

Working safely with the GENIE[®] hydrogen cylinder

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Purpose of the guide

When used with a fuel cell, BOC's GENIE® hydrogen (H₂) cylinder is a safe, convenient, clean and economic source of electrical energy for a wide range of applications, such as temporary lighting, security cameras, site offices, remote monitoring, telecoms backup power and many more.

This short guide aims to get you started on how to use the cylinder, where to get it from and how to use it safely and covers:

- 1 Introduction to hydrogen
- 2 Important safety checks
- 3 How to purchase the GENIE® H₂ cylinders
- 4 How to transport the cylinders
- 5 How to connect to a GENIE® H₂ cylinder
- 6 How to disconnect the GENIE® H₂ cylinder after use
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- 8 Safe storage
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Introduction to hydrogen

Hydrogen is a fuel but unlike petrol and diesel, it can be used directly in a fuel cell to generate clean, quiet electrical power. It does this highly efficiently and without any of the polluting and harmful emissions that come from conventional engines, all with a fraction of the carbon footprint.

In the UK, hydrogen is already widely used with fuel cells to power temporary lighting and security cameras and provide back-up power for IT and telecoms systems. Within the next few years many more of our cars, taxis and buses will run on hydrogen, making a big contribution to keeping the air we breathe clean.

As with all flammable products, hydrogen comes with its own set of hazards but, when used in correctly designed equipment and by competent people* hydrogen is a safe fuel. Being many times lighter than air, hydrogen doesn't "hang around" and unlike heavier than air fuels, such as petrol, diesel or LPG, hydrogen leaks dissipate very rapidly so the risk of a fire or explosion is low.

Hydrogen has been used in industry for over 100 years and up until the 1960s was fed directly into our homes as part of old fashioned "town gas". Major global companies such as Toyota, Honda and Daimler are investing heavily into the development of cars powered by hydrogen which are no less safe than today's petrol or diesel cars.

Hydrogen - some basic facts

What is hydrogen?

It is a colourless and odourless non-toxic gas that burns readily in oxygen to form water. It is 19 times lighter than air so dissipates very rapidly.

How is hydrogen made?

Hydrogen is manufactured from a wide range of energy sources including conventional fossil fuels such as natural gas but, unlike diesel or petrol, it is also produced from the electrolysis of water which means it can be manufactured from 100% renewable energy such as wind power or solar power.

What is hydrogen used for?

It is used extensively within the petrochemical industry as well as in applications including the manufacture of fertiliser and glass and in the surface treatment of metals. It is also increasingly used with hydrogen fuel cells as a fuel for cars, buses and stationary power applications such as the HYMERA® power generator.

What happens if hydrogen burns?

Hydrogen burns with a pale blue flame and also with a low radiant heat so it if does catch fire is less likely to set fire to anything nearby than fires from other fuels.



* To view the HSE definition of a competent person visit www.hse.gov.uk/involvement/competentperson.htm

Basic safety checks when using the GENIE® hydrogen cylinder



Extinguish all sources of ignition

Like other fuels, hydrogen is highly flammable, so make sure you have extinguished all cigarettes and other sources of ignition before making or breaking any connections or while in the vicinity of the GENIE® hydrogen cylinder.



Check your environment

This guide is for outdoor applications, where there is plenty of natural ventilation and no possibility of build-up of a flammable atmosphere. Hydrogen cylinders can be used indoors but the user must ensure that there is sufficient ventilation so that if there is a leak, then it will not be contained and cannot build up to a flammable level.



Check your equipment is fit for purpose and in good condition

If your application does develop a leak is there sufficient high and low level ventilation to prevent a build-up of hydrogen? Are O-rings in good condition and have all gas fittings been leak tested?



Undertake a risk assessment

Have all required tasks and activities been assessed by a competent person?



Leak detection

Every time you connect a new hydrogen cylinder always carry out a leak detection test, using an approved leak detection spray.



Listen for any leaks

Stay vigilant and if you hear a leak then immediately turn off the hydrogen cylinder and check all connections and if necessary replace faulty equipment.

Buying, transporting and storing GENIE® hydrogen cylinders



Where can I buy a GENIE® hydrogen cylinder?

The GENIE® hydrogen cylinder is only available from BOC and can be ordered online or by telephone.

Please visit www.boconlineshop.com and search for Hydrogen GENIE®, call 0800 111 333 or contact your local sales contact. You will need to have a BOC account and this can easily be set up online or over the telephone.

Cylinders can be delivered directly to your site, or you can arrange to pick up cylinders from one of BOC's Gas & Gear retail stores or BOC Agents (please note collection is not possible for online orders). Cylinders are stocked throughout the UK and can generally be ordered for next day delivery or collection.

For a full list of our stores and agents please visit www.boconline.co.uk and use the store locator tool.

How can I transport the cylinders?

The GENIE® hydrogen cylinder is a transportable compressed gas cylinder and its use and carriage/transport is covered by UK law. This means that the cylinder complies with strict standards and laws on how it is built, filled and maintained. It is designed to be carried on normal road transport without

specialist equipment provided you follow a few simple rules (see below). Detailed guidance can be found on the British Compressed Gas Association's website (www.bcgga.co.uk) see leaflet L1. Make sure you fully read and fully understand what is required and what is allowed.

The carriage of compressed gas cylinders is controlled by a "points system" which governs how many cylinders you can carry and of what type. Under this system you can carry up to 16 H₂ GENIEs (full or empty) but only if you are carrying no other cylinders of gas or other flammable products.

- The cylinders should be safely stowed on the vehicle so that they cannot move around.
- Ideally the cylinders should be carried on an open back vehicle or carried in the back of a ventilated van, separated from the driver by a bulkhead. If you are carrying cylinders in a car then carry them in the boot and ensure that they are safely secured.
- Always check that the cylinder valves are fully closed off before each journey – even if you think the cylinders are empty.
- Do not store the cylinders in the vehicle when not in use, such as parked up overnight.
- The driver should carry a 2kg powder fire extinguisher and should understand what

he is carrying and what to do in event of an incident

- You do not need to have hazard warning marks or labels on your vehicle.

For detailed guidance on the carriage of small quantities of compressed gas cylinders please visit the British Compressed Gas Association website (Guidance Note (GN) 27) www.bcgga.org.uk

How do I store GENIE® hydrogen cylinders when they are not being used?

Cylinders should be stored outside, in a well-ventilated and secure location such as a 'gas cage'.

You can store other compressed gas cylinders in the same cage but do not store any more than one x 45kg LPG cylinder in the same cage.

Keep the cage away from open windows and combustible material such as cardboard or old pallets.

There must be no smoking or hot works activities near to the cylinder store or cage.

How do I connect and disconnect a GENIE® hydrogen cylinder?



To connect the GENIE® hydrogen cylinder to your fuel cell application you will need a gas regulator to take the high pressure gas from the cylinder down to a low pressure (typically 5 barg) for your fuel cell. BOC supplies a range of GENIE® hydrogen regulators for most applications and no specialist tools are required to make the connections. Note: hydrogen threaded connections tighten anti-clockwise (the opposite to 'normal' threads) as they are left-handed threads

Firstly, check that there is an O-ring on the inlet to the regulator, that it is in good condition and that the outlet of valve on the GENIE® hydrogen cylinder is clean.

Ensure that the regulator pressure adjust knob is fully backed off (anti-clockwise) and then push the regulator onto the outlet of the GENIE® regulator and turn the barrel nut anti-clockwise until it is hand tight.



Check that the connection hose to your application has an O-ring and then connect to the outlet of the regulator, again by turning the nut anti-clockwise.



Slowly open the valve on the top of the GENIE® hydrogen cylinder until it is fully open and then turn back half a turn. Check that the contents gauge on regulator shows approximately 300 bar (for a full cylinder).



Turn pressure adjust knob on regulator until output gauge shows 4 barg (minimum for BOC's HYMERA® fuel cell).

How do I connect and disconnect a GENIE® hydrogen cylinder?



How do I disconnect the GENIE® hydrogen cylinder after use?

To disconnect the regulator from the cylinder you must turn off the main cylinder valve on the cylinder. Then vent all hydrogen from the system by either turning the fuel cell on or by slowly opening the outlet connection on the regulator (turning clockwise).



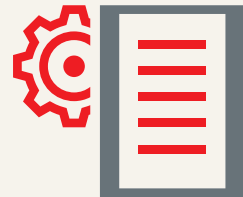
IMPORTANT – both gauges should now indicate zero. If there is any pressure left in the system it will be impossible to undo the regulator.

Once pressure in the regulator and connection hose is back to zero then the regulator can be removed from the cylinder by turning main barrel nut clockwise. You do not need any grips or spanners.

At this stage it is a good idea to do a 'pressure drop test' by simply turning the cylinder valve fully off and then waiting a few minutes to see if the regulator and hose "hold" the pressure in the system. If either of the needles on the gauges move, then there is a leak.

If a leak is found, then de-pressurise the system (by turning on the fuel cell to use any remaining hydrogen) and then re-assemble the fittings and use leak detection fluid to find it. Most leaks are due to loose fittings or damaged O-rings (that will need replacing). You can now use your fuel cell.

Common questions



Q. Isn't hydrogen highly explosive?

A. Hydrogen, on its own, like LPG or natural gas is not an explosive. If you give the hydrogen cylinder a knock it will not suddenly explode. However, as with LPG and natural gas, hydrogen leaks can result in the build-up of a flammable atmosphere.

Q. But what about the "hydrogen bomb"?

A. The hydrogen bomb is a thermonuclear device that requires a conventional fission (uranium) bomb to trigger it, nothing to do with a simple cylinder of hydrogen.

Q. HYMERA has shut down but there is still hydrogen left in some of the cylinders?

A. Check that the pressure regulator on ALL cylinders has been set to at least 4 bar. Do this by setting output pressure on each cylinder in turn to 4 bar, 4.5 barg 5 bar etc.

Q. Isn't hydrogen poisonous?

A. No hydrogen is not poisonous but do not breathe it as it is flammable. Hydrogen should not be used to fill party balloons.

Q. What about the Hindenburg then?

A. The Hindenburg was filled with hydrogen to make it lighter than air, but many people who have studied the incident believe that the real cause of the accident, and resultant fireball, was the highly flammable material used to contain the gas. This was a mixture of highly flammable aluminium film covered in acetate which is also highly flammable. It's also worth pointing out that had the Hindenburg been filled with natural gas the same thing could have happened, it just would not have floated. Today, hydrogen is not used in lighter than air balloons apart from in the annual Gordon Bennet balloon race which has been using hydrogen balloons for the last 110 years.

Where to find more information and relevant legislation

BOC's hydrogen safety
data sheet

HYMERA® fuel cell
www.boconline.co.uk/hymera

GENIE® Hydrogen Cylinder & GENIE®
regulator (to buy online)
www.boconlineshop.com

British Compressed Gas Association (BCGA)
www.bcgga.org.uk

Health and Safety Executive (HSE)
www.hse.gov.uk

Health and Safety at Work
www.healthandsafetyatwork.com

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