

Tasks

Model 7 – Fuel cell charging station / chemical energy

Fuel cells are used to convert the chemical energy in a fuel (such as hydrogen) into electrical current. A fuel cell, therefore, is not used to store energy, but rather to convert it.

The fischertechnik fuel cell is what is called a *reversible* fuel cell.

- It can use the energy carriers of hydrogen and oxygen to deliver electrical energy (energy converter).
- However, it can also be operated as an electrolyzer, so that electrical energy is converted into storable chemical energy (water electrolysis).

Excess power generated from renewable energies (in particular wind power and photovoltaics) can therefore be stored chemically on an intermediate basis in the form of hydrogen.

The effectiveness of reversible (hydrogen) fuel cells is between 30 to 40 % when generating direct electrical energy. The rest is released heat energy. In the 1960s, NASA technicians recognised the advantages of this technology for space flights, and installed 3 fuel cells in the Apollo capsules with a total power of just seven kilowatts.

Fuel cell cars do fill up on hydrogen, but drive with the help of an electric motor, meaning that they are electric cars. The technology is still being developed.

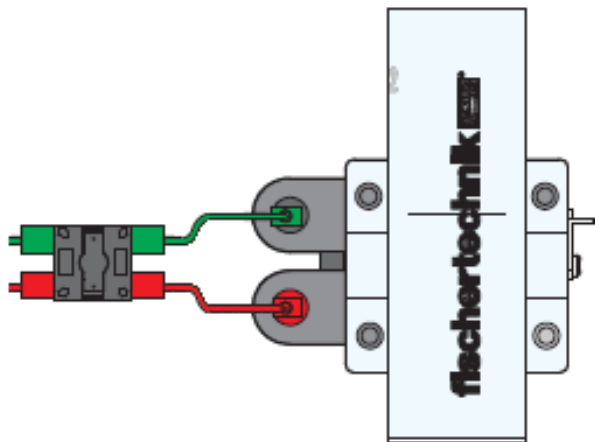
Construction task Model 7

First, read the operating manual for the fuel cell and familiarise yourself with how fuel cells function. Then build model 7 (fuel cell charging station and fuel cell vehicle) according to the instructions.

Fill the fuel cell with distilled water, and connect the fuel cell to the charging station.

Observe the following points:

- Lightly knock the fuel cell against the table so that the water can better flow around the membrane and the collecting metal plate, before inserting the fuel cell into the car.
- Ensure the connection points with the charging station have the correct polarity.
- Check whether the ON/OFF switch on the fuel cell vehicle is open before connecting the fuel cell to the voltage converter.



Once the solar module or solar cells are illuminated with sufficient solar energy or a suitable light source, the generation of hydrogen and oxygen will begin. The gases will be stored in their respective storage cylinders. The water will be pressed into the overflow chambers above.

The fuel cell is fully “charged” once all water has been pressed out of the hydrogen storage cylinder into the overflow chamber above. This process will take around 15 – 60 minutes, depending on the light intensity.

You can disconnect the fuel cell from the solar modules at any time. This will stop the production of hydrogen and oxygen.

Topic task

1. Observe the amount of gas in the two storage cylinders when generating hydrogen and oxygen. What do you observe?
2. What chemical formula can you use to describe the two functions of a reversible fuel cell?
3. How is this regulated reaction, which produces water, electricity and heat, called in contrast to an oxyhydrogen reaction?

Experimental task

1. Now, connect the voltage converter of the fuel cell car to the fuel cell. The fuel cell has a significantly greater drop in voltage as current increases, in contrast to batteries. In applications with different load requirements, therefore, a voltage converter is required in most cases. This allows the voltage level of the feed into the circuit to be controlled. Allow the car to drive straight ahead and measure the time until half the tank is empty. Use the second half of the tank for the car to drive around a curve. Here as well, measure the time until the

tank is empty. What is the energy consumption of the fuel cell like when the car is driving straight ahead, in contrast to when it is driving around a curve?

2. When cars drive around curves, the outer wheel travels farther than the inner wheel. The outer wheel therefore turns more quickly. To allow for the two wheels to travel at different speeds, just one of the wheels is driven; the other is mounted on the shaft so that it can rotate freely. How does the car drive differently if the drive wheel is on the inside or outside?
3. What technical invention can be used to drive both wheels at different speeds?

Optional:

1. Test the operation of the fuel cell with other fischertechnik models.
2. Try to operate the fuel cell in parallel with the solar modules.
3. You can test out other experimental setups: Solar module → Goldcap (parallel connection) → Fuel cell → Motor.