

Manual and Operational Instructions

Platform Series
Item # 4206



Fuel Cell,

Solar Energy, and

Hydrogen Technology

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Introduction:

Due to the increase of worldwide fossil fuel consumption, pollutants in the atmosphere are increasing to worsen the greenhouse effect everyday. Such pollutants endanger our health and greenhouse gases such as CO₂ cause global warming. In the near future, there will be insufficient amounts of fossil fuels compared to the demand because of the lack of natural resources. Therefore, it is our responsibility to solve this problem. We must look into new technologies in order to produce renewable and green energy without relying on fossil fuels. One of these new technologies is the fuel cell which is used as energy conversion devices in which hydrogen is used as an energy carrier. Hydrogen technology combined with renewable solar, wind, biofuel, and geothermal energy shows the most promising future and potential. Research and development of oil, power, and automobile industries are also aiming at hydrogen and fuel cell technology. In the onset of the oil era and the rise of hydrogen economy, it is our duty to inform and educate the next generation about hydrogen and fuel cell technology advantages to cause cost reduction and smooth transitions. We are trying to expand the young generation horizon about energy industry evolution and its direction.

The product shows:

- The advantages of fuel cells and hydrogen technology in tangible operations.
- How hydrogen can be used as an energy carrier.
- Advantages of electrochemical reactions, such as efficiency, clean and silent operations.

This manual helps to setup, operate, and maintain Platform Series.

Read the manual thoroughly before setup and then start running the educational kit.

Purpose of use:

The platform series is an educational tool for demonstration and education of renewable energy storage and conversion. Any other uses are prohibited.

The platform series needs light from the sun or a desk lamp and distilled water (with conductivity less than 2 μ S/cm) for operation. It produces H₂ and O₂ gases in small quantities.

Caution:

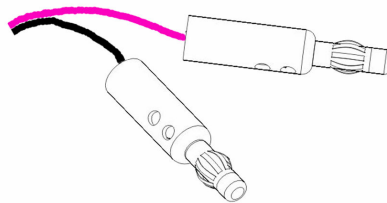
- **Do not accumulate a mixture of oxygen and hydrogen gas in a confined space.**
- **Do not expose metal catalysts to hydrogen gas.**
- **Do not expose hydrogen gas to a flame.**

Please follow the instructions in this manual and follow the safety precautions carefully to prevent any risk.

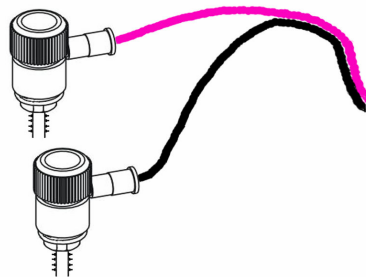
This manual is based upon our best of knowledge. H & FC is not responsible for any error in its content. We reserve our right to change it without previous notice.

Safety Precautions:

- Read the instructions before setting up the products. Follow the instructions during use and keep them available for any further references.
- Eye protection is strongly recommended.
- Care must be taken while connecting the light bulb to electricity to avoid electric shock.
- When the light bulb is on, the bulb and the desk lamp cover may become very hot. Avoid contact with any hot surfaces.
- The minimum distance between the light bulb (60w halogen, flood or spot) and the solar cell should be 12 inches (about 30 cm) to avoid damage to the solar cell. Lights with more power (higher watts) should be further from the solar cell to avoid damage to solar cells.
- The surface of solar cells will become hot if exposed to high intensity light.
- Never use the electrolyzer without water.
- Do not apply voltages more than 2.0 volts to the electrolyzer.
- Do not fold the flexible tubes or wires.
- Handle the educational kit with care.
- Insert each connector cable (banana plug) to its relative colored



Banana Plugs



Banana Jacks

terminal (banana jack) and never change the polarity.

- Never apply any external voltage to the fuel cell for it will cause damage to the system. Also, it will accumulate an explosive gas and will damage the catalysts.
- Operate system in a room with an appropriate ventilation system. Small amounts of excess hydrogen and oxygen normally exit from the system.

Hydrogen with more than 5% concentration in air is explosive in close space. Do not run the system in small spaces or small closets without ventilation.

- Do not use the system near flames or any device that can produce or accumulate static electricity.
- This system has been designed to operate at standard room temperature and pressure.
- Do not dismantle the fuel cell or electrolyzer. Do not swallow or inhale the anode and cathode catalysts. Avoid exposure of the catalyst to flammable organic compounds such as alcohol or hydrogen in the air. Catalysts can ignite spontaneous combustion reactions.
- This system is not a toy. Keep out of the reach of children.

H & FC Inc. is not responsible for any property damage or injury if the preceding safety precautions were not followed or if used in any other application rather than the intended use.

Parts and Materials:

The platform series consists of following items:

1. Platform with two terminals
2. Tilt-able solar cell
3. Electrolyzer cell (blue color cell)
4. Water and gas storage tanks: two 3/4" (2cm) diameter long tubes, two 3/4" (2cm) diameter short tubes, one 1/6" (4mm) diameter tube, two rubber connectors, and two rubber end caps
5. Fuel cell (transparent cell)
6. Electric load: wind turbine model (tower and blade), screw and nut
7. Eight rubber tubes and four clamps
8. Two sets of electric connector cables
9. Two nuts and two screws
10. A bottle of distilled water

(Keep packaging material for future use)

Set Up:

1. Insert the rubber connector (with the small diameter tube) inside the large tube as shown in figure 1. Then place the upper shorter tube on the top of the rubber connector (Fig. 1)
2. Place the water tank tube in the base plate. (Fig.2)
3. Connect the electrolyzer water inlet and gas outlet to the water tank tubes using the flexible tubes. Then, connect the water tank tubes to the fuel cell using flexible tubes. Prevent the flexible tubes from being folded. (Fig. 3)
4. Attach the wind turbine (model) tower to the base plate with the

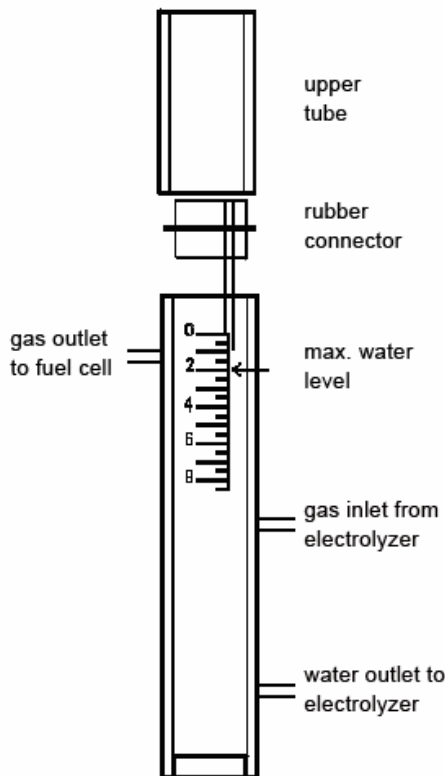


Fig. 1 Water tank tube assembling

- screw and nut provided. Connect the fan blade to the electric motor shaft. Avoid pushing the blade all the way to the end of the electric motor shaft. Check to make sure that the fan can rotate freely (Fig. 3)
5. Connect the solar cell to the electrolyzer via cable connector
 6. Connect the fuel cell banana plugs to the wind turbine banana jacks.

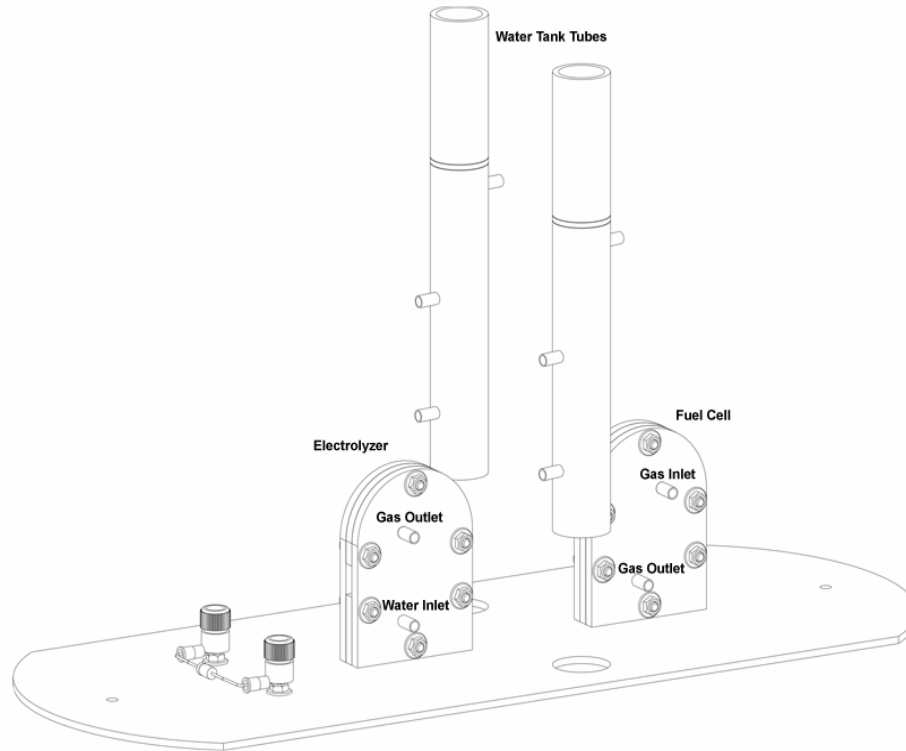


Fig 2. Placing the water tank tube to the base Plate

Hydrogen and oxygen reservoir in the water tank tube should be attached to the hydrogen and oxygen sides of the fuel cell respectively. Connect the tubes to the upper inlets of the fuel cell and set the lower outlets free for the excess gases to be carried off.

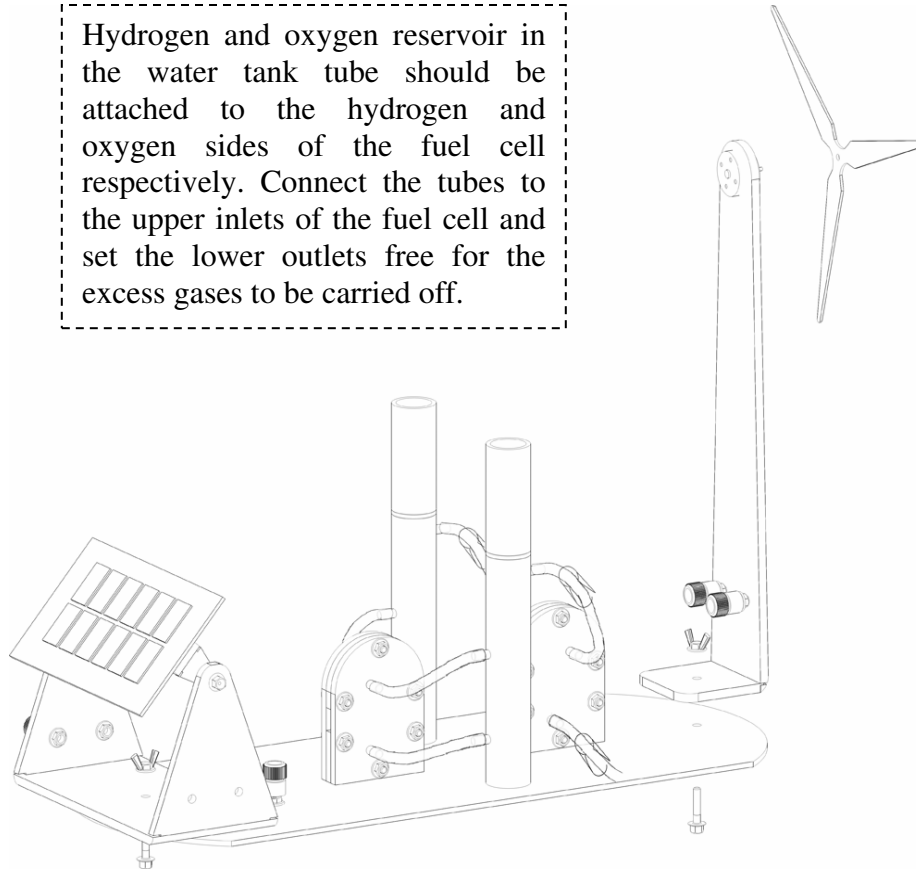


Fig. 3 Connecting Rubber Hoses and Clips

Operation:

1. Fill the electrolyzer water tank tube with distilled water (conductivity less than $2\mu\text{S}/\text{cm}$) to the height level 2 as shown in figure 1. Avoid overloading the tube.
2. Place the light bulb (halogen 60 W, flood or spot type) at a distance of approximately 12" (30cm) from the solar cell.
3. Turn on the light bulb and shine the light to the solar cell.
4. When the electric current with 1.6 volt or more reaches to the electrolyzer, hydrogen and oxygen bubbles will appear in the anode and the cathode of electrolyzer. To store hydrogen and oxygen block the two flexible tubes that connect the water tank tube to the fuel cell, by means of clips which are placed on the hoses. Fig. 3. Misplacing the polarity or applying voltages in excess of 2.0 volt will permanently damage the electrolyzer.
5. Wait until the water rises in the hydrogen side of the small top-tube of the water tank tube to about 1.6" (4cm) Fig 4.
6. Open the clips and let hydrogen and oxygen gases enter the fuel cell.
7. The electric motor will start to work after a while. (Otherwise, repeat steps 4 to 6.)

You should repeat this step several times in order for the hydrogen to wash

out the air in the tubes and reach the surface of the anode.

In addition, it takes some time for hydrogen to carry enough moisture to humidify the membrane. The dry membrane has a high resistance to proton conductivity.

Fuel cell works better when the hydrogen outlet is kept closed and the oxygen outlet is kept opened. Periodically, open the fuel cell hydrogen outlet shortly to washout the anode side.

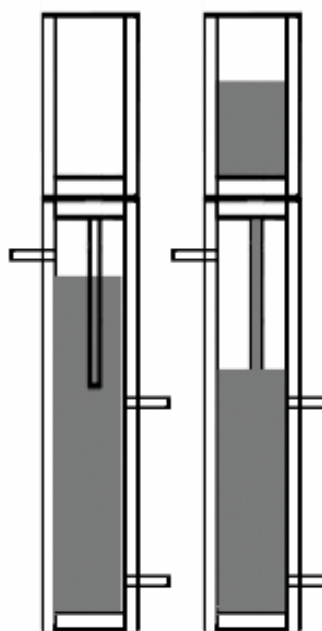


Fig. 4 Water rises during hydrogen storage

How the system works:

When light is emitted and reaches the solar cells, the cells convert the energy of light to electricity. The electrolyzer uses this electricity to decompose the water, producing hydrogen and oxygen gases. These gas products enter the fuel cell and within an electrochemical reaction, water and electricity is produced. As the end-product of the fuel cell, electric energy will power the electric motor.

Solar Cells Operation:

The solar cells work with a halogen type light bulb (flood or spot) with a minimum power of 60 watts. The minimum distance between the lamp and the solar cells should be about 12 inches (30 cm). The solar cells provide more power and the system works better if a more powerful halogen bulb (flood or spot type) is used. The distance between the bulb and the solar cells must be increased to avoid any damages to the solar cell.

Electrolyzer Operation:

The electrolyzer needs a minimum power of 1.6 volts and a maximum of 2.0 volts and distilled water with a conductivity of less than $2\mu\text{S}/\text{cm}$. In the anode side (positive), oxygen gas will be produced and in the cathode side (negative), hydrogen will be produced. Each storage tube tank can store about 12 ml of gas.

Fuel cell Operation:

First, the air in the tube and in the fuel cell will be washed out with hydrogen and oxygen. Then the fuel cell will start operating after the proton exchange membrane (PEM) receives enough moisture from the flow of the hydrogen and oxygen. The open circuit potential of the fuel cell will rise to about 0.8 volt and it will then be ready to start the fan. In most cases, the fuel cell will work better if excess oxygen comes out of the fuel cell and if the hydrogen outlet remains closed. It is safer and better to adjust the voltage of the power going to the electrolyzer (by adjusting light intensity) in order to produce slightly more than the amount of hydrogen that the fuel cell can consume.

Fan (Wind Turbine Model) Operation:

The fan acts as an electric load. The electric motor needs a minimum of 0.3 volts. Check to be sure the blade is not stuck. The blade could be in contact with the electric motor or other objects. Turn the fan with your hand to check it is not stuck.

Data Sheet:

Item Number 4206

General Specifications

Solar Module:	(3V/250 mA)
Electrolyzer:	PEM, 1.0 W
Gas Storage:	12 ml each
Fuel Cell:	0.6 W
Electric Load:	20 mW
L x W x H:	6.5"×16.2"×12.3" 166×413×312mm
Weight:	2.5 lb (1.14 kg)

Troubleshooting:

If the electrolyzer does not work:

1. Check if there is a fresh and sufficient amount of distilled water with the conductivity of less than $2\mu\text{S/cm}$.
2. The electrolyzer will operate with a minimum of 1.6 volt power. Power more than 2.0 volts will damage the electrolyzer. The solar cell's distance and its angle towards the light affect the power that the electrolyzer will receive.
3. Be sure a proper lamp (halogen, spot or flood type) with a minimum power of 60W is used. Solar cells can provide more power and the educational kit works better if a more powerful lamp is used.

If the fan does not rotate:

1. Check to see if the blade can rotate freely and is not stuck. (The blade should not be pushed all the way back and should not be touching the electric motor.)
2. Check all the electric connections between the fuel cell and the fan.

If the fuel cell does not provide power:

1. Fuel cells should receive sufficient amounts of hydrogen and oxygen. The proton conductive membrane (PEM) must have enough moisture and must not be dried out. During the operation, inlet hydrogen and oxygen gas will carry out sufficient humidity to moisturize the membrane in 10 to 15 minutes.
2. Fuel cell works better when the hydrogen outlet is kept closed and oxygen outlet is kept opened. During continuous fuel cell operation, if power production reduces, open the fuel cell hydrogen outlet shortly to washout the anode side.
3. If you run the system continuously for a long period of time (couple of hours), check to make sure that the cathode side of the fuel cell is not flooded with water. In this case drain the water droplet from the cathode side of the fuel cell.

Care and Maintenance:

1. If you are not running the system for long period of time (days), or storing the product, drain the water of the electrolyzer and the storage tank tube.
2. If running the system continuously, add distilled water to the electrolyzer to compensate the consumed water. Also, in the case of continuous running, change the water every three to four days.
3. Every time the educational kits are started, use fresh distilled water.
4. To prevent the scratching of the external surface of the educational kits use soft cloths such as lens cloths for cleaning purposes.

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