FuelCellStore

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Operating instructions

D114 DEMO Car & Gas Station

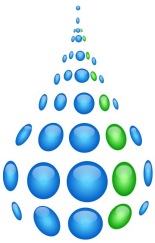

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Table of contents

04 Introduction
05 About these instructions
05 Safety instructions
06 Content
10 Overview
12 Starting up
14 Operation
19 Technical data
21 Troubleshooting
23 Shutting down
24 Maintenance
24 Transport and storage
25 Disposal

Introduction

Dwindling resources, increasing environmental pollution and an ever-growing energy demand lead companies in the energy sector to rethink their business models. Both the automotive industry and mineral oil companies are increasingly investing in hydrogen technology, because it can offer a way out: The use of hydrogen technology allows for a more efficient energy supply while conserving natural resources as much as possible.

The hydrogen filling station “DEMO Gas Station” is used to generate and store hydrogen. The car named the “DEMO Car” is filled with hydrogen, showcasing the technology of future fuel cell vehicles under realistic conditions.

These devices allow for the function of PEM fuel cells (PEM = proton exchange membrane) and PEM electrolysers to be demonstrated.

We hope you enjoy many instructive hours with the DEMO Gas Station and DEMO Car. Sincerely yours,

Fuel Cell Store

About these instructions

These operating instructions are intended for the supervisor in charge.

- These operating instructions must be read and observed before use.
- These operating instructions must be available for reference and must be stored in a safe place.
- All safety instructions must be observed.
- This product may only be put into operation and operated under the direction of the supervisor in charge.

Safety instructions

Read and observe the **general safety instructions** included separately with this product and keep them in a safe place together with the operating instructions!

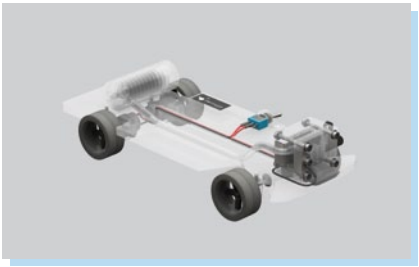
Product-specific safety instructions

The product may only be used:

- According to its intended use
- In compliance with all safety instructions
- In perfect working order

The components of this product feature freely accessible, live electric contact surfaces. Connecting to an impermissible operating voltage may result in a fire hazard, a risk of electric shock and damage to the components.

Content



1 x car

1 x filling station

1 x overflow

1 x image cartridge

1 x solar module

1 x presentation block

1 x set of cables

1 x tube
with shut-off valve

1 x water bottle
250 ml
with separate tube attachment

1 x pair of safety goggles

1 x transport box with insert
(optional)

1 x companion book

1 x operating instructions

1 x general safety instructions

1 x Service Card

Overview

The “DEMO Gas Station” at a glance

The “DEMO Gas Station” filling station consists of an electrolyser, a hydrogen storage tank and a water reservoir. In addition, the filling station also comes with a removable image cartridge with interchangeable image slides. When the electrolyser is supplied with electrical energy, it produces hydrogen that is then stored in the hydrogen storage tank. Hydrogen is removed via the tube. The electrolyser is equipped with two 2 mm female connectors for connecting multilam plugs. The individual components are shown in the following graphic.

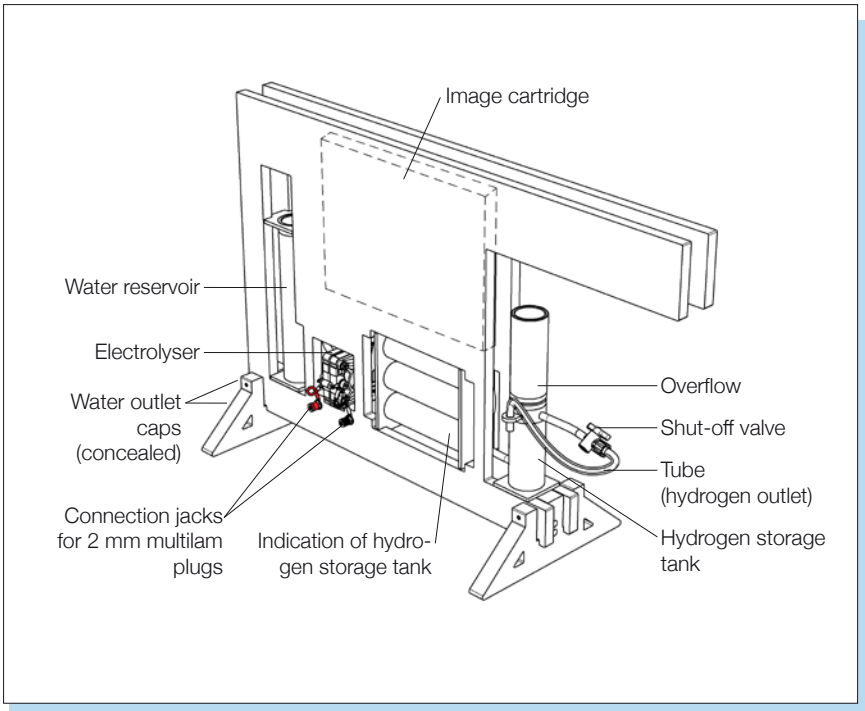


Fig. 1: The filling station at a glance

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The “DEMO Car” at a glance

The “DEMO Car” vehicle consists of a two-cell, air-breathing fuel cell stack and a hydrogen storage tank, mounted to a vehicle base plate. The car can be operated once it is supplied with hydrogen via the hydrogen storage tank. The individual components are shown in the following graphic.

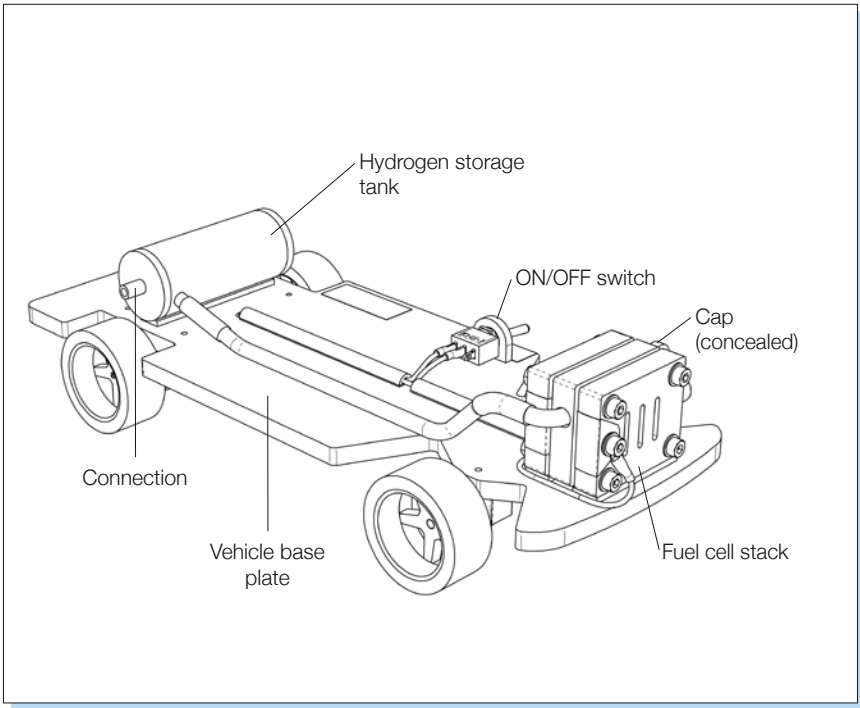

Fig. 2: The vehicle at a glance

Starting up

Assembly

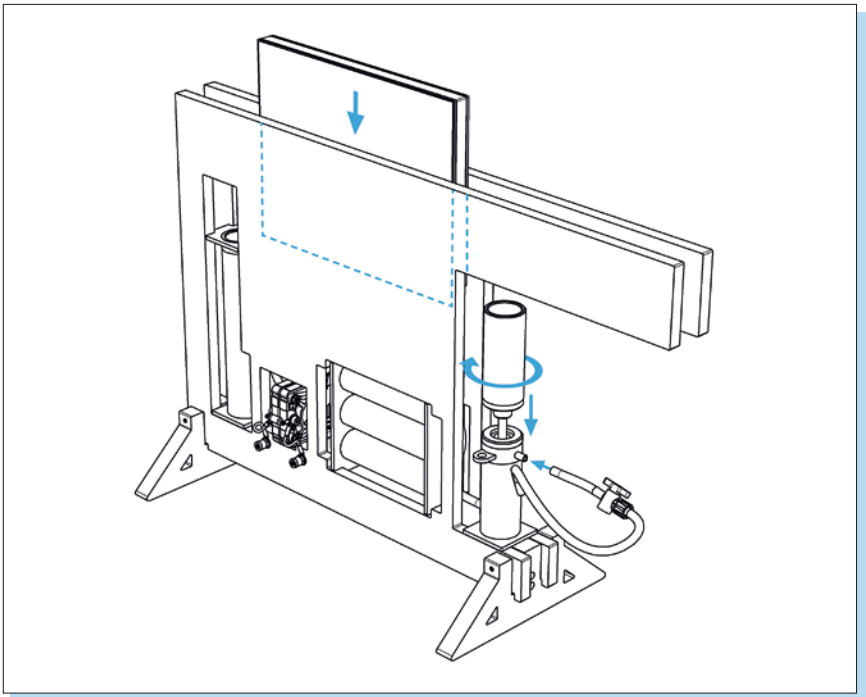

Fig. 3: Assembly

Assemble the filling station as shown in figure 3.

- Attach the overflow to the hydrogen storage tank using a clockwise motion.
- Attach the tube to the connection on the hydrogen storage tank.
- Insert image cartridge.

The two image slides of the image cartridge are interchangeable.

Do not yet connect the power supply to the electrolyser.

Filling

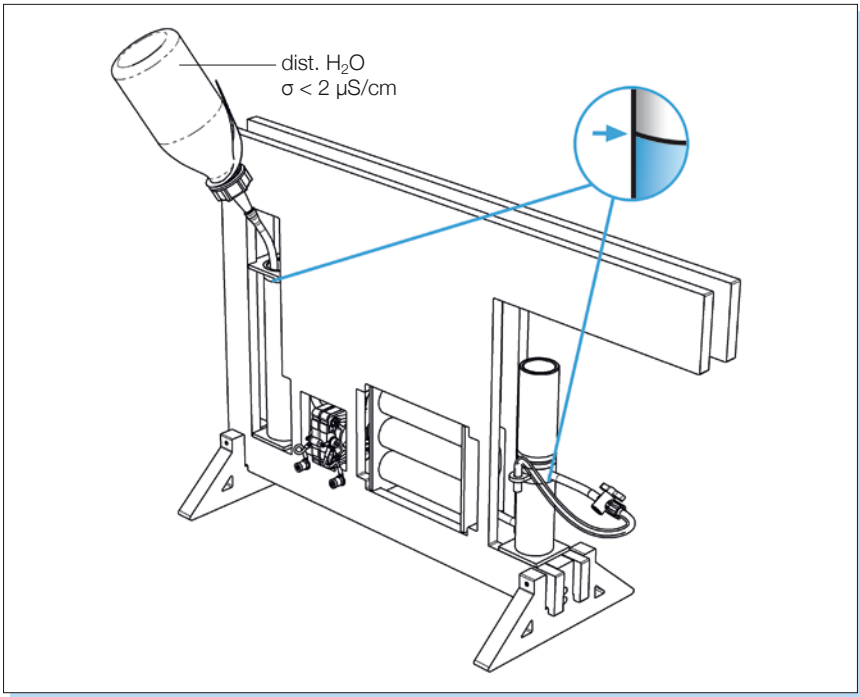

Fig. 4: Filling

- Open the shut-off valve on the tube.
- Close both water outlet caps.
- Fill the water reservoir up to the mark with distilled water (σ < 2 µS/cm) as shown in figure 4.
- Fill the hydrogen storage tank up to the mark with distilled water (σ < 2 µS/cm) as shown in figure 4.

Operation

⚠ CAUTION

Risk of injury from hydrogen ignition

Damaged tubes or leaking connections may cause hydrogen to leak. Hydrogen and hydrogen-air mixtures may ignite when in proximity to an ignition source.

Check tubes and connections for damage before each setup and before each use.

⚠ CAUTION

Risk of injury from hot surfaces

The protection diode on the electrolyser becomes very hot in case of incorrect polarity.

Touching the diode on the electrolyser may cause injuries.

Before starting up, ensure correct polarity of the connecting cables and the electrical connections (red = “+”, black = “-”).

Do not touch the diode.

⚠ CAUTION

Risk of injury from hot surfaces

The surface of solar modules may become very hot during operation.

Touching the surface of solar modules may cause injuries.

Do not touch the surface of solar modules during operation. Let the surface of the solar modules cool to 60 °C before removing.

⚠ CAUTION

Risk of injury from hydrogen ignition

Escaping hydrogen may ignite when in proximity to an ignition source.

Prevent hydrogen from escaping. Completely use up all hydrogen before dismantling.

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⚠ CAUTION

Risk of fire due to electrical overload

Any operation beyond the electrical specifications will lead to excessive overheating of the electrolyser. This may cause a fire.

Never operate the electrolyser beyond the electrical specifications stated in the technical data.

CAUTION

Risk of damage due to electrical overload

Any operation beyond the electrical specifications will lead to irreparable damage to the electrolyser.

Never operate the electrolyser beyond the electrical specifications stated in the technical data.

CAUTION

Risk of damage due to insufficient distance to lamps

The solar module may become excessively hot or sustain irreparable damage if it is too close to the lamp.

Observe the minimum distance defined by the manufacturer when operating solar modules with lamps.

CAUTION

Risk of damage due to improper handling

Operating the electrolyser using water with an electrical conductivity of ≥ 2 µS/cm will cause irreparable damage to the electrolyser.

Only fill the electrolyser using distilled water with an electrical conductivity of < 2 µS/cm.

NOTE

Water in the fuel cell

Ensure that there is no water in the tube of the filling station. Remove any water in the tube by briefly opening the tube clamp or the shut-off valve, if and as needed.

If water enters the fuel cell by way of the tube, a film of water on the electrode surface may suppress the reaction of hydrogen and oxygen within the fuel cell. In such cases, the output of the fuel cell will be inadequate.

Operating the filling station

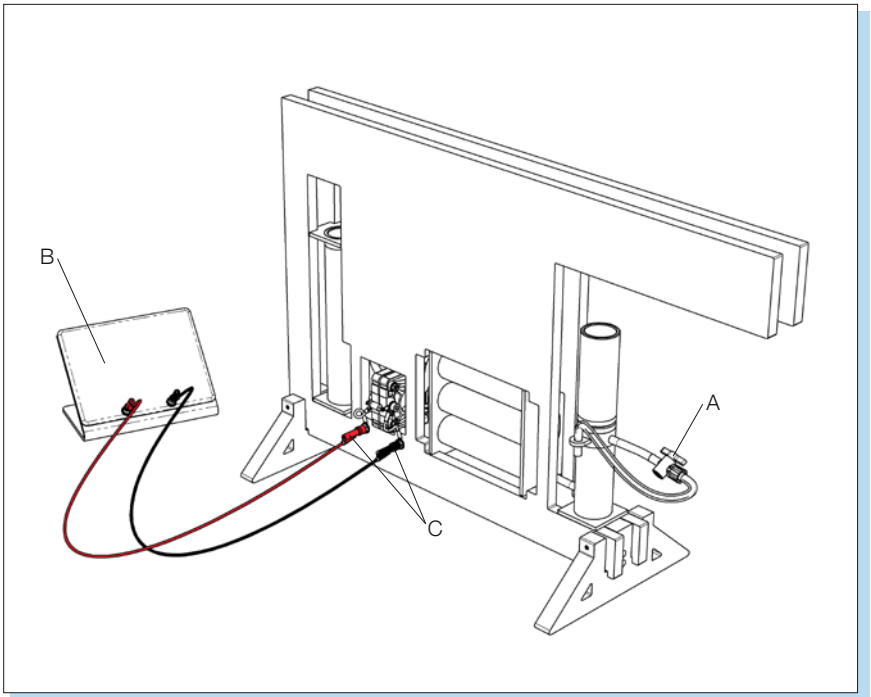

Fig. 5: Operating the filling station

- Read and observe the general safety instructions.
- Close the shut-off valve (A).
- Using the connecting cables, connect the solar module (B) with the respective connections (C) on the electrolyser while ensuring correct polarity (red = "+", black = "-"). If using an alternative power source, make sure to comply with the electrical specifications as defined in the technical data.

- Provide solar module with adequate direct sunlight or with light from a powerful, concentrated electrical light source.
  The water is split into hydrogen and oxygen at a ratio of 2:1. Oxygen escapes into the room via the water reservoir.
- After each refill with distilled water, the residual air must be purged from the system once. To do this, produce approximately half a tank full of hydrogen and release the gas by briefly opening the shut-off valve.
- When the hydrogen storage tank is filled, excess hydrogen escapes as bubbles. Gas production must then be stopped. For this purpose, remove the connecting cables on the power supply from the respective connections on the electrolyser.
- The filling station is now ready for use.
- During operation, small amounts of water pass through the PEM from the oxygen side to the hydrogen side. This may cause the water level to rise on the hydrogen side and fall on the oxygen side. Check and, if necessary, adjust the water level regularly during operation. To this end, the water on the hydrogen side must be removed and supplied to the oxygen side. If the water level needs to be adjusted, hydrogen production must be stopped. For this purpose, remove the connecting cables on the power supply from the respective connections on the electrolyser. The water levels in the water reservoir and in the hydrogen storage tank must be kept at the approximate level of the fill level marking at all times. (For the hydrogen storage tank, this is only possible if no hydrogen is being stored.)
- The distilled water is consumed during operation. Pay attention to the water levels and regularly top up with a little distilled water ($\sigma < 2$ µS/cm).

Operating the car

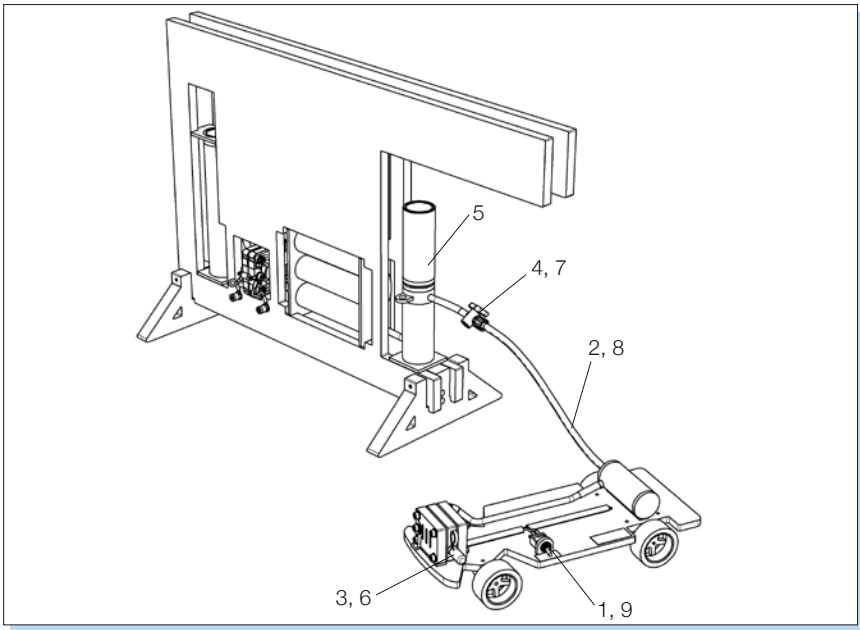

Fig. 6: Operating the car

- 1. Set the switch to “OFF”.
- 2. Attach the tube to the connection on the hydrogen storage tank of the car.
- 3. Open the cap on the fuel cell stack.
- 4. Open the shut-off valve.
- 5. Wait until the column of water inside the overflow of the filling station’s hydrogen storage tank has completely dropped. The hydrogen is now inside the hydrogen storage tank of the car.
- 6. Close the cap on the fuel cell stack.
- 7. Close the shut-off valve.
- 8. Remove the tube from the connection on the hydrogen storage tank of the car.
- 9. To start operation of the car, set the switch to “ON”. The driving range on one full tank is approximately seven minutes.
- The car can be placed on the presentation block for presentation purposes.

Technical data

Item name: ..... DEMO Car & Gas Station
Item no: D114

Solar module

H x W x D: ..... 85 mm x 130 mm x 80 mm
Weight: ..... 150 g
Active solar area: ..... approx. 80 cm²
Open-circuit voltage: ..... approx. 2000 mV DC
Operating current: ..... approx. 600 mA*

Filling station “DEMO Gas Station”

H x W x D: ..... 335 mm x 525 mm x 175 mm
Weight: ..... approx. 3000 g
Permissible operating pressure: ..... 0 - 20 mbar

Electrolyser:

Number of cells: 1
Active surface per cell: ..... 17 mm x 17 mm
Operating medium: ..... distilled water, $\sigma < 2$ µS/cm
Permissible operating voltage: ..... 0 - 2000 mV DC
Permissible operating current: ..... 0 - 1500 mA
Rated power consumption: ..... approx. 1500 mW
H2 gas production at rated power output ..... approx. 5 cm³/min
O2 gas production at rated power output ..... approx. 2.5 cm³/min

Gas storage tank and water reserve:

Fill volume H2O, H2-side: ..... approx. 30 ml
Fill volume H2O, O2-side: ..... approx. 70 ml
Gas storage volume H2: ..... approx. 25 cm³
Gas storage volume O2: ..... –

* Under standard test conditions (STC)

Vehicle “DEMO Car”

H x W x D: ..... 70 mm x 105 mm x 245 mm
Weight: ..... 320 g
Permissible operating pressure: ..... 0 - 20 mbar

Gas storage tank:

Gas storage volume H2: ..... approx. 10 cm^3
Gas storage volume O2: ..... –

Fuel cell:

Number of cells: 2
Active surface per cell: ..... 20 mm x 20 mm
Operating media: ..... hydrogen and atmospheric oxygen
Open-circuit voltage: ..... 2000 mV DC
Short circuit current: ..... approx. 650 mA
Rated power output: ..... approx. 300 mW
H2 gas consumption at rated power output: .. approx. 6 cm^3/min
O2 gas consumption at rated power output: .. approx. 3 cm^3/min**

Drive/propulsion:

Type: ..... electric motor
Number of motors: 2
Rated power consumption (total): ..... approx. 150 mW

** from ambient air

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Troubleshooting

The fuel cell has only a low output.

Possible cause:

- The fuel cell was stored too dry or for too long. A fuel cell with a dry polymer electrolyte membrane (PEM) will lose power.

Solution:

- Continue operation. The fuel cell automatically moistens itself during operation, which will slowly let it reach its full capacity again.

Despite hydrogen being present, the consumer connected to the fuel cell (e.g. the motor) is not working.

Possible cause:

- Water has entered the fuel cell during operation (e.g. through the gas storage tanks). This may cause a rapid decline in performance.

Solution:

- Dry the fuel cell by opening and blowing out the connections.

CAUTION

Risk of damage due to compressed air

The use of compressed air for drying the fuel cell may cause irreparable damage to the fuel cell.

When drying it, only blow out the fuel cell without using any technical tools.

With the solar module connected, no hydrogen is produced in the electrolyser.

Possible cause:

- The light intensity is insufficient.

Solution:

- Operate the solar module(s) using either adequate direct sunlight or concentrated light from a powerful electrical light source. Energy-saving light bulbs, fluorescent tubes etc. are unsuitable for the operation of solar modules.

The power supply is connected and there is gas production, but no gas is stored in the hydrogen storage tank.

Possible cause 1:

- The shut-off valve is not closed.

Solution:

- Close the shut-off valve.

Possible cause 2:

- The overflow tank is not secured firmly in place.

Solution:

- Secure the overflow tank firmly in place.

Despite correct setup, the electrolyser or the fuel cell is not working.

Possible cause:

- No distilled water was used. The electrolyser and/or the fuel cell has/have sustained irreparable damage.

If the above-mentioned solutions do not eliminate the cause of the error, please contact H-TEC EDUCATION.

Shutting down

Continue operating the fuel cell until the motor stops by itself. This allows some water to remain in the fuel cell, moistening the PEM. In addition, this procedure also prevents that hydrogen is released unnecessarily.

⚠ CAUTION

Risk of injury from hydrogen ignition

Escaping hydrogen may ignite when in proximity to an ignition source.

Prevent hydrogen from escaping. Completely use up all hydrogen before dismantling.

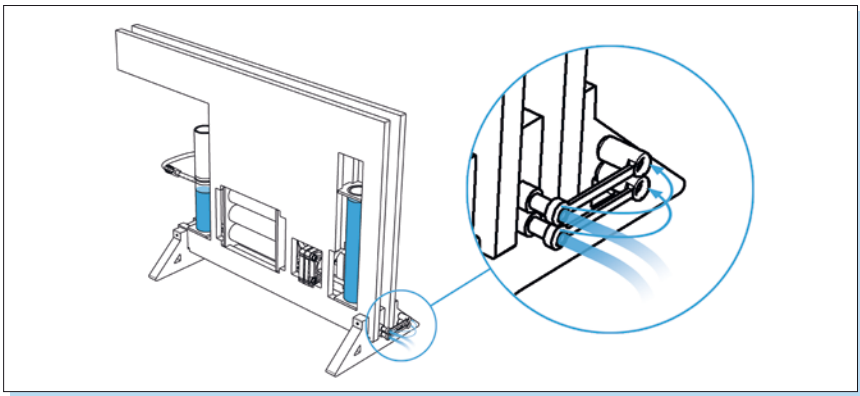

Fig. 7: Draining the hydrogen storage tank and the water reservoir

- Disconnect the power supply from the connections on the electrolyser.
- Stored hydrogen has to be consumed before draining the storage tanks.
- Open both water outlet caps.
- Drain the hydrogen storage tank and the water reservoir, as shown in figure 7. The water must be disposed of correctly (e.g. drain).
- Close both water outlet caps again.

Before putting the product into storage, observe the following points:

- You must ensure that the power supply is disconnected from the connections on the electrolyser.
- Carefully remove any water drops from the product with a soft, lint-free cloth. This prevents the formation of water stains. No cleaning agents must be used.

⚠ CAUTION

Risk of fire due to catalytic substances

The catalysts for the electrodes of fuel cells and electrolysers promote burning when they come into contact with flammable substances.

Avoid contact with flammable substances.

Maintenance

The components of this product do not require maintenance. The following points should be observed, however:

- Use fresh, distilled water for each new start-up.
- After operation, remove the water from the hydrogen storage tank and from the water reservoir.

Transport and storage

With regard to transport and storage of the product, the following points should be observed to ensure a long service life. Transport and storage only:

- In the original packaging
- Dry and dust-free
- At temperatures from 4 °C to 50 °C
- Protected from shock and vibrations

Disposal

Do not dispose of fuel cells and electrolysers as general household waste.

⚠ WARNING

Risk of fire due to catalytic substances

The catalysts for the electrodes of fuel cells and electrolysers promote burning when they come into contact with flammable substances.

Avoid contact with hydrogen, alcohol fumes or other organic fumes. Ensure correct disposal.

According to European regulations, used electric and electronic devices may not be disposed of as unsorted household waste. The symbol of the crossed-out wheelie bin indicates the requirement for separate disposal.

Your local waste management company can provide you with additional information about disposal options.

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