Operating Instructions

F101 Fuel Cell $\text{H}_2/\text{O}_2$
F102 Double Fuel Cell $\text{H}_2/\text{O}_2$
F103 Fuel Cell $\text{H}_2/\text{O}_2/\text{Air}$
F104 Double Fuel Cell $\text{H}_2/\text{O}_2/\text{Air}$

Overview

Fuel Cell $\text{H}_2/\text{O}_2/\text{Air}$
- Stopper
- Oxygen- ($\text{O}_2$) side
- Hydrogen- ($\text{H}_2$) side

Fuel Cell $\text{H}_2/\text{O}_2$
- Air- side
- Hydrogen- ($\text{H}_2$) side

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The units may only be set up and operated by a responsible supervisor.

WARNING! Not suitable for children under 12 years!

Read the Operating Instructions before setting up the fuel cell. Follow them during use and keep them readily available for reference.

Wear protective goggles.

Equipment and gases must be used and stored out of the reach of small children.

Plug-in power supplies can be dangerous - they are not toys!

Disconnect the unit from the plug-in power supply and the solar module before cleaning with liquids.

Unless instructed to the contrary by the manual, do not reverse or short-circuit the connecting terminals.

The units must not be operated when empty. Always ensure that they contain sufficient water. Pay attention to the water level marks.

Remove flammable gases, vapours or liquids from the area surrounding fuel cells and electrolyzers. The catalytic materials involved may cause spontaneous ignition.

Hydrogen and oxygen may escape from the units. Operate the units in well-ventilated rooms to ensure that the gases do not accumulate and form explosive mixtures.

The units may only be operated in display cases if adequate ventilation is guaranteed under all circumstances. The operator is responsible for ensuring this.
General Safety Precautions

- Remove from the vicinity of the units anything that could ignite the hydrogen (e.g., open flame, materials that can become charged with static electricity, substances with a catalytic action).

- Remove from the vicinity of the units all substances that could spontaneously ignite in increased oxygen concentration.

- Do not smoke.

- Hoses, plugs and gas tanks are used for pressure compensation. They must not be fixed or secured with clamps, adhesive, etc.

- Only use the gas storage tanks associated with or supplied with the units. Never connect alternative gas storage tanks.

- The units may only be operated at room temperature and ambient pressure.

- Minimum separation distances must be observed when using solar modules and artificial lights. These are: 30 cm between h-tec solar modules and the h-tec Videolight, and 50 cm in the case of the h-tec Spotlight. When using lights from other manufacturers, observe the minimum distance specified by them.

- **WARNING!** The surface of solar modules can get very hot during extended operation.

- Tell your students about any potential dangers and carefully supervise experimentation.

- h-tec accepts no responsibility for injuries or damage sustained in the event that these Safety Precautions are not followed.
Introduction

This PEM fuel cell (PEM = Proton Exchange Membrane) produces electricity by using hydrogen and oxygen gas (or atmospheric oxygen). Its only by-products are water and heat.

H₂/O₂ Setting up

Read the Operating Instructions and the General Safety Precautions before using any of the equipment.

1. Fit caps to the bottom outlets of the fuel cell.

   Note:

   Make sure that the stopper is fitted to the air inlet.

2. Connect the gas supply (e.g. h-tec Electrolyser 10 Item No. E102) to the top gas connectors: hydrogen to the negative pole side (black) and oxygen to the positive pole side (red).

3. Connect an electrical load (e.g. h-tec Ventilator Fan Tutorial Item No. A105). When doing so, make sure that the polarity is correct (red = "+", black = "-").

4. The equipment is now ready for operation and can be used for demonstrations or experiments.
H₂/Air Setting up

When you use a Type F103 or F104 fuel cell, you also have the option of operating the cell in air-breathing mode simply by removing the stopper. When operating with atmospheric oxygen, the power of the cell is somewhat lower than when operating with pure oxygen.

1. Fit a cap to the bottom hydrogen output of the fuel cell.
2. Remove the stopper on the oxygen side of the fuel cell.
3. Connect the hydrogen supply (e.g. h-tec Electrolyser 10 Item No. E102) to the negative pole side (black).
4. Connect an electrical load (e.g. h-tec Ventilator Fan Tutorial Item No. A105). When doing so, make sure that the polarity is correct (red = "+", black = "- ").
5. The equipment is now ready for operation and can be used for demonstrations or experiments.
The fuel cells we provide in our sets are maintenance-free. However, always remember:

Before putting the cell away:

- Continue operating the cell until the electric load (e.g. the motor) stops by itself. This will ensure that a little water remains in the cell and keeps the membrane moist.

- Close the caps and the stopper so that the water in the cell does not evaporate quickly.

**Accessories** (not included)

- Electrolyser 5 Item No. E101
- Electrolyser 10 (for Double Fuel Cell H₂/O₂ or Double Fuel Cell H₂/O₂/Air) Item No. E102
- Fan Tutorial Item No. A105
The cell only produces low power

Cause 1:
- The cell has been stored for a very long time or is too dry. A cell with a dry membrane will lose power.

Solution 1:
- Continue to use the cell. The cell will moisten itself during operation and gradually return to full power.

Cause 2:
- Water forms in the cell during operation. This can lead to the gas supply to the cell becoming blocked.

Solution 2:
- Open the bottom caps so that moisture can escape.

The cell does not work in spite of being set up correctly

- You have connected an external voltage to the fuel cell. This leads to the immediate destruction of the catalyst. The cell is permanently damaged.
**Fuel Cell H₂/O₂ (F101)**
Single-cell fuel cell for H₂/O₂ operation
Power: 500 mW
H x W x D: 50 x 40 x 50 mm
Weight: 54 g

**Double Fuel Cell H₂/O₂ (F102)**
Double-cell fuel cell for H₂/O₂ operation
Power: 1 W
H x W x D: 56 x 42 x 57 mm
Weight: 63 g

**Fuel Cell H₂/O₂/Air (F103)**
Single-cell fuel cell for H₂/O₂ operation or H₂/Air operation
Power H₂/O₂: 500 mW
Power H₂/Air: 150 mW
H x W x D: 50 x 40 x 50 mm
Weight: 52 g

**Double Fuel Cell H₂/O₂/Air (F104)**
Double-cell fuel cell for H₂/O₂ operation or H₂/Air operation
Power H₂/O₂: 1 W
Power H₂/Air: 300 mW
H x W x D: 56 x 42 x 40 mm
Weight: 60 g