KOHLER

Going for Green: Why the ‘color’ of hydrogen really matters

Hydrogen is the lightest element, and the most abundant, making up an estimated 90% of all the atoms in the universe[1]. It also makes up nearly two-thirds of the atoms in our bodies.

Today, hydrogen is mostly used in industrial processes, such as fertilizer production and petroleum refining. But it’s finding increasing usage in fuel cells in vehicles and electricity generation, including as part of mission-critical and back-up power systems. Its key advantage is that it can deliver power with zero greenhouse gas emissions at the point of use.

But not all hydrogen is the same. The ‘color’ associated with its source and production technology really matters and has a significant impact on lifecycle emissions – as we will find out.

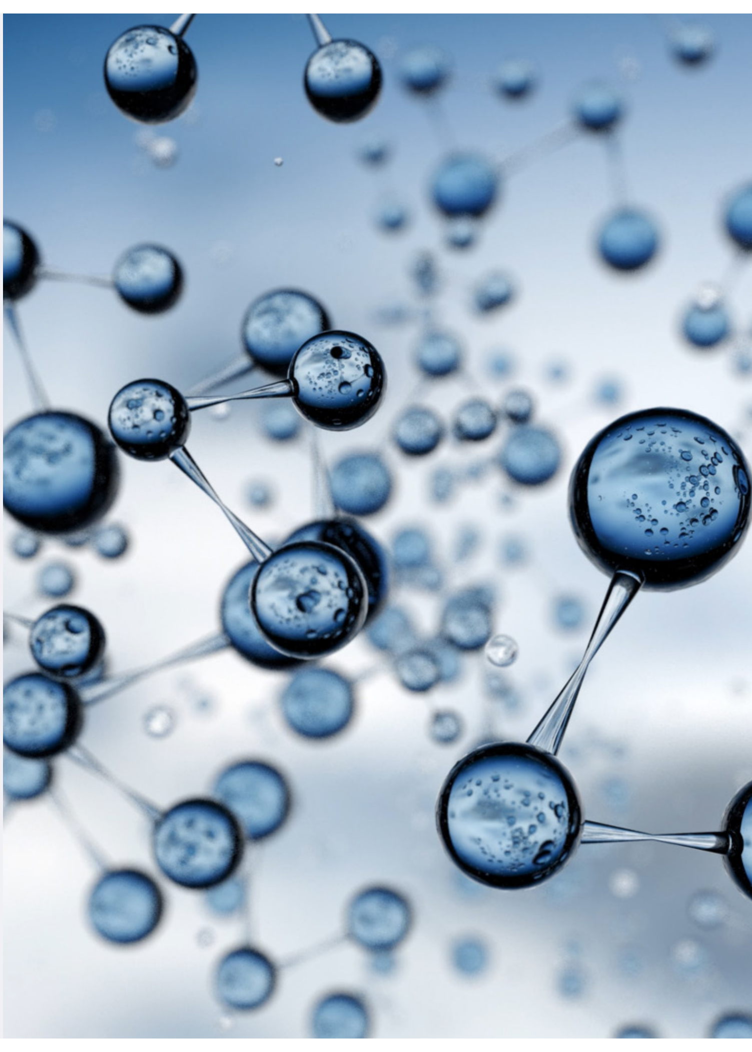
[1] www.nature.com/articles/nchem.2186

CHALLENGES OF HYDROGEN

Hydrogen is difficult to work with, and to scale to large installations. For a start, it is 14 times lighter than air. This means that it likes to escape, and to go wherever it can through the smallest gap or defect in an imperfectly sealed system.

Compared to traditional fossil fuels, hydrogen’s energy density is very low. This means that you must store a lot of it, which is difficult, and requires a high pressure to compress the hydrogen to occupy a reasonable space.

And once it’s been produced, the hydrogen must be transported to where it will be consumed. To limit emissions, you need the locations of production and consumption to be physically close together, which may not be practical.



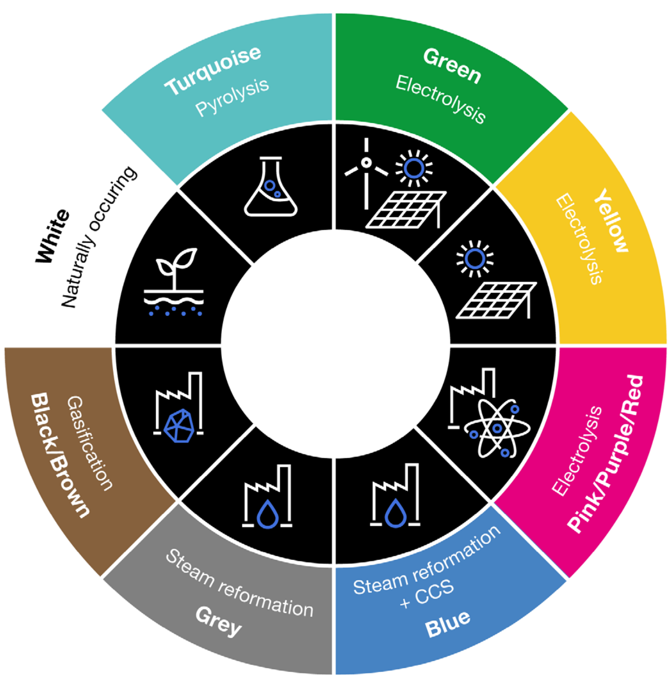


FIG. 1: THE SOURCES OF HYDROGEN COLOR TYPES

HYDROGEN PRODUCTION

Typically, hydrogen is defined with a color that indicates its source and production technology, including black, brown, gray, yellow, turquoise, pink/red/purple, blue, white, and green.

Black or brown hydrogen are the worst options from an emissions perspective. They use a gasification technology to create the hydrogen, typically using coal, which leads to a very high carbon footprint.

Alternatively, the cleanest is green hydrogen. This is made using electrolysis to split water molecules into hydrogen and oxygen, with the electricity required coming from renewable energies such as wind, solar and hydropower. This means it has a minimal carbon footprint, so is the best choice to reduce emissions – but does also mean that large-scale production is constrained by the limited availability of electricity from renewable sources.

CLEAN POWER FROM FUEL CELLS

Fuel cells are more energy-efficient than combustion engines and hold the promise of zero carbon emissions. Figure 2 shows how a fuel cell works. Hydrogen molecules (H2) enter at the anode and oxygen molecules (O2) enter at the cathode. The hydrogen atoms in the hydrogen molecules split into electrons and positively charged hydrogen protons.

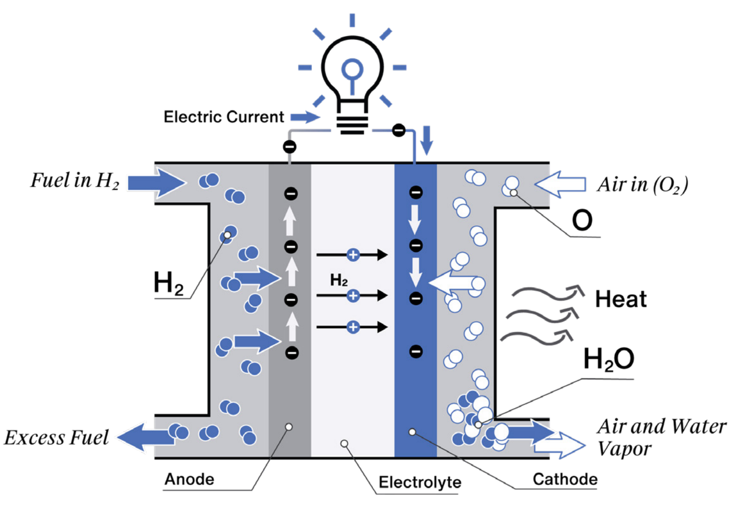


FIG. 2: HOW A FUEL CELL WORKS

The electrolyte membrane allows only hydrogen protons to pass through. The electrons are forced through an external circuit, thus generating an electric current. This flow of electrons reaches the cathode, where the negatively charged electrons combine with the positively charged hydrogen protons and oxygen from the air to form water (H2O). This process also dissipates heat.

Some types of fuel cells can also operate on hydrogen-rich fuel. Depending on the type of fuel used, these fuel cells will have some carbon emissions, along with the usual by-products of heat and water.

Different materials can be used as the electrolyte, leading to different characteristics of the fuel cell, and making it suitable for different applications. For example, Polymer Electrolyte Membrane (PEM) fuel cells use an acid membrane and a solid polymer as an electrolyte, with porous carbon electrodes containing a platinum or platinum alloy catalyst.

PEM fuel cells offer a quick start up time of just a few seconds, and low operating temperatures of 80°C which help improve durability. PEM fuel cells have an electrical efficiency of around 45% to 65%, as well as being smaller and lighter than other fuel cells. They have a typical stack size of between 1kW and 100kW.

FIG. 3: KOHLER HYDROGEN FUEL CELL POWER SYSTEM

KOHLER HYDROGEN SYSTEMS: RELIABLE AND ZERO EMISSIONS

The KOHLER hydrogen fuel cell system is modular and scalable, and it enables mission-critical power users to rapidly deploy a sustainable energy solution. The system can be used as a prime or backup power source, for peak shaving, or as part of a distributed energy network.

It uses a PEM fuel cell for high efficiency energy conversion and is flexible and scalable to suit a broad range of mission-critical power users, including hospitals, utilities, ports, data centers and water treatment plants.

The power system can operate in an extended range of temperatures, from -30°C to 45°C, and has a low-maintenance 20-year design life. The system is built to last, with a compact, durable steel housing featuring lockable access doors and a textured paint finish for corrosion and abrasion protection.

Kohler is focused on providing our customers with sustainable, resilient sources of electricity. Hydrogen fits with that product portfolio, providing reliable power with zero carbon emissions at the point of use.

And if it’s green hydrogen produced from renewables, it really is possible to have zero-emissions power across the lifecycle.

FOR MORE INFORMATION, VISIT
WWW.KOHLERENERGY.COM/POWERSYSTEMS/EN/HYDROGEN-FUEL-CELLS