen land internal combustion engine was invented in 1804, with the first vehicle the "hippomobile" being on the roads in 1860. Even modern hydrogen vehicles were running from 1966.

At present, which respect to light passenger vehicles, electric vehicles are significantly cheaper to run than hydrogen vehicles, and as such it is unlikely that large-scale hydrogen fuelling infrastructure for passenger vehicles will be developed. In comparison, the heavy vehicles hydrogen does appear to be more efficient than electric vehicles, it is at present getting limited use due to a lack of hydrogen infrastructure and the availability of fossil fuels for heavy vehicle transportation. It is highly likely that as green hydrogen infrastructure develops it will be used within bus and truck transportation, and some train transportation as hydrogen fuel cells. It is also highly likely that hydrogen will be directly used as a fuel source for aviation and shipping.

The talk finished with a discussion of how long the transition will take and the importance of investment in research in engineering and physical sciences in order to speed this transition.

Questions

Will hydrogen be used in passenger cars in the next 10-20 years and will hydrogen become cheaper?

Hydrogen cars exist, but are very expensive. The key to any technology becoming cheaper is investment in research and development. This investment occurs because of revenues from sales, or potential revenues from future sales. With the move away from fossil fuels investment is being made in green hydrogen technology with the focus being on heavy vehicles (airplanes, ships, some trains and trucks), in addition to hydrogen application in the chemicals and manufacturing industries. This investment will lower the price of hydrogen technology, but this is not expected to occur in a 10-20 year time frame.

Between electric vehicles and hydrogen vehicles, which will be more popular in the future?

Because of the time scale for the net zero transition, electric vehicles and their infrastructure are being rolled out. Once infrastructure is embedded it is challenging to convert to another technology (e.g. hydrogen technology). In addition, green hydrogen technology uses electricity to generate hydrogen, this means that the price of hydrogen is dependant on the price of electricity. This increases the challenge for green hydrogen vehicles to reach the same price as electric vehicles. Present predictions indicate that electric vehicles will dominate the small passenger vehicle market, and that hydrogen vehicle will dominate for the heavier vehicle categories (airplanes and ships). For the intermediate size vehicles whether it is hydrogen or electricity, or a hydrogen fuel cell will depend on the relative investment in research. At present electric vehicles are ahead in research and embedded infrastructure.

Is there any development in pink hydrogen (from nuclear energy)

Ignoring the cost of construction of a nuclear powerplant, the cost of nuclear electricity generation is one of the lowest energy costs. If a country has made the investment in the construction of a nuclear power plant there is a strong incentive to keep the power plant turned on and generating as much cheap energy as possible. Given peaks and troughs in energy demand, using nuclear energy to generate hydrogen as a form of energy storage is a very good use for excess energy. There is not much difference in the electricity source in terms of the technology for hydrogen generation (electrolysers).

The drop in available helium and natural gas shortage occurred in 2008,was this related to the turning off of the oil pipeline through Georgia?

This is unlikely. As this would cause a diversion of gas to other places, helium would still be produced. The issue in 2008 was the global recession causing a reduction in demand for natural gas. In addition, in 2008 Russia was a minor producer of helium. Today the production of helium in Russia is growing and it will become one of the world's major producers.

Green hydrogen is produced via electrolysers which use expensive rare metals. Due to this will the cost of green hydrogen increase?

Yes, the rare earth elements is important and a big issue for green hydrogen production. However, comparing green hydrogen production to electric vehicles. The electrolyser generates hydrogen for many vehicles for many years using its rare earth elements. Whereas the rare earth elements for electric vehicles are on a per car basis. A large volume of rare earth elements is currently needed for electric vehicles in comparison to hydrogen vehicles

Is hydrogen just a replacement commodity for fossil fuel companies and government as a replacement fuel that can be taxed and charged per unit?

At present the major economies investing in hydrogen technologies are those which are fossil fuel rich as they are able to generate large quantities of Black and Blue hydrogen. Hydrogen vehicles are very similar to petrol and diesel vehicles in terms of the experience of the user. There is a potential for governments to tax this, but the investment that would be needed to make hydrogen vehicles cheaper than electric vehicles makes this unlikely in the future.