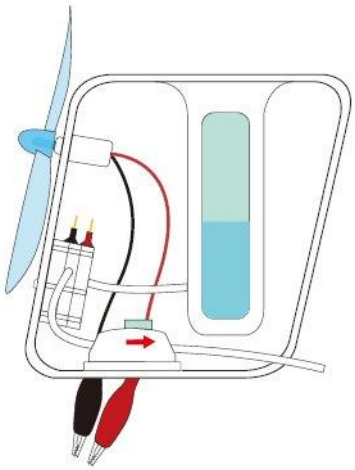
Bio-Energy Kit

Horizon Bio-Energy Kit FCJ-22

Experiment 1: Create electricity from ethanol and water

1. Open the purging valve by pushing the switch to the right side (see red arrow). Make sure that the tubing connecting the container to the fuel cell is securely attached.

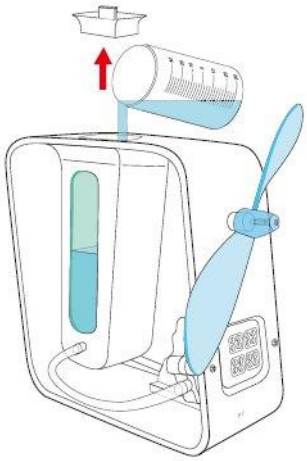


2. Prepare in a glass container 100 ml solutions of 10 % ethanol in distilled water.

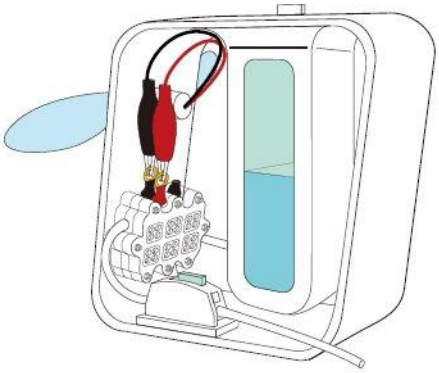
Warning:
Do not allow **pure ethanol** to enter the fuel cell.
The DEFC (Direct Ethanol Fuel Cell) creates power using 5-15% alcohol only. A concentration higher than 15% could damage the fuel cell and cause it to stop working correctly. For best operation please use a mixture of 10% ethanol and 90% distilled water.

To get a **10 % solution** you should fill the container with 10 ml of pure ethanol (fill container to the 10 ml level). Fill the remainder of the container with distilled water to the 100 ml level. Stir the liquid in the container thoroughly.

3. Pour the solution into the ethanol container. Put the lid back to the container.
Note: When the solution starts dripping out of the tube, close the purging valve by pushing the switch to the left side. Then wait for 5 to 10 minutes before connecting the wires.



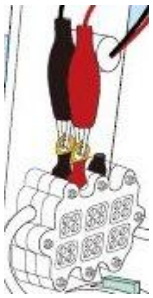
4. After waiting for 5-10 minutes, connect the two crocodile clips (red and black) that are attached to the motor to the two terminal plates of the fuel cells current collector, which are both located on the upper part of the fuel cell.



Since the reaction is slow, the fan can run for up to several hours without purging.

Experiment 2: Exploring polarity

1. Connect the positive (red) crocodile clip to the positive side of the fuel cell (red "+" mark), then connect the negative (black) crocodile clip to the negative side of the fuel cell (black "-" mark). You will notice the fan will turn **clockwise**.



2. Now repeat the process, this time however connect the positive (red) crocodile clip to the negative side of the fuel cell (black "-" mark) and connect the negative (black) crocodile clip to the positive side of the fuel cell (red "+" mark).
You will notice the fan will turn **counter-clockwise**.

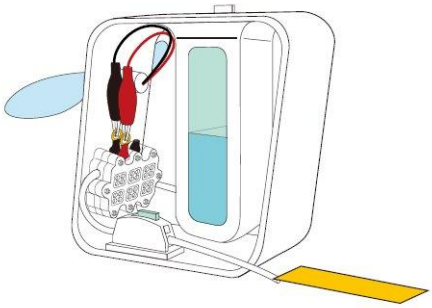
3. Conclusion: The current flows from positive to negative, creating a clockwise spin of the fan. By inverting the polarity connections, the current flow reverses and makes the fan spin in the opposite direction.

Experiment 3: Ethanol fuel consumption

When the fan begins to run slower or stops running completely, this means the ethanol present in the fuel cell chamber is mostly consumed. In normal temperature conditions, the majority of the ethanol inside the fuel cell chamber turns into **acetic acid**, which is the main component of vinegar.

Let's investigate the consumed fuel (acetic acid) when the fan begins to run slowly.

1. Place a piece of PH paper under the outlet of the purging tube.



2. Open the valve slowly by sliding the switch towards right side, and release a drop of the solution onto the pH paper, and then close the valve. You can see the paper color changing to a reddish color quickly.

The chemical reactions taking place at the anode showing that acetic acid is formed as hydrogen protons depart from the ethanol molecule and the water molecule. These hydrogen **protons** cross the fuel cell membrane, and the liberated electrons form the electricity that is able to propel the fan.

Conclusion: The Direct Ethanol Fuel Cell creates electricity by chemically converting the ethanol solution into an acid solution, which is close to common vinegar. In order for the fuel cell to function continuously, "spent" fuel must be replaced with new fuel regularly.

The Bio-Energy Kit can be bought, for example, in an online store with educational tools:
https://www.sklep.fpnnysa.com.pl/Bioenergia-etanol-zrodlo-energii

Price 461 zł (Polish zloty). It is abort 110 EUR.

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