

OPERATION MANUAL FOR QL HYDROGEN GENERATORS

OPERATION MANUAL

FOR QL-1000 SERIES MODEL



Dear Clients: Please read carefully the Operation Manual prior to operation.

Juveniles and those who do not understand the requirements of the manual cannot operate the generators .

Operation Manual for QL Series Hydrogen Generators

1. General description

The data and operating requirements stipulated in this Operation Manual are applicable to QL-1000 hydrogen generators.

This QL-1000 hydrogen generators is advanced patented products, which are light, highly effective, energy-saving and of environmental protection, producing extremely pure hydrogen through the electrolysis of pure water (without adding alkali).

The SPE electrodes, as the core of the product, are highly active catalytic electrode with nearly zero distance between the electrodes , which is formed by integrating composite catalyst with and ion membrane with high electrolytic efficiency. The other key parts are all produced by use of top-grade engineering plastics dies with superior quality. With perfect electric control system, designs of the generators are advanced with reliable quality, high automaticity, extremely pure generated hydrogen, huge output , the models and specifications of the generators are complete , and the generators are widely used . The small-sized generators are ideal equipment for all kinds of gas chromatographs and thin-film chromatographs, and the large-sized generators can be used in hydrogenation process of chemical industry and pharmaceutical industry, gas reduction protection of electronic industry, purification of semiconducting materials, metal welding, smelting and purification of heavy metals, surface protection of metals, water decomposition and composition in spacecrafts and submarine, and concentration of heavy hydrogen in atomic energy industry, etc. The products can absolutely take the place of hydrogen steel cylinders with safety and convenience in operation.

2. Operational principles and technological process

For the technological process, please refer to Fig.1.

Electrolytic water meeting the requirements (With electrical resistivity $>1M \Omega / cm$, and deionized or redistilled water in electronic and analysis industries can be used for this purpose.) , after being put into the anode chamber of electrolytic cell, when power is switched on ,will be decomposed at once at the anode : $2H_2 O = 4H^+ + 2O^{-2}$. The decomposed negative oxyanion (O^{-2}) will immediately release electron to form oxygen (O_2), which will then be discharged from the anode chamber, with some water, into the water tank. The water can be used circularly, and oxygen will be discharged from the small hole of the top cover of the water tank into the atmosphere. The hydrogen proton, in the form of aqua ion ($H^+ \cdot XH_2 O$), and under the action of electric field force , through PEM/SPE ion membrane, will arrive in the cathode to absorb electron to form hydrogen ,which will then be discharged

from the cathode chamber into the gas/water separator, where most of water it brought with from the electrolytic cell will be removed . The hydrogen with little water will be under moisture absorption of the desiccator, with its purity thus reaching 99.999 % or above. When the condensed water in the gas/water separator is accumulated to some limit, the float inside the separator rises, and water will be discharged from the gas/water separator into the water tank for recycle. After drainage, the float returns to the original place. This is repeated and keeps the water level inside the separator at the stable position.

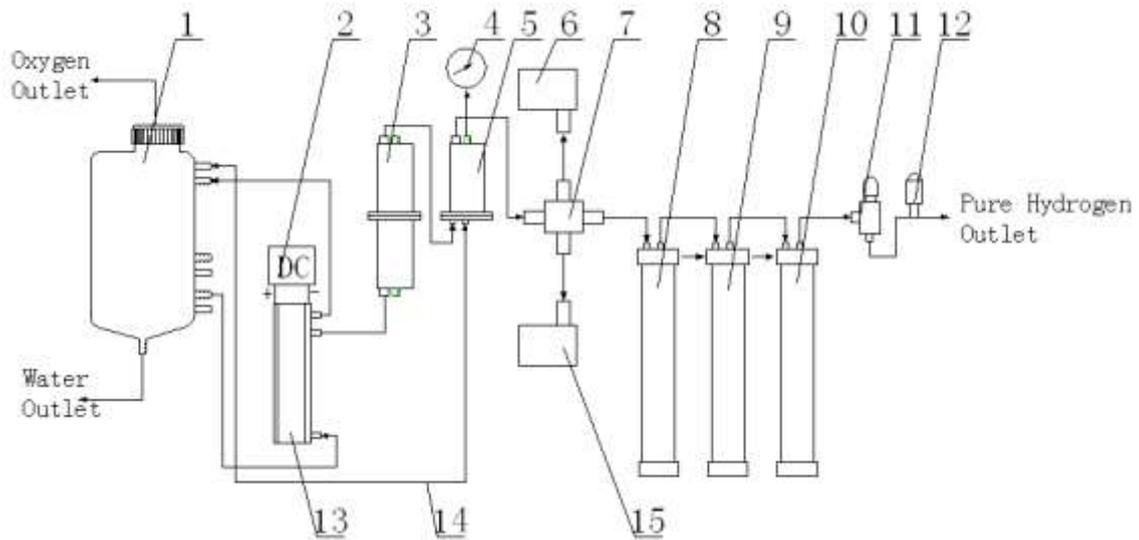


Fig. 1 Technological Process Schematic Diagram

- | | | |
|---------------------------|--------------------------|----------------------------|
| 1. Water Tank | 2. Switch power supply | 3. Condenser |
| 4. Output Pressure Gauge | 5. Gas/water Separator | 6. Flow Controller |
| 7. Four-way connector | 8. I Degree Desiccation | 9. II Degree Desiccation |
| | | 10. III Degree Desiccation |
| 11. Flow Adjustment Valve | 12. Discharge Valve | |
| 13. Electrolysis Cell | 14. Water Return fitting | 15. Overpressure Protector |

3. Electrical control

The whole electrical system is mainly composed of three parts, a power supply system for electrolysis, control board and display parts. When the power switch is pressed, the generator will go into operation. In the course of electrolytic process, when pressure reaches the preset value, the flow controller will start to take control to make electrolytic current decreasing along with rising of pressure, thus enabling output of the generated hydrogen, under the stable pressure, to meet the demand of the consumption automatically.

In addition, the generators, for ensuring normal operation, are equipped with two alarming protection systems.

3.1 Overpressure Alarm

If the output pressure is out of control and rises to 0.46 MPa because of being strongly shaken or something is wrong with its certain parts in the course of operation, the generator will beep four times with an interval and automatically cut off the power supply for electrolysis and stop the electrolysis for realizing the overpressure protection. At that time the front board will show that hydrogen output is zero with pressure alarming light (red) on. End-users should release the pressure and restart up the generator after ensuring that power connection is good with no shaking. If the above-mentioned phenomenon still reoccurs, it can be considered as an failure, end-users should inform the manufacturer for maintenance.

3.2 Water-level Alarm

If water level in water tank during operation drops down to the minimum limit or long-time operation of the generator under zero output pressure causes ponding in the gas/water separator to rise to the maximum limit, the generator will beep for alarming once every six seconds approximately and stopping electrolysis. End-users should switch off the generator to find out and clear the faults .If the water level in the water tank is normal and output pressure of the generator remains over 0.012 MPa, it can be considered the alarming is not caused by the above-mentioned two factors, and the manufacturer should be informed for maintenance.

4. Technical parameters

Specifications / Parameters	Models	QL-1000
Output Flow Rate (ml/min)		0-1020
Output Pressure (MPa)		0.4
Purity of Hydrogen (%)		>99.999
Pressure Value for Overpressure Protection (MPa)		0.46
Power Voltage (V)	110±15% V 50~60Hz	220±15% V 50~60Hz
Input Power (W)		< 500
Net Weight of a Complete Set (Kg)		< 26
Dimension (L*W*H)(mm)		455×360×352

5. Structure of the Generators

5.1 Contour of Hydrogen Generator

For the contours and dimensions of hydrogen generators, please refer to the front view, side view and rear view in Fig. 3.

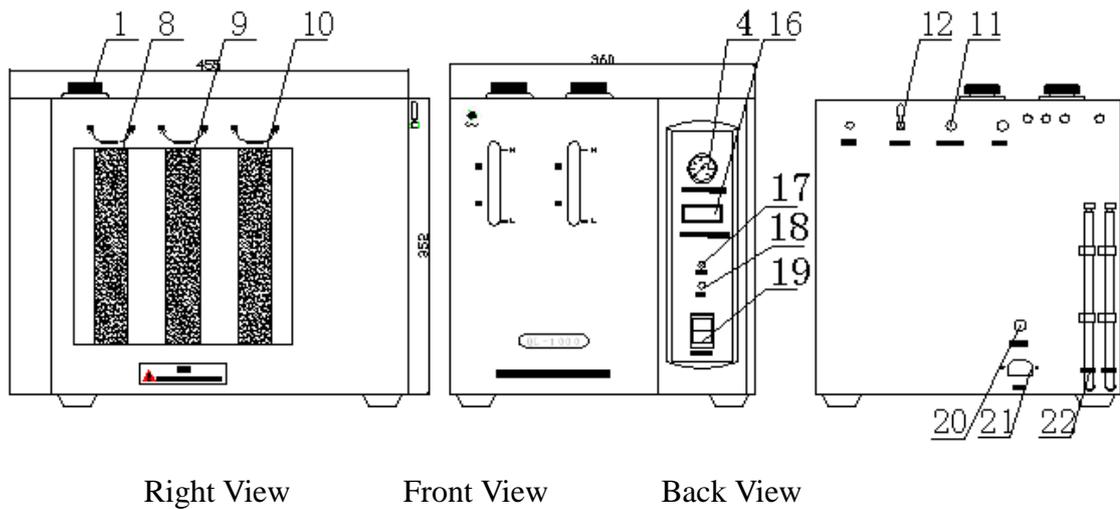


Fig. 3 Contours and Dimensions Of Hydrogen Generators

5.2 Internal Structure of Hydrogen Generators

For the internal structure of hydrogen generators, please refer to the following Fig. 4 .

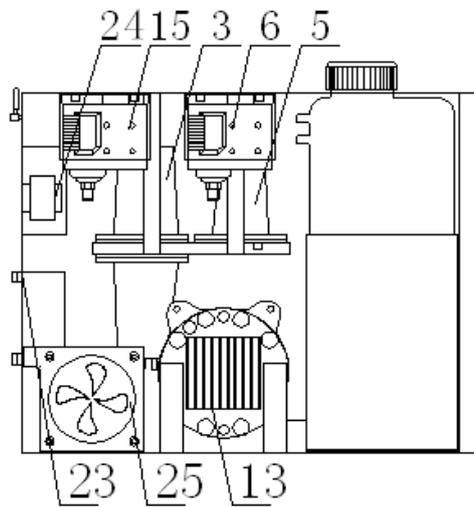
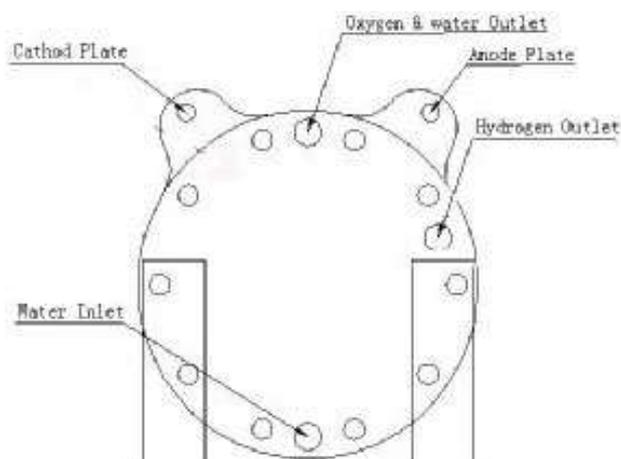


Fig. 4 Left Side View

5.3 Key Parts for Hydrogen Generators

5.3.1 Electrolysis Cell



(1) Replacement Method

① Take away the sealing film in water inlet and H₂/water outlet. Let the cell erected, and then little water will flow out.

② Fix the frame of the cell with M5 bolts in right place.

③ Connect water inlet and water tank outlet with $\Phi 6 \times 9$ Silicone pipe. At the same time, connect oxygen & water outlet and water tank cycle water inlet with another silicone pipe.

④ Connect the power positive line to the positive plate of cell. Negative line is connected to negative plate of the cell. Fix and tighten with M6 bolts.

⑤ Connect H₂ outlet and H₂/water Separator inlet. Please tighten the nuts in the joints, in case of leakage.

(2) Common Faults

① The electrolysis efficiency decline, so the flow display is less than 50ml/min. It can be judged as electrolysis cell failure.

② The cell is made up with one or several unit cells. Each unit cell is separated into Anode chamber and Cathode chamber by PEM/SPE membrane. There are oxygen gas and water in Anode chamber, and hydrogen gas and water in cathode chamber. If there is holes in PEM/SPE membrane, the hydrogen gas will penetrate into Anode chamber, then the output pressure cannot reach the set pressure. There will be little or no bubbles in water inlet of gas/water separator. And there are more bubbles from the oxygen/water outlet on the cell. It can be judged as cell reverse osmosis failure. The cell should be replaced.

(3) Notices

① Please use deionized or redistilled water with electrical resistivity $>1M \Omega / \text{cm}$, and unqualified

water will damage the cell.

② Please connect the power line right.

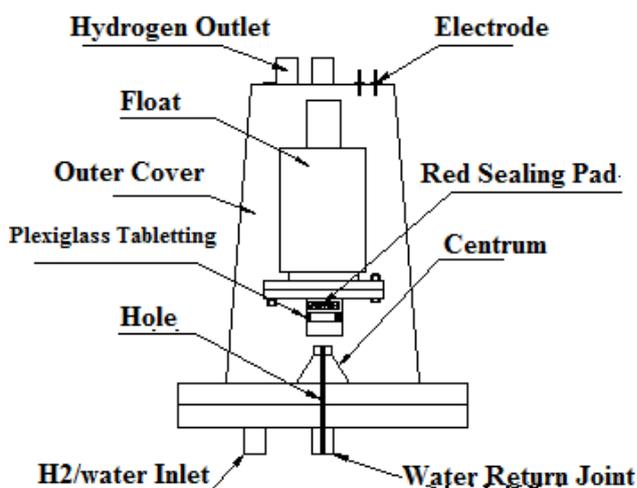
③ There must be water in the cell in any time. If you don't use that for long time, it should fill some water into the cell.

5.3.2 Gas/water Separator

(1) Function of Gas/water Separator

Hydrogen and water from H₂/water outlet on electrolysis cell, go through the H₂/water inlet of gas/water separator, and enter it.

When condensed water in gas/water separator reaches some level (about half of the outer cover), the float rises. Red sealing pad leaves from the top of centrum. Condensated water is drained into water tank to recycle, because of hydrogen pressure. After drainage, the float returns to original position. This repeats, so water level inside gas/water separator could keep stable, to separate hydrogen from water.



(2) Leakage Reasons

If red sealing pad and centrum are in poor connection, it causes hydrogen leakage. Hydrogen pressure couldn't reach set value, or pressure fluctuates obviously. At the same time, there is little or no condensed water inside gas/water separator. There are bubbles flowing quickly inside the silicone pipe from water return joint. It can be judged as gas/water separator leakage. The reasons are as follows.

- ① After using the red sealing pad for a long time, the surface becomes accidented.
- ② The plexiglass tableting become loose, so sealing pad moves up and down.
- ③ The red sealing pad becomes inflated after adsorbing water for a long time. This makes the plexiglass tableting squeeze it tightly to form spherical surface.
- ④ There is foreign matter or burr on top of centrum.
- ⑤ All above reasons could result in gas/water separator leakage, please check it one by one.

(3) Water Ponding Alarm Troubleshooting

- ① If small hole on the gas/water separator is blocked by foreign matter, it causes the

gas/water separator drains water abnormally.

② While reassembling gas/water separator, after installation, be sure that float could float up and down. If the float is locked, it also block the small hole and make gas/water separator drain water abnormally.

6. Operational Requirements

6.1 The hydrogen generators are forbidden to be operated in a sealed room.

6.2 Requirements for operational environments and conditions of the generators :

- a. Temperature : 4°C– 40°C ;
- b. Humidity : <85% ;
- c. Power supply : 220v--240V~50-60Hz or 99-121v~50-60Hz;
- d. The generators should be put horizontally near hydrogen-applied instruments with their front boards facing operators for the convenience of operation;
- e. There should be no obvious shaking and striking;
- f. There should be no direct sunshine and open fire;
- g. There should be no big dust , conducting particles , acid , alkali , and other corrosive gases ;
- h. Ventilation should be good ;
- i. Ground connection of power supply should be good . 

6.3 The water tank of a generator should at first be filled with deionized or redistilled water and then you should wait for five minutes prior to startup.

6.4 Requirements on pressure rising and keeping

(1) During operation of the generators, operators are not allowed to uninstall the desiccator under pressure.

(2) The minimum pressure for operation is 0.012 MPa. After start-up the pressure should be raised before it is too long, or it will lead to internal ponding without normal draining of gas/water separator, making the water level reach the maximum limit of alarming, resulting in stopping electrolysis. When output of hydrogen reaches the maximum value, time of the operation with zero of output pressure should not be over 10 minutes. (Generally speaking , after the generators are delivered some internal resistance will be produced since the generators have been equipped with two-stage desiccators and brass pipelines connecting hydrogen output flow direction , and generally speaking , the internal resistance can reach the required limit of the minimum pressure.)

(3) After start-up a generator is not allowed to be operated for a long time when the set pressure is reached without connecting hydrogen-applied equipment, or it will damage the core components of electrolytic cell.

6.5 The pressure of a hydrogen generator should be released to zero after it is shut down

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The pressure can be released by loosening the nut of venting valve in front of the hydrogen outlet on the backplate. The valve should be sealed again after the pressure is released .

6.6 Requirements for Water Quality

As hard ions in unqualified water may cause sediment to block pores of electrodes, thus resulting in scrapping of the electrodes, the electrical resistivity of water (deionized or redistilled water) in electrolysis should not be less than $1M \Omega /cm$. All end-users should keep it in mind, otherwise they should be responsible for all consequences.

6.7 Water Level Requirements for Water Tank

The water level should keep between high limit and low limit.

6.8 Requirements for Changing Water and Cleaning Water Tank

The water tank should be kept clean. Even the water is qualified at first, it will breed microorganisms and become turbid when it is used for a long time, influencing output of the hydrogen and the service life of electrolysis cell. The water tank, therefore, should be emptied through the drain pipe every two or three months, and then washed several times (fill the tank with a small quantity of new water and shake the generator lightly several times in every direction) until discharged water becomes transparent without cottony things.

The drain pipe of water tank is attached to the backplate of the generator and can be freely taken off and put in.

The small hole on the top cover of the water tank is used as oxygen discharging port, therefore do not block it , and the top cover of the tank should not be changed at random.

6.9 During transportation of the generators, the water tanks should not store water so as to prevent the water from spilling out to cause damages of the electrical components.

6.10 The electrolytic cells should not be short of water .

6.11 Requirements and Methods for Replacing Desiccant

6.11.1 Requirements for replacing desiccant

(1) The desiccant should not be replaced during the operation of the generators to prevent high-pressure hydrogen from leaking and injuring people .

(2) Before desiccant is replaced, a generator must be shut down and the pressure must be released prior to unscrewing and opening top cap of the purifier .

(3) The generator, after desiccant replacement, should be in idle operation for several minutes to wait for air to be emptied from the desiccant cartridges ,and hydrogen can only be used when purity of generated hydrogen reaches the standards .

6.11.2 Methods for Desiccant Replacements

There is three grades desiccants. I grade is silica gel, II grade is silica gel, and III grade is molecular sieve. There is some palladium catalyst to remove oxygen in II grade and III grade

desiccants.

After using for some time, users should notice the color changing condition of I grade and II grade silica gel. If II grade silica gel becomes pink over half of the window, please replace I grade, II grade and III grade desiccants at the same time. The palladium catalyst shouldn't be regenerated, and its life is two years.

6.11.3 Desiccant Regeneration

- ① The silica gel should be baked under the temperature between 120 and 140 °C until its color changes into blue completely .
- ② The molecular sieve should be baked under the temperature between 150 and 180 °C for 2 hours.
- ③ The above-mentioned desiccant should be packed for use when it is dried and its temperature decreases to below 50° C , and it will scald skin if its temperature is too high . Too high temperature will scale the containers or skin of operators.

6.12 There is flow regulator on the back panel, and it could be used for adjusting hydrogen output flow. Users could adjust it according their demand.

6.13 A generator must be shut down by power cord disconnect with power source before cartridge fuse is replaced . Model of cartridge fuse used in QL-1000 is F8A L250V, please do not make mistakes in using the cartridge fuse so as to avoid fires .

7. Acceptance Check

7.1 Unpacking for the acceptance check

There are safe transportation marks on the surface of the packing boxes for the generators with some damp-proof and shockproof materials inside the boxes . The generators should remain intact if no accident occurs during the transportation, otherwise claims should be filed against carriers in accordance with the actual conditions.

7.2 The attached accessories and technical documents should be checked according to the packing list.

7.3 Operation for the acceptance check

7.3.1 The operational environment and conditions of the generators should satisfy the requirements stipulated in 6.2 .

7.3.2 Open the outer cover of water tank, and take away the inner plug. The water tank must be filled with deionized or redistilled water, and the other kinds of water will damage electrodes , resulting in damage of electrolytic cells . Water level in the tank should be between the minimum and maximum water level lines, and then screw the top cap.

Inner plug is used for preventing water leakage during transportation. Please keep it

well, in order to use it in future.

While equipment working, oxygen gas enters water tank. Because the inner plug could seal it well, if forgetting taking away the inner plug, the pressure inside water tank could rise continuously, and make the tank explosion. So be sure to pull out of the inner plug before using the equipment.

There is a small hole in the water tank outer cover, about 3mm diameter. This hole is used for discharging oxygen, please don't block it.

Caution : The generators must be filled with water prior to startup ! Water must be guaranteed for electrolytic cells !

7.3.3 Ground connection of power supply must be good according to the requirements of 6.3 of the operation manual. After connecting the power cord, turn on the switch of power supply on the front panel. Both the power supply indicator and the electrolysis indicator will be on, and the number indicating the output of hydrogen will be increasing all the way to the maximum output of the generator.

7.3.4 When the nut for hydrogen outlet of the generator is sealed (or screwed) securely, output pressure will rise, and when the pressure reaches the preset value, the pressure control system will take control to make the electrolytic current reduce to zero, and the number indicating output flow rate will show falling to zero. The number indicating output flow rate will show returning to the maximum of generated hydrogen when the above-mentioned nut is unscrewed, which indicates the generator is in normal operation. After the acceptance check is completed, the generator can be operated in accordance to the Operational Manual.

7.3.5 Connecting hydrogen-applied equipment

After acceptance check, at first shut down a generator when you are prepared to use it. Produce the pipe (a brass coil pipe with outer diameter of 3 mm , wall thickness of 0.5 mm and length of 1,500 mm) connecting hydrogen-applied equipment from an accessories bag along with the generator . When a generator is delivered , the two ends of the pipe have been equipped respectively with an international standard threaded nut of M8×1 and three O-rings for sealing . Distance between each end of O-rings and that end of the brass pipe is 6-8mm . The one end will connect outlet port of a generator , and another end will connect a set of hydrogen-applied equipment in the same way . If nozzles of hydrogen equipment are measured in the British system , for example , chromatographs made by Shimadzu of Japan , Agilent and Varian of USA , whose sizes of nozzles are measured in the British system , We can accessorize relevant nozzles according to different requirements of our customers and will mark out on the accessories bags of nozzles .

Insert the two ends of a connecting pipe into the relevant nozzles , and use a spanner

delivered along with the generator to seal the nuts and nozzles in clockwise sense . Do not overexert yourself in sealing the nuts prevent the O-rings losing elasticity , resulting in influencing the sealing effect .

After hydrogen-applied equipment is connected , use soap suds to check the sealing for leakage . If bubbles occur , the assemble should be readjusted until no leakage is found . The same method should be used for checking leakage in sealing nuts of the other parts and components .

8. Troubleshooting

Warning: The qualified person can go into the maintenance and repair of the generator only. Draw the power cord plug off from the power supply socket before any working of maintenance and repair, to avoid electric shock.

Breakdown	Causes	Guide for maintenance
1.When the power switch is turned on, the power indicator light will not be on and the generator will not be in operation.	<ol style="list-style-type: none"> 1. The power plug is in poor connection. 2. Blown fuse. 3. Power switch is damaged. 	<ol style="list-style-type: none"> 1.Recheck the plug and make it in good connection. 2.Take out and replace the damaged safety wire in the fuse. The replaced safety wire must be up to the type of the original safety wire. Do not change type of safety wire at will. 3.Repair or make replacement.
2.When the electrolysis indicator light is on with the maximum output generated, the pressure does not rise.	<ol style="list-style-type: none"> 1. Leak in the pipe system. of hydrogen. 2. Poor sealing condition at the float of the gas/water separator with water outlet. 3. Sharply increasing output from the oxygen outlet means electrolysis cell has been damaged. 	<ol style="list-style-type: none"> 1.Use leak-hunting liquid to check sealing of all nuts, screw securely the fittings at the leaks. 2.Repair or replace the fittings. 3.Shut down the generator at once !The electrolysis cell, if damaged, must be returned to the manufacturer for replacement. Do not disassemble it by yourself, or you will be responsible for all the consequences arising thereby.
3. Pressure shows 0.46MPa, equipment stops electrolyzing.	Flow controller is broken.	Release the pressure and restart it. If still occurs, please contact manufacturer for maintenance. Don't disassemble it by yourself.

Breakdown	Causes	Guide for maintenance
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<p>4. If water is found to drain out of basal crack of the generator (The problem is rarely seen).</p>	<p>1. Silicon rubber soft pipe and nylon ribbons are aging. The sealing O-rings between the metallic pipe and nuts are aging.</p> <p>2. The sealing pad of electrolytic cell is aging.</p>	<p>1. Shut down the generator and release the pressure of hydrogen. After draining off water from the draining pipe on the back board, it will be ok to replace the same accessories. (Water used by the generators is not corrosive , so rub out the spilled water in the housing and use an air blower to blow it dry before restarting up the generator.</p> <p>2. The manufacturer will be responsible for repairing breakdown of electrolytic cells or making replacements.</p>
<p>5. Beep once every six seconds approximately.</p>	<p>Water tank is short of water.</p> <p>Ponding in the gas/water separator.</p>	<p>1.Add some water to the water tank.</p> <p>2.The generator has been operated for a long time with zero pressure or there are leaks in the pipe system .If the system gives an alarm when the pressure is over 0.012 MPa, it is a breakdown of the generators, inform the manufacturer for maintenance.</p>

9. After-sales service

The warranty period of the generators is one year, and the maintenance will be lifelong . Maintenance and replacement of parts within the warranty period will be done free of charge, and beyond the warranty period, they will be done with only cost of the raw materials charged.

If the following occurs , the maintenance will not be done free of charge:

- a. users do not operate the generators according to the operational manual;**
- b. users disassemble parts by themselves , which are forbidden by the manufacturer to be disassembled.**

Our company is able to undertake maintenance of all hydrogen generators with the PEM/SPE technology at home or abroad.