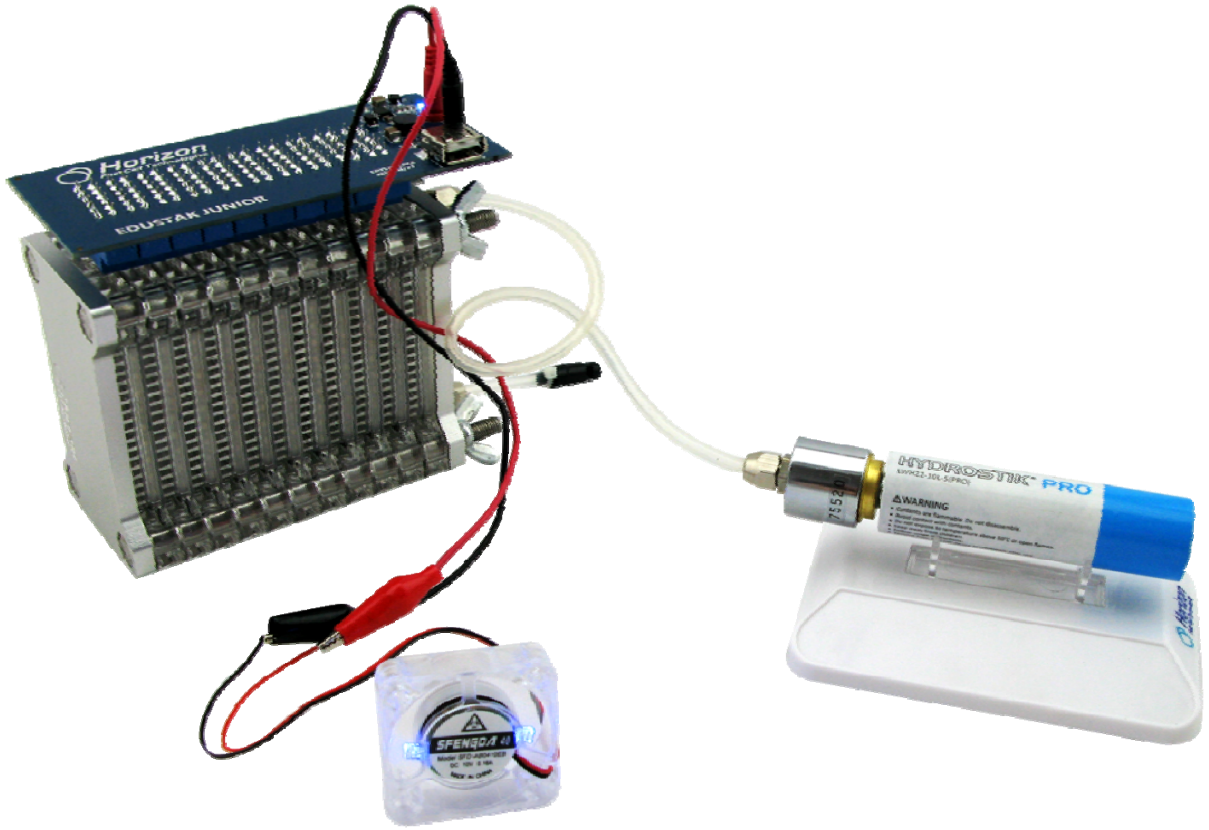
EDUSTAK JUNIOR

Build Yourself Fuel Cell Stack Kit – FCSU-32



User Manual

EDUSTAK JUNIOR User Manual rev.1.1
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Contents

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1. Introduction

1.1 Foreword

Thank you for choosing Horizon Fuel Cell Technologies' EDUSTAK JUNIOR. We hope you will enjoy to use it! Please read all these instructions before operating the EDUSTAK JUNIOR for the first time, and shall keep all manuals for future reference.
If you still have any questions about operating or using your EDUSTAK JUNIOR. please contact Horizon.
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1.2 Production disclaimer

Any unauthorized service, modification may adversely affect the safety, durability, and performance of the system and shall immediately void any warranty on the system. Misuse, neglect, or improper servicing of this equipment may result in the kit damage. Do not operate this kit if it is damaged. Failure to observe instructions contained in this manual will void any limited warranties and could result in suspension or denial of service, legal action, or both.
The EDUSTAK JUNIOR has not been tested at environmental temperature extremes. Therefore, no guarantee of performance is made for operation at ambient temperatures less than 5° C and greater than 40° C .

1.3 Contact details

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General Safety Instructions

- Read the user manual before operating the EDUSTAK JUNIOR, and keep it close to the device at all times.
- EDUSTAK JUNIOR and its fuel cartridge must not be stored at temperatures over 40℃ (313 K) and must not be operated at temperatures over 40 ℃ (313 K). Protect from heat and direct sunlight.
- Operate the EDUSTAK JUNIOR in a well-ventilated space.
- When the EDUSTAK JUNIOR is not used for a long time, ensure to store it in a cool, dry storage.
- Do not smoke in the vicinity of the EDUSTAK JUNIOR or its fuel cartridge. Protect from heat and ignition sources. Hydrogen is highly flammable!
- After an accident or in the event of damage to the fuel cartridge potentially poses a fire hazard. Keep away from ignition sources and ensure good ventilation.
- Keep all EDUSTAK JUNIOR and its fuel cartridges out of reach of children, even when cartridge is empty or only partly full.
- The area surrounding the fuel cartridge shall be kept clear and free of combustible materials, gasoline and other flammable vapors and liquids.
- This appliance is not tested for use with medical devices.
- Save these instructions and review frequently during use.

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HYDROSTIK PRO SAFETY INFORMATION:

- Remove the HYDROSTIK PRO from the pressure regulator immediately after use.
- DO NOT try to disassemble, open or repair the cartridges when broken or worn out!
- DO NOT store cartridges under direct sunlight.
- Keep it away from fire. Fire Hazard!
- Keep it in a safe, dry and cool place.
- Keep it away from temperatures above 50˚C while filling, storage and using.
- Provide adequate ventilation and refrain from placing items on or around the appliance during operation. Refrain from placing the appliance in enclosures or causing the appliance to not vent freely.
- Keep away from alkaline and acidic environment.
- This is not toy – keep away from children.
- The HYDROSTIK PRO cartridge must be placed horizontally when it is being charged otherwise the cartridge can crack!
- HYDROSTIK PRO contents are flammable. Do not disassemble.
- Avoid contact with HYDROSTIK PRO contents.
- Remove the HYDROSTIK PRO from the pressure regulator immediately after use.
- When using the appliance, basic safety precautions should always be followed to reduce risk of fire, or personal injury.
- Hydrogen shall be stored, handled and used with caution so life and health are not jeopardized and the risk of property damage is minimized.

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3. Part List

a. EDUSTAK JUNIOR*
b. HYDROSTIK PRO**
c. Manometer
d. Electronic PCB card
e. Blower fan
f. Air pump
g. HYDROATIK PRO base
h. Purging valve with tube
i. Screws
j. Three port connector
k. 3 silicon tubes
l. Clamp with tube
m. Pressure regulator
n. HYDROSTIK PRO support
o. Wires


a

b


c

d


e


f


g


h


i

j


k

l


m


n


o

* The EDUSTAK JUNIOR is already assembled when you receive it for the first time.
**The HYDROSTIK PRO contains no hydrogen when you get it for the first time, you have to fully charge it with the refilling station HYDROFILL PRO (sold separately) or hydrogen charging tube (sold separately).

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4. EDUSTAK JUNIOR Specifications

Type of fuel cell	PEM
Number of cells	10
Rated Power	4W
Performance	6V @ 0.7A
Reactants	Hydrogen and Air
External temperature	5 to 35ºC
Max stack temperature	55ºC
H2 Pressure	0.45-0.55bar
Hydrogen purity	≧99.995％ dry H2
Humidification	self-humidified
Cooling	Air (integrated cooling fan)
Dimension	125mm*60mm*95mm
Weight	510 g
Flow rate at max output*	0.05 L/min
Start up time	≦30S at ambient temperature
Efficiency of stack	40% @ at full power
Low voltage shut down	5V
Over current shut down	1A
Over temperature shut down	50ºC

** The flow rate may change with the power output.*
*** The specification is subject to change without notice.*

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Using advices

In order to reach the best performances from your EDUSTACK JUNIOR, and to guarantee his life span; we strongly recommend to respect the following advises:

- Strictly follow the user's manual.
- Make sure the EDUSTAK JUNIOR has passed the leakage testing before operation.
- Operate it in a well-ventilated, dry area.
- HYDROSTIK PRO should be connected to the pressure regulator tightly when operation.
- Make sure to respect the polarity when you connect the EDUSTAK JUNIOR to a load.
- The EDUSTAK JUNIOR PCB is not allowed to contact the metal parts in case shorting circuit occurs.
- Operate it under ambient temperature. Keep it away from the strong direct sunlight.
- Manually use the purging valve to purge the system every 3 minutes for good performance.
- EDUSTAK JUNIOR is not a cell phone charger, but it could be used as a demonstration device.
- After you have finished using the system, disconnect the HYDROSTIK PRO from the pressure regulator immediately. store it in the zip lock bag for storage.
- If leakage happens after several assemblies, place the EDUSTAK JUNIOR into the purified water without the electrical PCB card. Use the air pressure bulb to inject air into the stack. Observe where the bubbles come from and then adjust the stack assembly. But the stack must not be tested and operated with the water vapor inside. The stack must be dry.
- Avoid strong collision.

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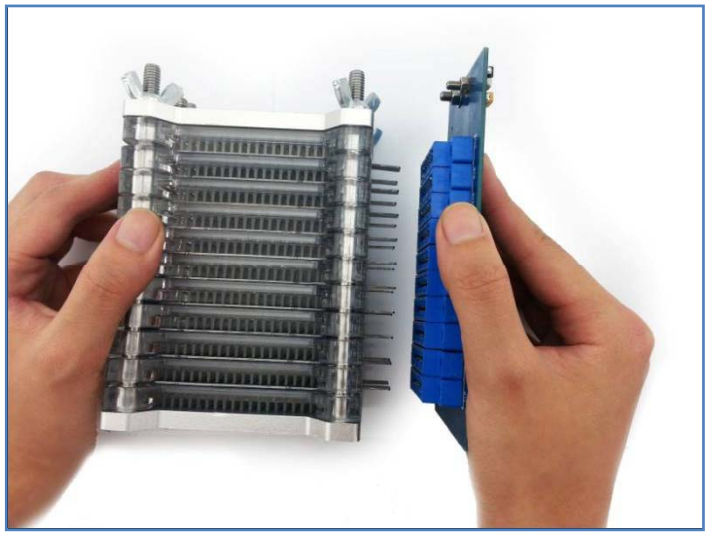
Note: The EDUSTAK JUNIOR is already assembled when you receive it for the first time, which could be directly tested.

Step 1: Clips the EDUSTAK JUNIOR and the electronic PCB card directly together. Ensure the connection in the good sense (electronic plugs in the same side than the wing nuts on the EDUSTAK.)



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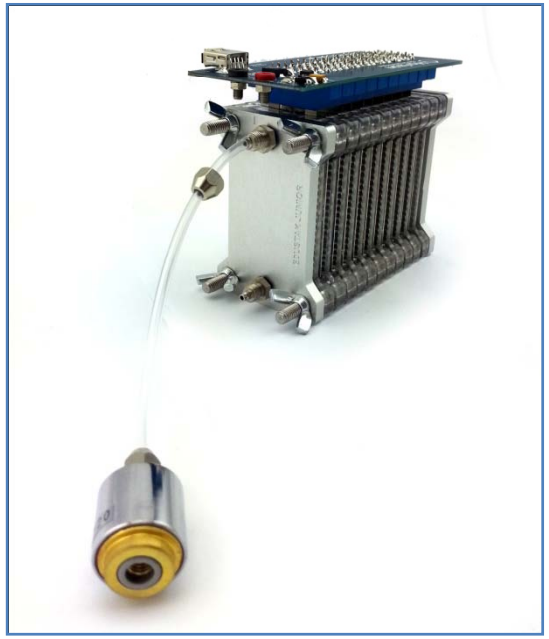
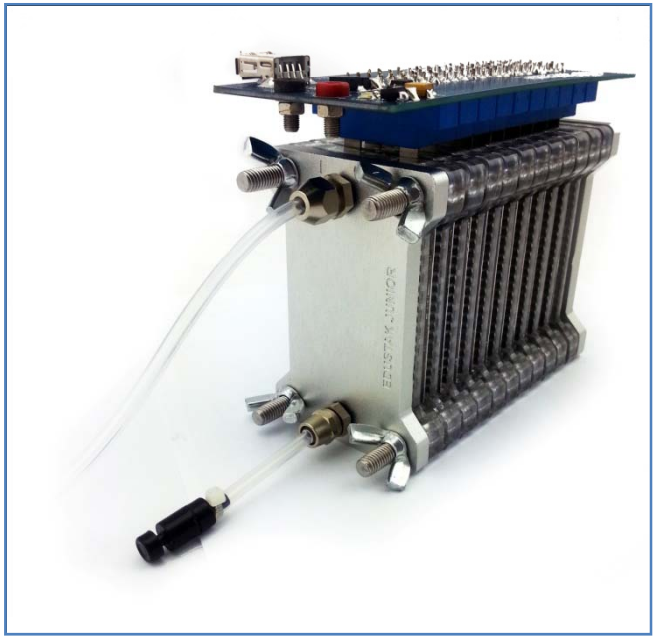
Step 2: Unscrew the pressure regulator bolt, and pass it around the longest silicon tube. Connect one tube end to the main part of the pressure regulator. Ensure the connection in tight and then, screw the bolt on the pressure regulator. Do the same operation between the other end of the tube and the upper nozzle of the EDUSTAK JUNIOR close to the PCB card.

Step 3: Unscrew the lower nozzle bolt, and pass it around the purging valve tube. Connect it to the lower nozzle of the EDUSTAK JUNIOR and then screw the bolt.





Make sure all the tube connections are tight.

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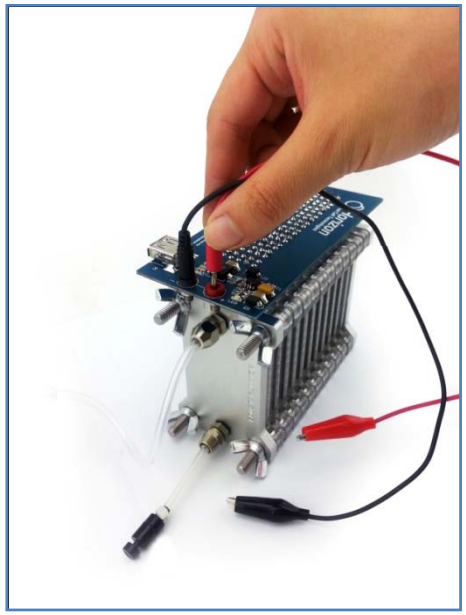
Step 4: Put the HYDROSTIK PRO support on its base. Ensure both part meet perfectly. Place the HYDROSTIK PRO onto its support and lightly screw the pressure regulator onto the HYDROSTIK PRO nozzle. Stop to screw it as soon as both part meet together. On the opposite, the hydrogen will go out of the HYDROSTIK PRO.

Step 5: Plug the two crocodiles pincers into the sockets located on the electric card.
Ensure to respect the polarity shown by the color code.



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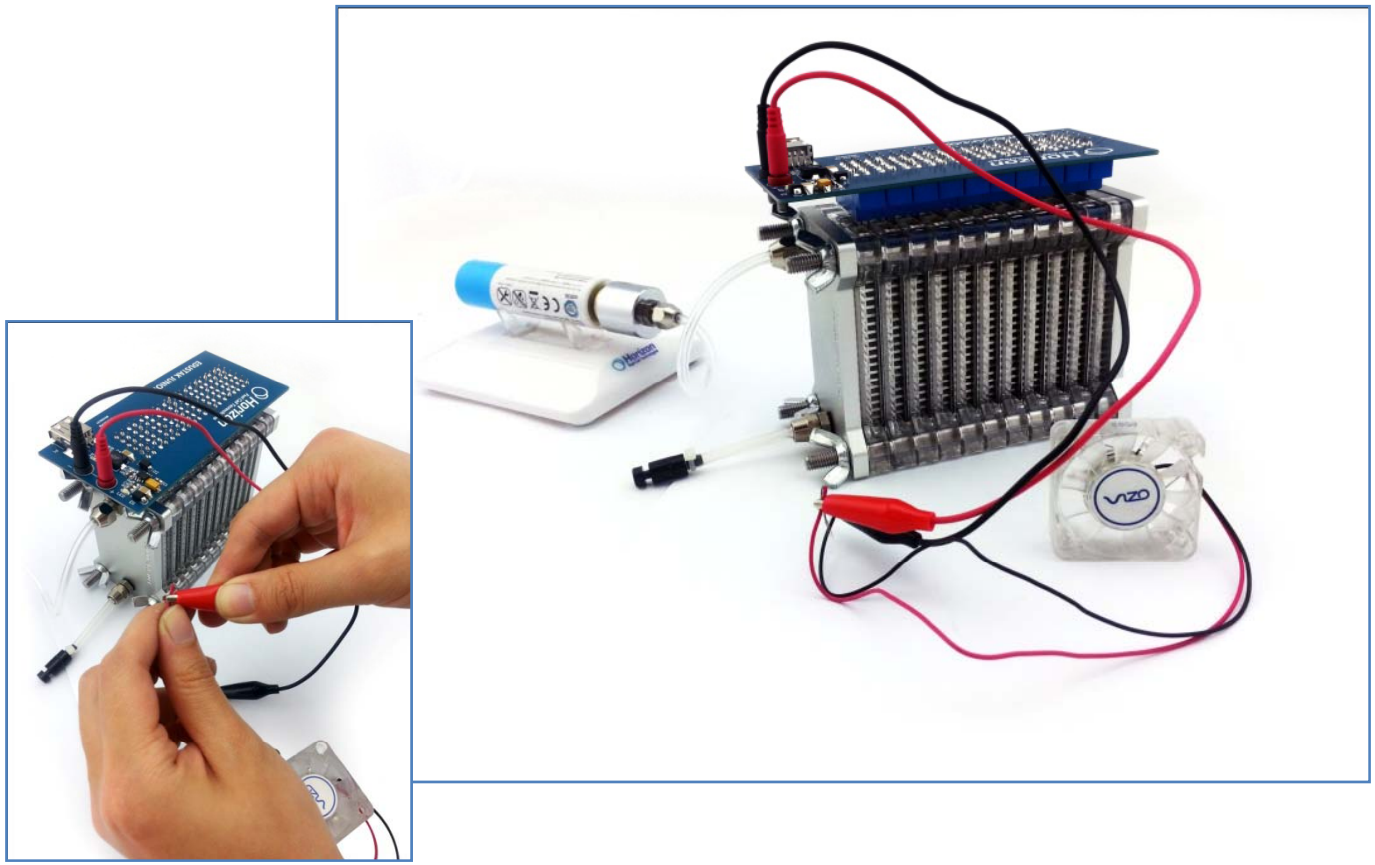
Step 6: Connect the crocodiles pincers to the blower fan wires. Ensure to respect the polarity shown by the color code.
Now your system is ready to work.



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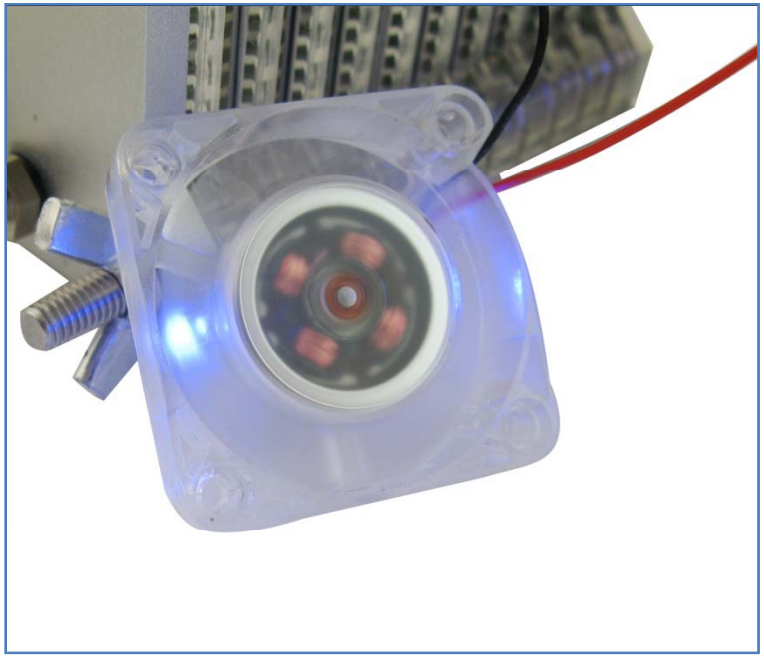
Step 7: Finish to screw the pressure regulator to the HYDROSTIK PRO. As soon as it will be done, the blower fan will start and the LEDs on it will light on.



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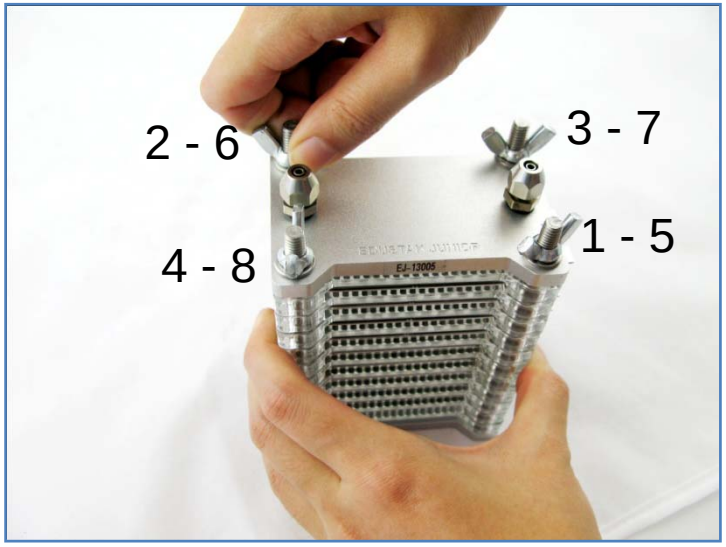
Note: If you wish to disassemble the stack by yourselves, do the following guide.

Step 1: Start by unscrew the right closest corner wing nut (1) only on the half of the available length. Do the same with the left opposite (2) corner wing nut, then with the closest left one and finish by the bottom right corner. After that, restart the operation in the same order and fully unscrew the wing nut. Put off the washers.



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Step 2: Hang the system and remove the long screw from their position. Your cell is disassembled.

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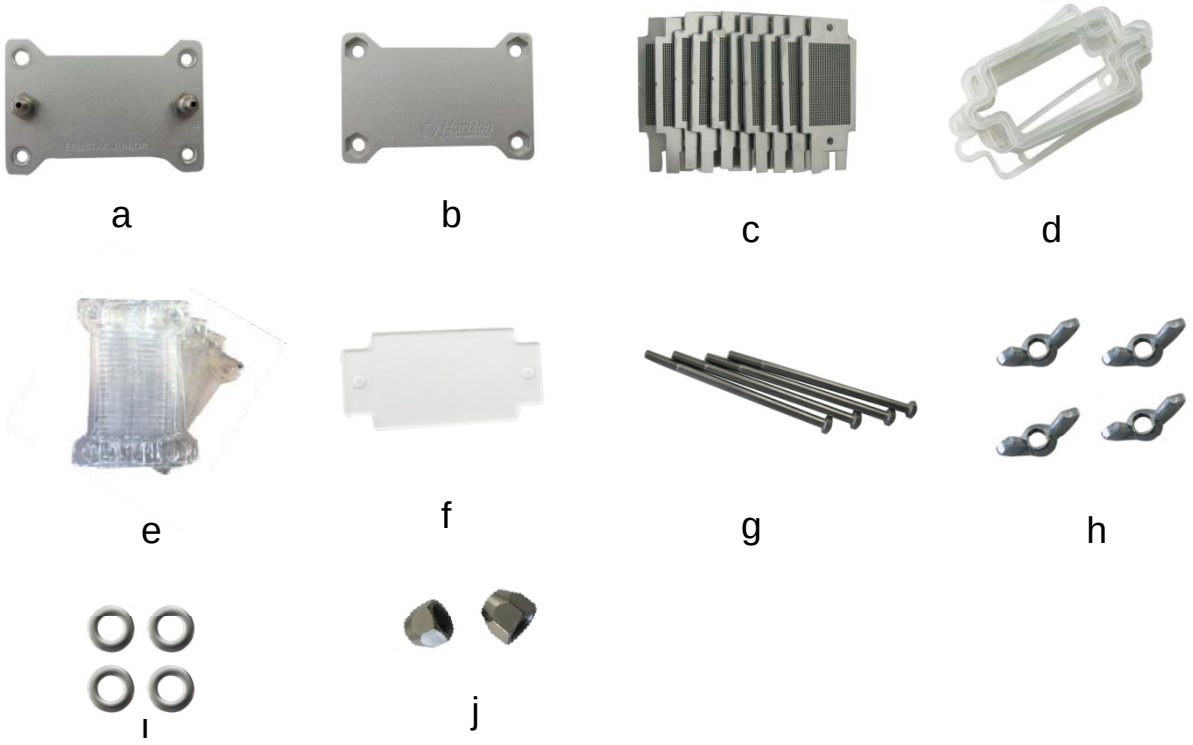
6. Disassembly Guide

Now you have disassembled the EDUSTAK JUNIOR, you get the following parts from the EDUSTAK.

a. Upper end plate
b. Low end plate
c. Single cell (10pcs)
d. Sealing (11pcs)
e. Plastic plate (11pcs)
f. Plastic cell
g. Screw rods
h. Wing nuts
i. Washers
j. Bolts



Note: For any manipulation of dismounted elements, be sure not to insert elements which could disturb the system sealing, damage MEAs and/or create short-circuit.

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7. Assembly Guide

Note: Now you may assemble the EDUSTAK JUNIOR, please do the following guide.

Tools maybe needed during the assembly.

Step 1: Pass the screw rods through the basis of the low end plate. Return the basis and put it on a plane area.
Note: Pay close attention to the direction of the low end plate.
The side of the plate with the Horizon logo should face downwards.

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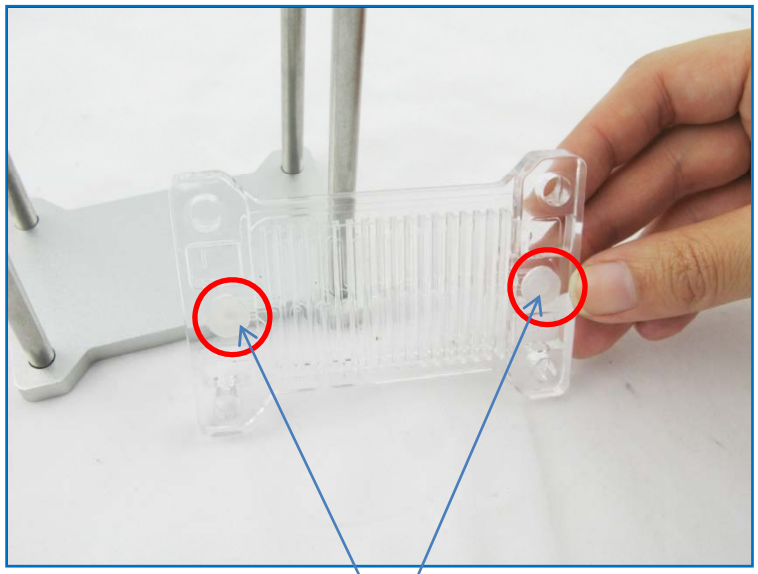
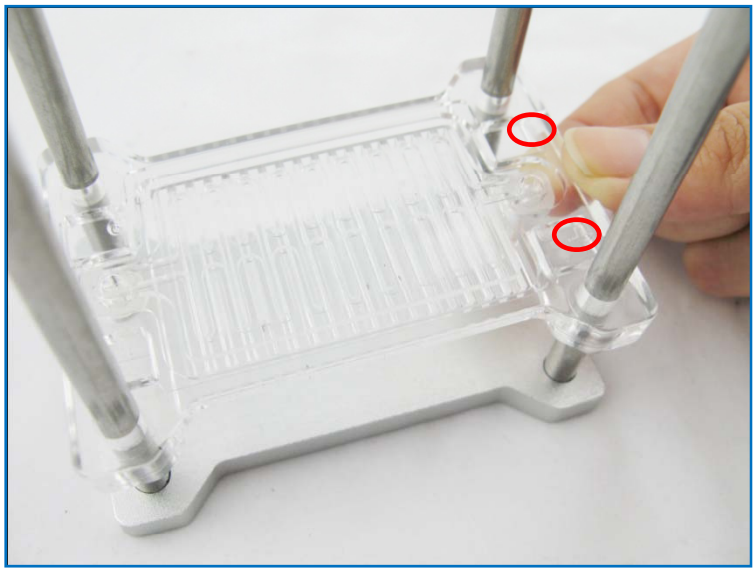
Step 2: Insert the plastic plate with the rubber sealing ring facing downwards on the screw and ensure the grooves are putted on the upper side.
Note: Pay close attention to the "+" and "-" on the plastic plate. Make sure all the plastic plate should face the same direction.





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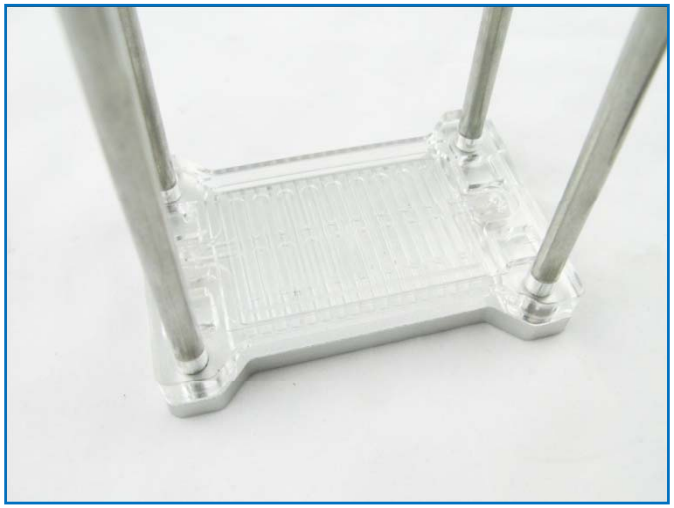
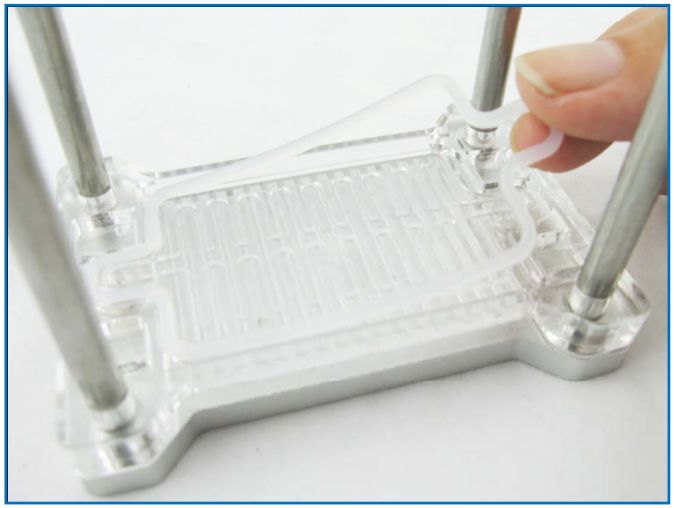
Step 3: Add a rubber seal in the corresponding groove and ensure it is deeply inserted.





Note: Pay close attention to the direction of the rubber seal. The round side of the rubber seal should be facing upwards.

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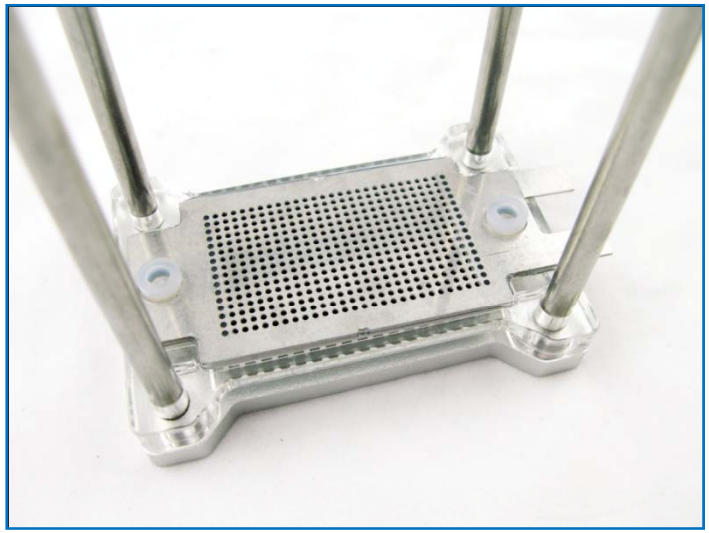
Step 4: Put the first single cell on it. Ensure the white nozzles are on the upper side.



Note: Pay close attention to the direction of the single cell. Ensure to put the two ends of the cell in the same side than the side of the plastic plate without the raised edge.

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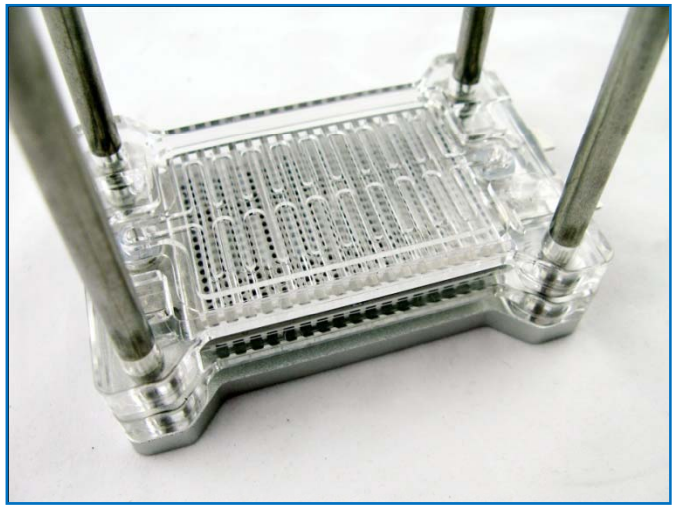
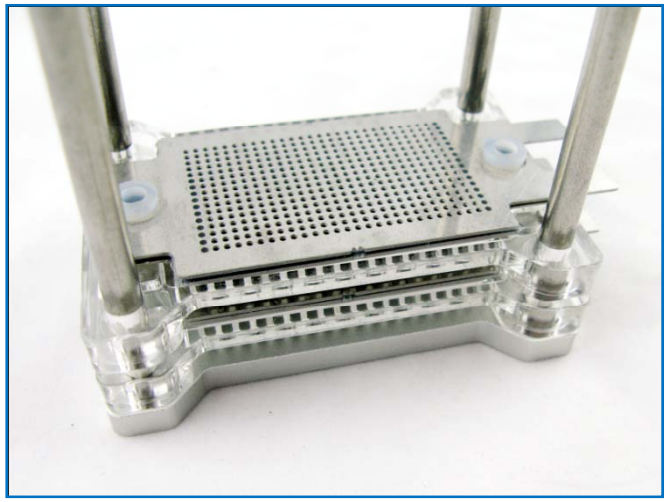
Step 5: Restart at step two with all the remaining plates, cells and seals.
Make sure all parts direction are correct.





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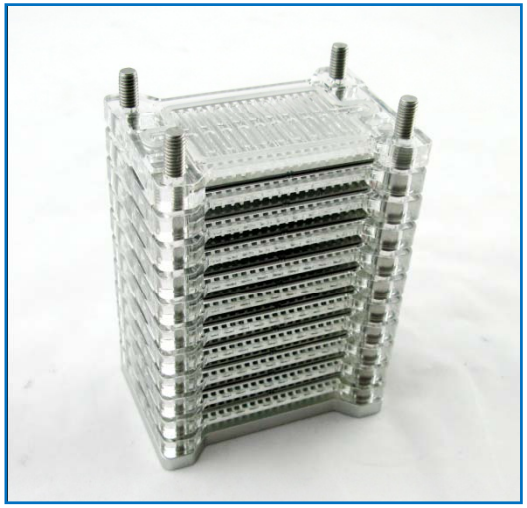
Step 6: Put the plastic cell with the sealing facing upwards on the top and ensure the whole on it is faced to the corresponding one on the previous plate.



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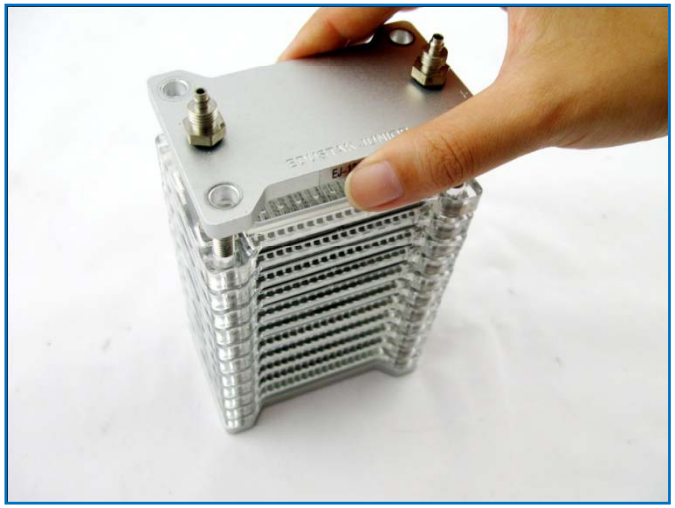
Step 7: Add the upper end plate of the EDUSTAK JUNIOR on the top, put the washers on the screw rod and screw the wing nuts on it. You have to screw the nuts tightly in the opposite sense than you used to disassemble the kit.

Note: 1. Pay close attention to the direction of the upper end plate. You can notice on the upper end plate it also marks “+” and “-” . Make sure they are facing the same direction as the plastic plate.
2. After assembly, measure the length between the upper end plate and the lower end plate. The length should be less than 110mm. You have to reassemble the stack. Otherwise leakage will occur.



Now your EDUSTAK JUNIOR is assembled and ready to pass the leakage testing.

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8. Leakage testing

8.1. Part lists for leakage testing

a. EDUSTAK JUNIOR

b. Manometer

c. Air pressure bulb

d. Purging Valve with tube

e. Three-port connector

f. 2 silicon tubes

g. Clamp with tube

a

b

c

d

e

f

g

Note: After assembling the product, you have to do the leakage testing before any use. THIS STEP IS VERY IMPORTANT because it permits to avoid any risks of damaging the EDUSTAK JUNIOR.

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8.2. Leakage testing process

Step 1: First connect the lateral ends of the tree ways port to the two short silicon tubes. Then link the tube where there is the clamp (bigger diameter) to the three way port.

Step 2: Connect the other side of the clamp tube with the air pressure bulb. Ensure all the connections are tight.

Step 3: Connect a free ends of one of the lateral tubes to the manometer after having unscrewed the small bolt on its base and having passed it around the tube. After that screw the bolt on the manometer basis.

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8. Leakage testing

Step 4 : Unscrew the bolts on the upper part of the EDUSTAK JUNIOR. Connect the EDUSTAK JUNIOR to the last free end of silicon tubes after having passed one bolt around. Notice that you have to link the tube with the nozzle located on the socket side of the EDUSTAK JUNIOR. Do the same with the purging valve tube and the remaining nozzle.

Step 5: Turn the switch slowly on the air pressure bulb in clockwise until it can't be turned anymore.

Step 6: Squeeze the air pressure bulb in order to reach an internal pressure of 0.4 kg/cm^2 (0.4Bar). You can read the pressure directly on the manometer.

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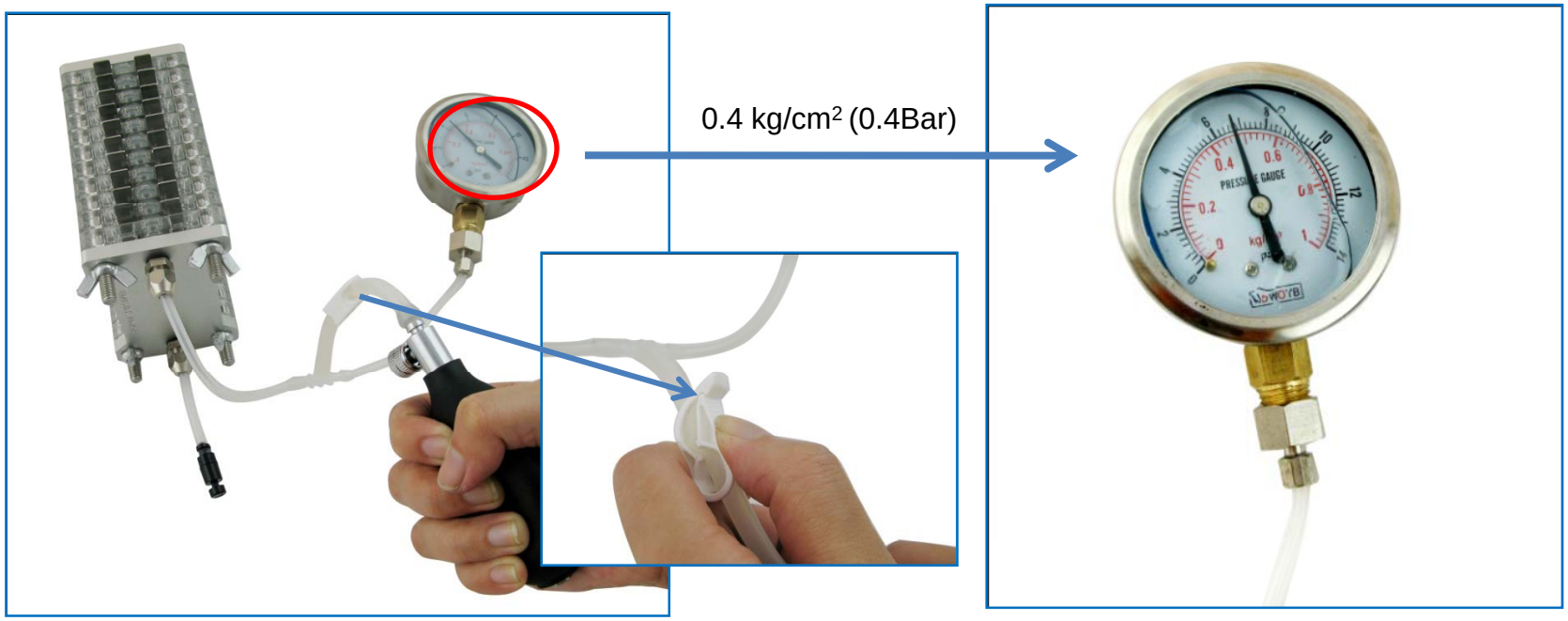
8. Leakage testing

Step 7: Close the clamp and release the air pressure bulb . Then observe the pressure gage, if the pressure stays between 0.3 kg/cm^2 (0.3Bar) to 0.4 kg/cm^2 (0.4Bar) in 30s, then there is not serious leakage on the whole EDUSTAK JUNIOR. The EDUSTAK JUNIOR could be used without problems.



Step 8: If the pressure goes down lower than 0.3 kg/cm^2 (0.3Bar) quickly, please re-assemble the EDUSTAK JUNIOR and check the following things carefully:

1. If the single cells have been installed in the right direction.
2. If the rubber sealing has been installed in the right direction.
3. If the plastic plates and single cells have been screwed tightly.
4. If the plastic cell with the rubber sealing has been installed, if yes, if it is in right position.

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9. FAQ

Q: What is EDUSTAK JUNIOR?
A: EDUSTAK JUNIOR is designed by Horizon Fuel Cell Technologies for the stringent demand of fuel cell scientists and professionals.
Built for long life performance and scalability, they fit the needs for those who want to:
- do advanced research on MEAs
- investigate thermal effects in stacks
- perform professional training
- integrate fuel cell systems
- quick start a fuel cell lab

EDUSTAK JUNIOR is fully modular from one to ten cells or more as required. Scale down or up can be achieved in lab environment by the user with simple tools.
Made of thick (8mm) plastic separators, the stack can be heavily equipped with sensors to investigate MEAs behavior.

Q: How does EDUSTAK JUNIOR work?
A: After the stack has been assembled, and leakage checking has been done, connect the hydrogen supply, purging valve and load, etc. Make everything is ready for operation.
Supply hydrogen to the stack. The fuel cell starts heating and produce electricity. The current flows into the circuit board through the electrode and then output by negative and positive polarity.
Purging must be done manually every 3 minutes during operation for good performance.

Q: What are the key features?
A: The key feature are listed below:
- Stack can be taken apart and rebuilt to change single cells or insert sensors.
- Stack power can easily be scaled by adding/removing cells.
- Optimal thermal management with air cooling circulation in each plate.
- Stack is delivered with complete instruction guide.

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9. FAQ

Q: What is the EDUSTAK JUNIOR composed of?
A: It is composed of end plates, single cell, sealing ring, flow channel plate, screw rod, electrical PCB card and fastening screws.

Q: What is the power output of the EDUSTAK JUNIOR?
A: The rated output power for EDUSTAK JUNIOR with 10pcs of single cell is 4W.

Q: What are the requirements for the hydrogen supply to the EDUSTAK JUNIOR?
A: The hydrogen pressure during stack operating should be maintained between 0.45-0.55Bar and the purity should be more than 99.995%. The stack should be purged timely during the running time to ensure the hydrogen purity inside the cell.

Q: How is EDUSTAK JUNIOR different from other fuel cell education kits?
A: The key feature of the EDUSTAK JUNIOR is its ability to be personally assembled and dismantled by the user. We believe it's the best way to understand how a fuel cell really works.

Q: What is a HYDROSTIK PRO and what is it used for?
A: HYDROSTIK cartridges store energy (up to 15 Watt hours) as hydrogen, which is stored in a solid metal hydride form inside the cartridge. The HYDROSTIK PRO does not store any power. Power is delivered by a fuel cell that converts the chemical energy of hydrogen stored in HYDROSTIK into usable electricity. When HYDROSTIK PRO cartridges are connected to Horizon's fuel cell devices, hydrogen from the HYDROSTIK PRO cartridge joins oxygen form the air through the fuel cell to generate electrical power. The HYDROSTIK PRO storage method makes it possible to use specially designed fuel cell devices with a practical, refillable and safe hydrogen supply. The HYDROSTIK PRO also offers the feature of being refillable many times.

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9. FAQ

Q: What is the hydrogen consumption rate?
A: The hydrogen consumption rate is related to the load current and number of cell. The ideal value is I x number of cell x 7 ml/min • A. But during the running process, the value will be changed because of short circuit loss, purging loss, blower running loss and controller operation loss, etc. The loss is about 10%. Take 10pcs of cell as an example, the hydrogen consumption rate at max. output is 55ml/min or more.

Q: Wouldn't repeated assembly and dismantling damage the fuel cell?
A: In conventional fuel cell stacks, yes, due to change in compression, gas sealing issue and mechanical disintegration. Not for EDUSTAK JUNIOR. The secret is in our technology, a sealing border which allows the separation of Membrane Electrode Assemblies (MEAs or the fuel cells) from the bipolar conductive plates.

Q: How can I replace the single cells?
A: If a single fuel cell in the stack is damaged due to mishandling or loses power after extended usage, you can simply replace it with a new one. This is not possible in a conventional fuel cell stack as you cannot dismantle it.
You can purchase a cell replenishment kit from us (a pack of 5 MEAs).

Q: How can I obtain the required hydrogen supply?
A: We strongly recommend metal hydride canisters as they are safe and simple to use. You can purchase from us or from your local market.

Q: Do students need to be trained on any specific technical skills prior to building the EDUSTAK JUNIOR?
A: No. All they need is enthusiasm, creativity, and exploratory minds.

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9. FAQ

Q: Can students share the EDUSTAK JUNIOR?
A: Yes, we designed it to be an interactive and fun learning educational kit. From building the stack, running simple experiments to full system integration projects, there are so many activities that students can do with the EDUSTAK JUNIOR. We believe the ideal group size would be 3-4 students per stack.

Q: How to keep EDUSTAK JUNIOR always in a good condition?
A: It should be kept in an air tight container. You should test it 2-3 times once a week and control it based on the temperature curve.

Q: What are the refill options for HYDROSTIK PRO cartridges?
A: 1. HYDROSTIKs can be recharged using Horizon's HYDROFILL PRO cartridge refilling solution.
2. You may contact your local Horizon service provider for HYDROSTIK PRO refill support at sales@horizonfuelcell.com
3. If needed HYDROSTIK PRO can be disposed after use, they are fully recyclable and do not contain any harmful materials.

Q: Where do I recycle a spent or damaged HYDROSTIK PRO ?
A: Contact your local consumer waste recycling center or return the HYDROSTIK PRO to a Horizon Fuel Cell Technologies vendor. Typically, HYDROSTIKs can be recycled where rechargeable batteries are recycled.

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10. Troubleshooting

1. The EDUSTAK JUNIOR generates no voltage.
Solution: If the electrical connection to the EDUSTAK JUNIOR is correct, check whether :
a. The HYDROSTIK PRO has been fully charged with hydrogen.
b. The hydrogen cartridge HYDROSTIK PRO is tightly connected to the pressure regulator.
c. The EDUSTAK JUNIOR has passed the leakage testing.

If, in spite of correct setup, the no-load voltage on the EDUSTAK JUNIOR is too low , the cause probably lies in a dried out PEM (proton exchange membrane) in the EDUSTAK JUNIOR. The PEM is moistened automatically during operation .This may take up to 5 minutes.

2. The EDUSTAK JUNIOR leakages after assembly.
Solution: Check the following parts:
a. The rubber sealing direction.
b. The single cell direction.
c. The plastic cell direction
All these parts should be placed in the correct direction and connected tightly. Please refer to the Assembly Guide for detailed information.

3. I squeeze the air pressure bulb, but the Manometer shows no pressure at all and the connection s are tight.
Solution: Turn the switch slowly on the air pressure bulb in clockwise until it can't be turned anymore.

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4. The pressure goes down quickly when I squeeze the air pressure bulb.
Solution: Close the clamp on the air pressure bulb tube . If the pressure still goes down quickly after the clamp has been closed, please re-assemble the EDUSTAK JUNIOR and check the following things carefully:

1. If the single cells have been installed in the right direction.
2. If the rubber sealing has been installed in the right direction.
3. If the plastic cell and single cells have been screwed tightly.
4. If the low end plate has been installed in the right direction.

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