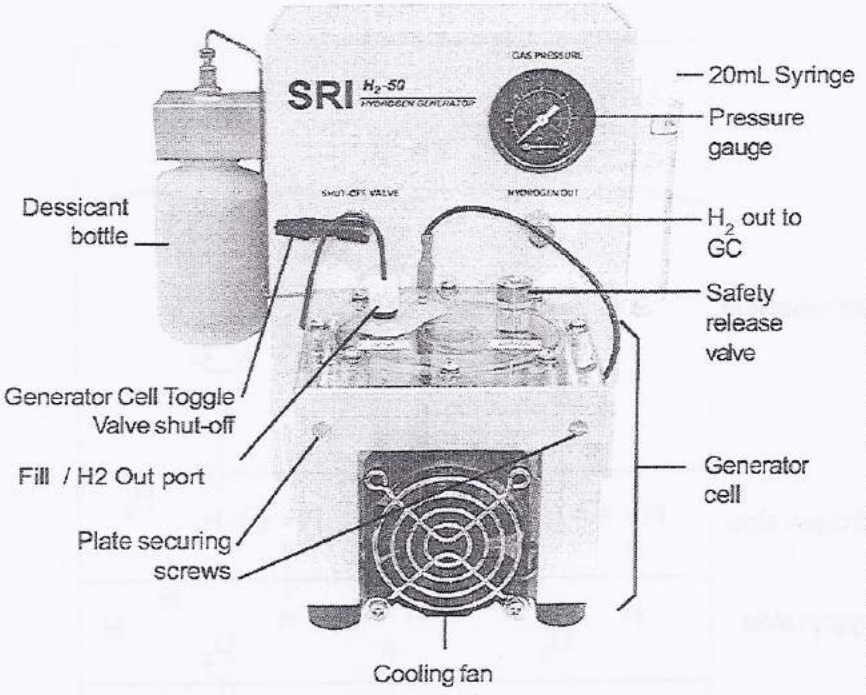
H_2-50 Stand-Alone Hydrogen Generator

Overview

Your SRI H_2-50 Stand-Alone Hydrogen Generator consists of a generator cell mounted on a metal chassis. The generator cell is attached to the chassis with two screws for easy disassembly—just unscrew them, unplug the power cord, and the entire cell comes off. On the metal chassis is a pressure gauge, an interior pressure switch, a dessicant bottle, and a toggle valve shut-off for isolating the generator cell. The dessicant bottle contains Indicating Molesieve dessicant beads which turn from blue to gray when they absorb water. Water vapor that is released from the generator cell with the hydrogen is removed by the dessicant before reaching the GC column, thus drying the hydrogen gas. The H_2-50 can supply enough gas for a detector or two as well as the GC carrier gas. During operation, there is about 40mL of hydrogen gas stored in the dessicant, which is enough to operate a split injector for short periods, in addition to the detector(s) and carrier. The toggle valve shut-off facilitates checking for leaks and allows the H_2-50 to reach operating pressure more quickly, while the interior pressure switch maintains the operating pressure. As a safety measure, a pressure release valve protects the generator cell from pressure overload. An external power supply/transformer that is provided enables the H_2-50 to operate on various voltages around the world. You may use any approved power supply rated 100-240VAC with 12VDC, 7amp output. Conveniently, the H_2-50 produces 50mL/min at 35psi (241316Pa, 2.4bar) using distilled water from the grocery store.

The SRI H_2-50

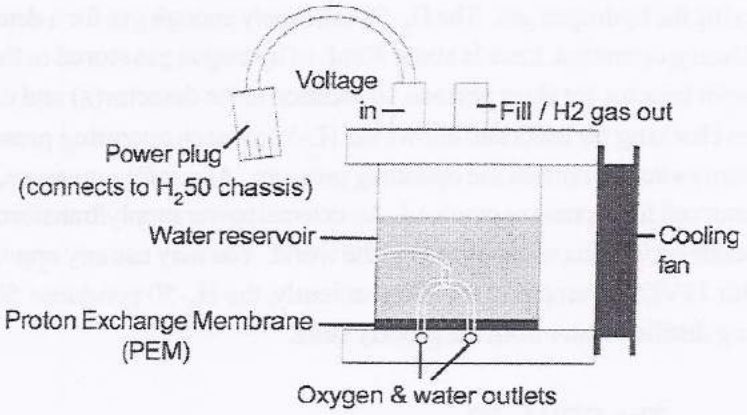


H_2-50 Stand-Alone Hydrogen Generator

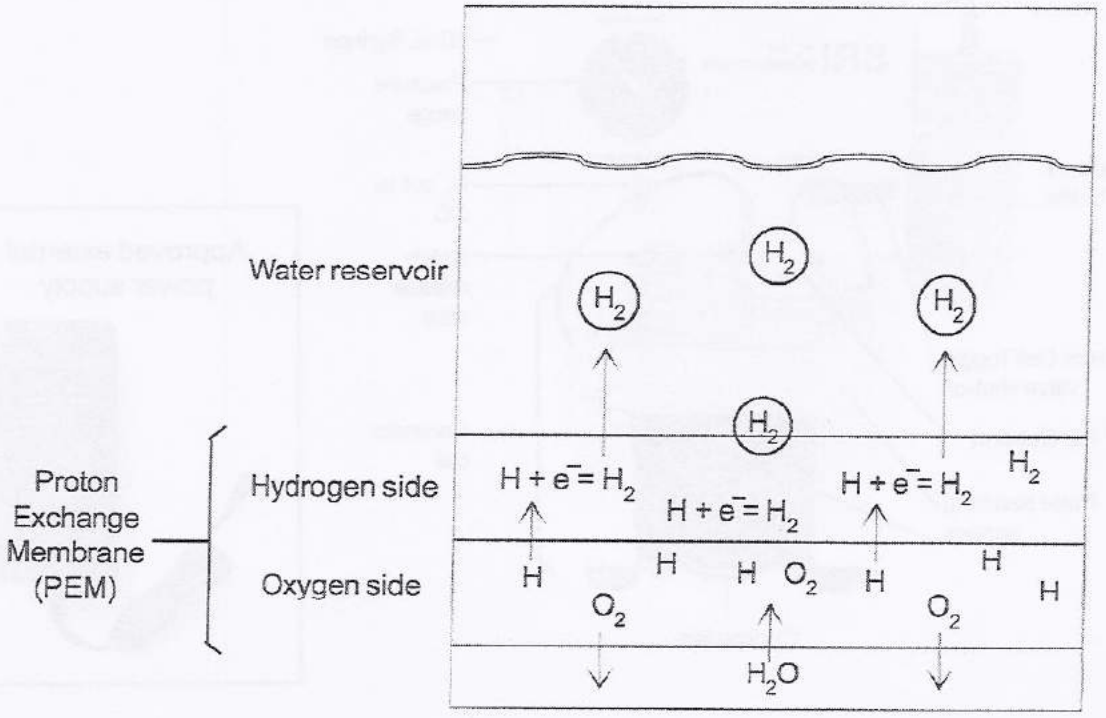
Theory of Operation

The SRI H_2-50 Hydrogen Generator separates water into hydrogen and oxygen using a Proton Exchange Membrane (PEM). The water on the oxygen side of the PEM is disassociated into O_2 and hydrogen protons. The hydrogen proton is transported through the PEM to the hydrogen side, where it recombines with an electron to make H_2, then bubbles up through the water reservoir.

The $H_2$50 Generator Cell



Operational Diagram of the $H_2$50 Generator Cell



General Operating Procedure

Use the H_2-50 on a flat, level surface, away from open flame and any other ignition sources, including spark sources.

1. Remove the nut with the septum from the Fill / H_2 Out port on the top of the generator cell.

2. Use the 20mL syringe mounted on the right-hand side of the H_2-50 chassis to inject clean distilled water into the water reservoir. Although clean tap water will work in a pinch, use distilled water whenever possible. Fill only to the top fill line; do not overfill. Replace the nut and septum on the fill port and hand tighten until the nut contacts the black o-ring on the fitting.

3. Make sure the dessicant bottle contains dry beads. Dry dessicant beads are blue in color; they turn grey when wet. See below for instructions on recharging and replacing the dessicant beads.

4. Connect the H_2-50's "H2 OUT" fitting to the GC's hydrogen gas inlet. Output from the H_2-50 "HYDROGEN OUT" fitting is connected to the GC with 1/8" or 1/16" O.D. tubing. Make sure the red and black power cord is plugged into the H_2-50 chassis, and connect the external power supply cord to the generator and a wall outlet. Make sure you have the correct input cord for the voltage you are using. Properly used, the transformer is not a spark source and poses no ignition threats.

5. Close the H_2 shut-off valve. Always build up pressure initially with the toggle valve shut; it will take 5-15 minutes.

6. The H_2 gas pressure is preset to 35psi (241316Pa, 2.4bar). Once this pressure is attained, the interior pressure switch will shut off the current to the generator. The water in the generator cell reservoir should stop bubbling.

7. Wait 10 minutes to make sure that 35psi (241316Pa, 2.4bar) pressure is maintained. If pressure is not being maintained, there is probably a leak. Check the dessicant bottle; it should be snug against the o-ring. Make sure the Fill / H_2 Out port nut and septum are intact and snug. Check the bottom of the water reservoir around the PEM for moisture to ensure generator cell integrity; if you find any seepage, tighten each of the eight screws that hold the cell layers together.

8. If you find no indication of a leak after 10 minutes of stabilization at 35psi (241316Pa, 2.4bar), open the toggle valve to let the H_2 gas flow into the GC.

9. When the water in the generator cell water reservoir reaches the bottom fill line, it is time to refill it.

10. Close the toggle valve.

11. Unscrew the Fill / H_2 Out port nut and septum and use the syringe to refill the cell to the top fill line.

12. Replace the nut and septum, and tighten until snug.

13. Since you have the cell pressure vented, it is a good idea to check the dessicant for any grey coloring to see if the beads need recharging. If they do, follow the instructions on the next page (***General Operating Procedure continued***).

General Operating Procedure continued

Recharging and Replacing the Dessicant Beads

Periodic recharging of the dessicant beads will be necessary as they absorb water during operation and turn grey. The blue color of the dry beads comes from cobalt chloride. Take care not to bake out the dessicant beads with any food item.

1. Before you loosen the dessicant bottle on the H_2-50 chassis, vent the hydrogen pressure in the generator cell by unscrewing the nut capping the fill port on the top of the cell. It will hiss audibly until it is released.

2. Dry the dessicant beads by pouring them onto a paper plate and cooking them in a microwave oven for 2-3 minutes. Or, pour them onto a glass or metal pan and bake them in the GC oven at 250°C. Do not microwave or bake the plastic dessicant bottle. The dessicant beads can be recharged over and over again; they last indefinitely. Should you need them, dry dessicant beads are available in kilogram quantities from Alltech (1-800-ALLTECH; part # 05553).

3. Let the beads cool, especially after microwaving them. Refill the dessicant bottle with the dry, blue beads.

4. Replace the bottle on the H_2-50 chassis and hand tighten it. There is an o-ring that engages with the bottle top; tighten the bottle until it is snug against the o-ring.

5. The dry dessicant contains some air which will purge out during the first few minutes of operation. You may notice your retention times change temporarily since the carrier gas may intially be a mixture of hydrogen and air for a few minutes after dessicant replacement. The FID flame may also be hard to light until pure hydrogen comes through. You can speed up this equilibration process by building up pressure in the generator cell then venting with the toggle valve 2-3 times before reconnecting the H_2-50 to the GC. Keep in mind that the internal pressure switch will cut the current when the cell reaches 35psi (241316Pa, 2.4bar), so you don't need to build up too much pressure before venting it. Experiment to learn what works best for your particular GC system.

Maintenance and Troubleshooting

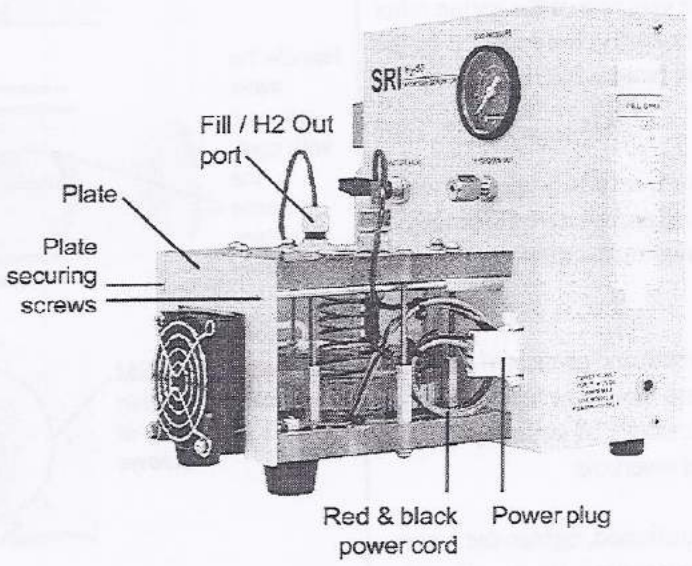
If the water in the H_2-50 water reservoir looks cloudy, it needs to be replaced:

1. Remove the nut with the septum from the Fill / H_2 Out port on the top of the generator cell.

3. Turn the generator over and pour the water out. When the water is almost all out, shake the generator to help it drain.

4. Use the syringe to refill the water reservoir with clean, distilled water through the Fill / H_2 Out port.

5. Replace the nut and septum on the Fill / H_2 Out port.



See the following page for PEM replacement

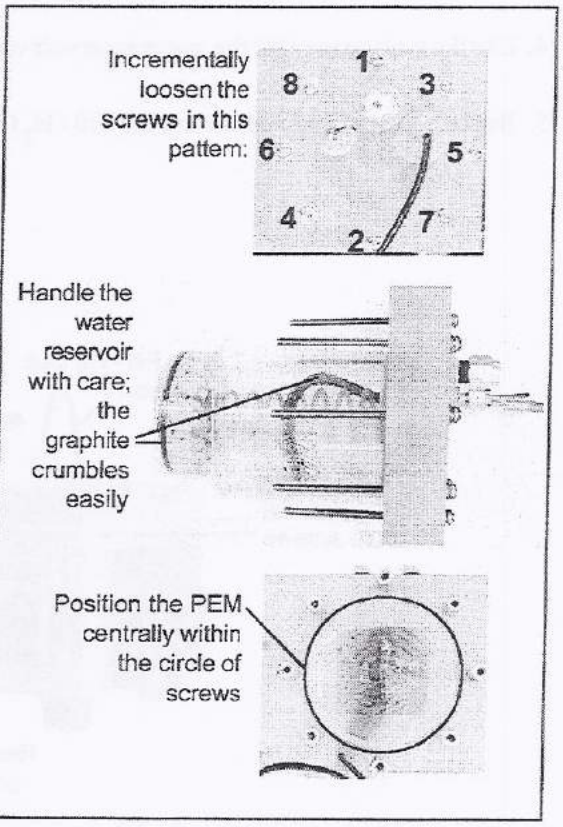
Maintenance and Troubleshooting continued

If the Proton Exchange Membrane (PEM) changes color, it most likely needs to be replaced. New H_2-50 PEMs are available from SRI under part # 8690-0151.

1. Put the replacement PEM in clean distilled water to soak while you take apart the generator cell.

2. Remove the generator cell from the H_2-50 chassis by unplugging the red and black power cord from the chassis, and unscrewing the two screws that hold the clamping plate against the cell.

3. Loosen the eight screws that hold the water reservoir with a philips head screwdriver. Loosen each screw in increments; first one, then the one opposite, and so on in a star-like pattern. As you progress, be mindful of the spring in the water reservoir; don't loosen the screws too suddenly, or it may pop open the reservoir, presenting safety and damage risks. You can feel the pressure of the spring relax as you loosen the screws sufficiently; hold the top of the generator cell firmly with one hand while loosening the screws with the other.



4. Once the screws are removed, carefully take the water reservoir off the bottom of the cell and remove the old PEM. Be very careful handling and moving the graphite coil, as it can easily come apart.

5. Take the new PEM out of its bath and position it centrally within the ring of screws. Place the water reservoir back on the bottom, over the PEM; the PEM should protrude slightly on all sides of the water reservoir.

6. Once the PEM is properly positioned, tighten the screws in increments until the water reservoir is snug against the bottom of the generator cell.

7. Put the generator cell back on the chassis and secure it with the plate and two screws. Plug the red and black power cord into the chassis.

8. Plug the H_2-50 into a wall outlet and pressurize the generator cell to 30psi. Check the bottom of the water reservoir around the PEM for moisture; if you see any seepage, tighten each of the eight screws a little more.

WARNING!

Warnings and Safety Precautions:

The H_2-50 generates hydrogen, which is an extremely flammable gas. Under normal operation, the safety features of the H_2-50 protect the operator. However, operators must use common sense and take basic precautions. Hydrogen burns with a flame that is invisisble to the naked eye. Do not use the H_2-50 near any flames, sparks, or sources thereof, including lab ovens, heater elements, bunsen burners, torches, etc. When venting the hydrogen from the generator cell, NEVER open the H_2-50 toggle valve near an ignition source!

Hydrogen is non-toxic, but it can cause asphyxiation in confined spaces by displacing oxygen. Use the H_2-50 in a ventilated room with an ambient temperature of 5-40°C (40-100°F). If the GC power is interrupted or cut off during hydrogen generation, flip the toggle valve to isolate the generator cell, then disconnect the external power source from the H_2-50 and the wall outlet. This is a good general response in any situation of uncertain risk; if you're not sure what's happening, isolate the cell and pull the power plug. That way, you can take the time to diagnose any problems without H_2 accumulation. Familiarize yourself with the safe operation of the GC and other equipment to which you intend to connect the H_2-50.

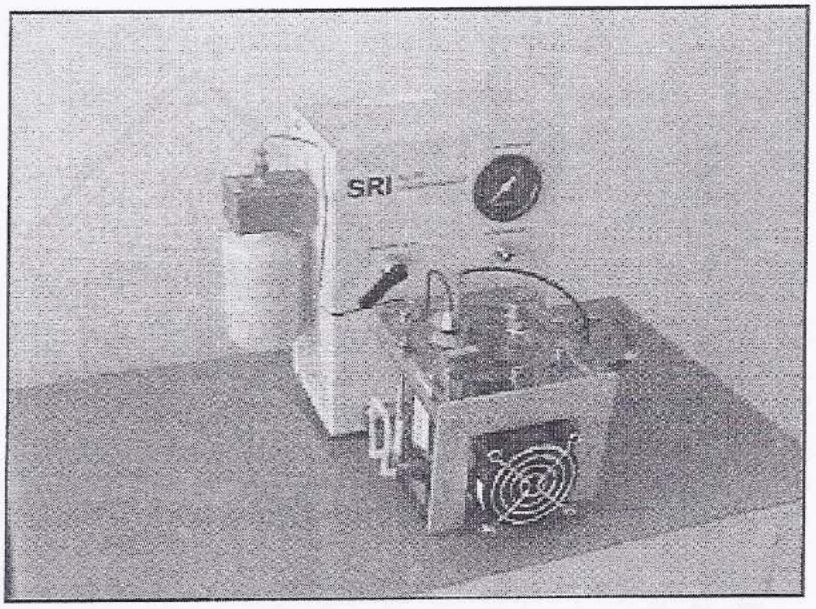
The H_2-50 is designed to be safe under the following Environmental Conditions:

- indoor use;
- altitude up to 2000 meters;
- temperature 5°C-40°C;
- maximum relative humidity 80% for temperatures up to 31°C, decreasing linearly to 50% relative humidity at 40°C;
- POLLUTION DEGREE = 2 in accordance with IEC 664.

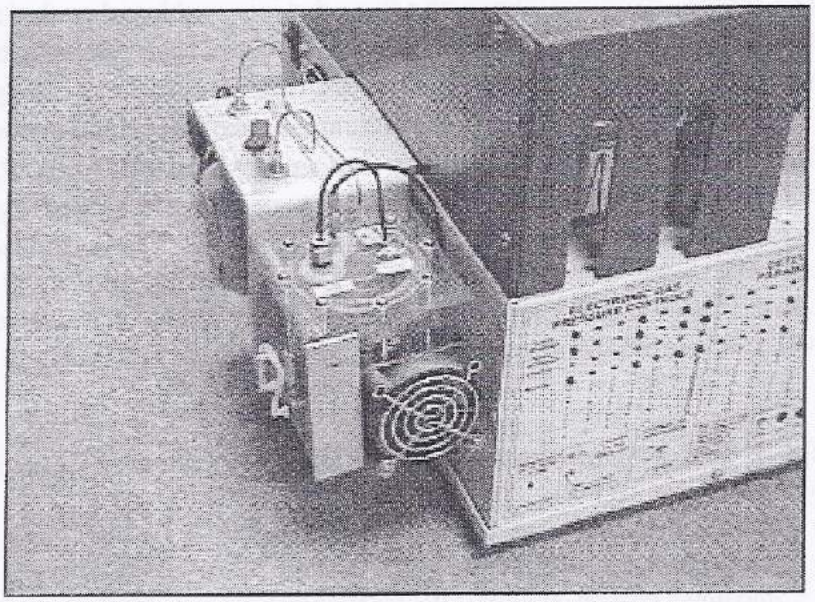
WARNING!

Changing the PEM membrane on the SRI hydrogen generator

The SRI Hydrogen generator is most commonly found as the stand-alone H2-50 version shown to the right.

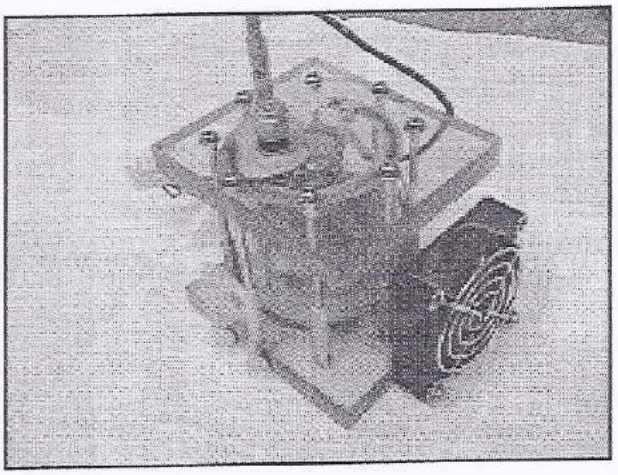


A smaller 25ml/min version may also be found built-in to some SRI 8610C GCs.

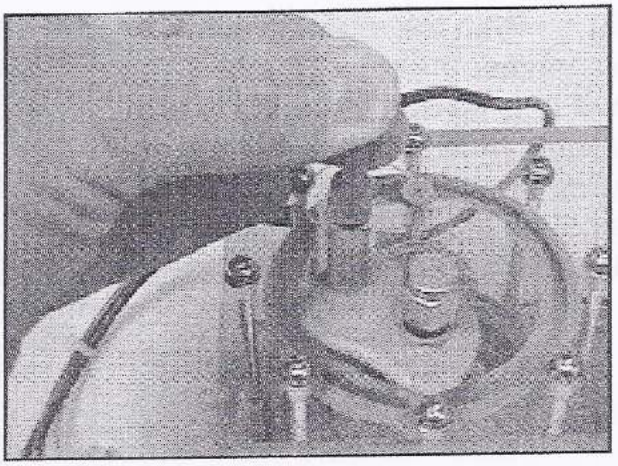


Changing the PEM membrane on the SRI hydrogen generator

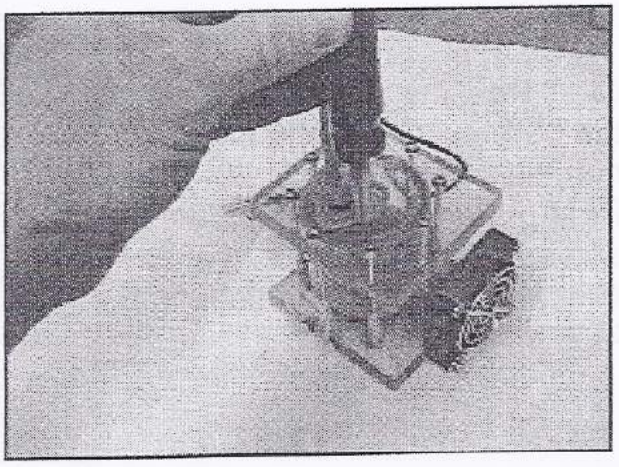
1) The Proton Exchange Membrane (PEM) used in the SRI hydrogen generator may need replacing periodically. If the generator does not make hydrogen at all, or only very little, if the membrane looks very dark or dirty, or if the generator gets hot and steamy, it may be time to replace the PEM.



2) Remove the H2 generator cell from the GC or stand-alone chassis, then gently wiggle off the black wire connector on the top of the cell.

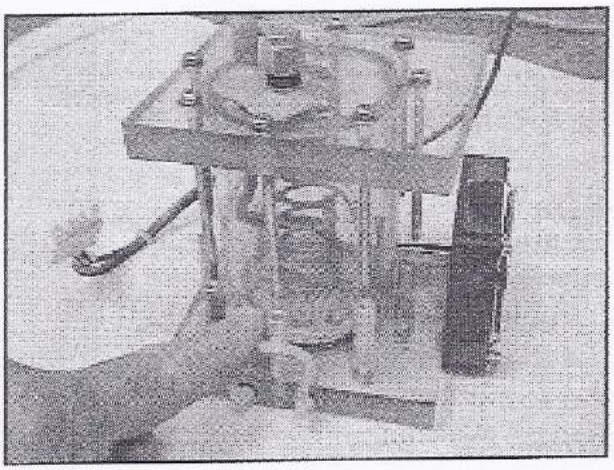


3) Loosen the eight screws which clamp the top of the cell to the bottom. Initially, just loosen each screw a little bit and loosen them evenly to avoid putting too much stress on any one screw. The water in the cell will leak out when you do this, so it may be a good idea to do this over a sink.

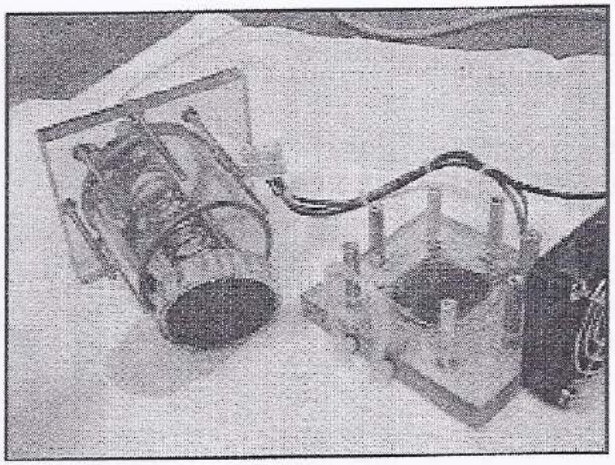


Changing the PEM membrane on the SRI hydrogen generator

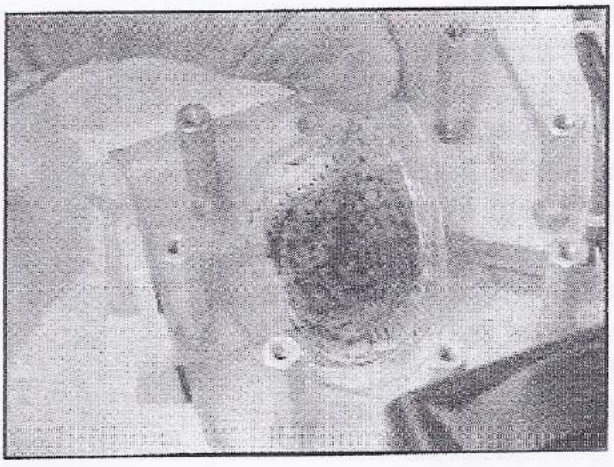
4) Be sure that the aluminum stand-offs on the bottom of the cell don't rotate as you remove the screws. Hold each stand-off with a small wrench if you have to.



5) With the eight screws removed, the top of the cell will pop up due to the spring inside which pushes the graphite rope electrode against the PEM. Carefully lay the top of the cell aside.

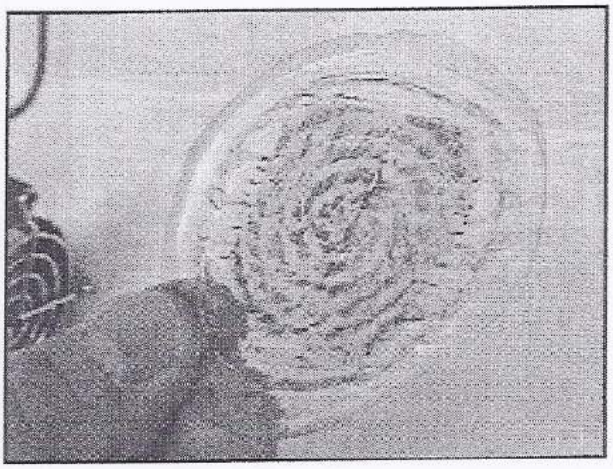


6) Peel the old PEM off the bottom. Check the platinum screen for bits of old PEM material. If the platinum screen seems rough or has sharp edges, use your fingers to smooth it down

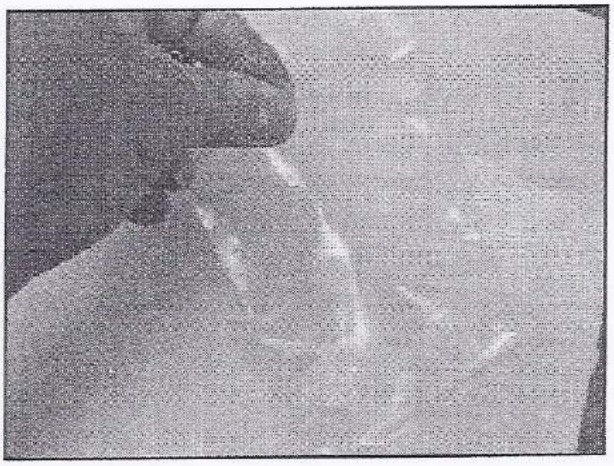


Changing the PEM membrane on the SRI hydrogen generator

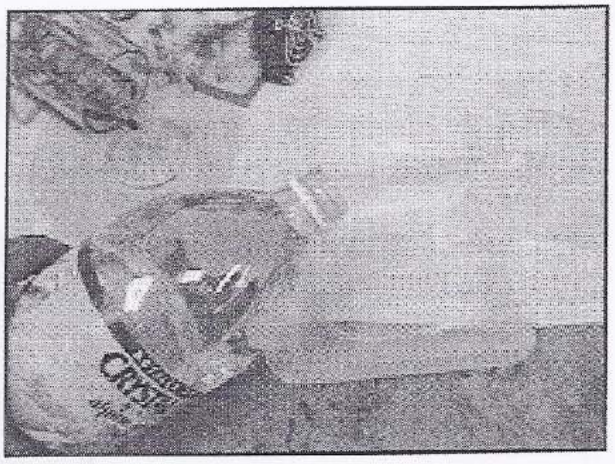
7) Examine the old PEM for clues as to why it may have failed.



8) The new PEM is available from SRI under part# 8690-0151 for the 50ml/min H2 gen and 8690-0152 for the 25ml/min model. The new PEM is crystal clear and comes in a plastic bag. It is easy to think the bag is empty because the PEM is clear.

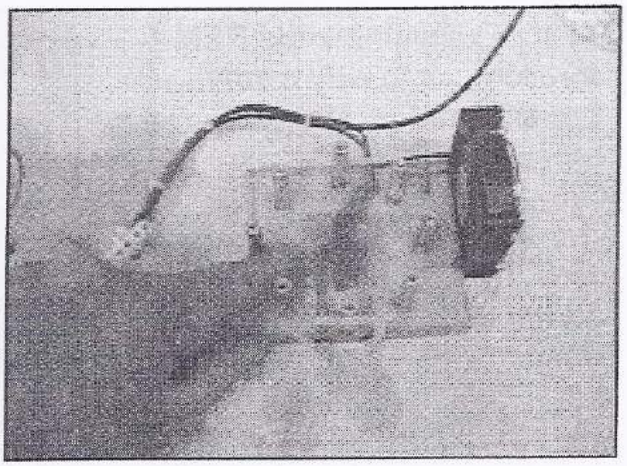


9) Soak the new PEM in clean water prior to installation. The PEM is extremely hydroscopic (absorbs water) and will expand slightly as it is soaked. Soak the PEM for a minute or two.

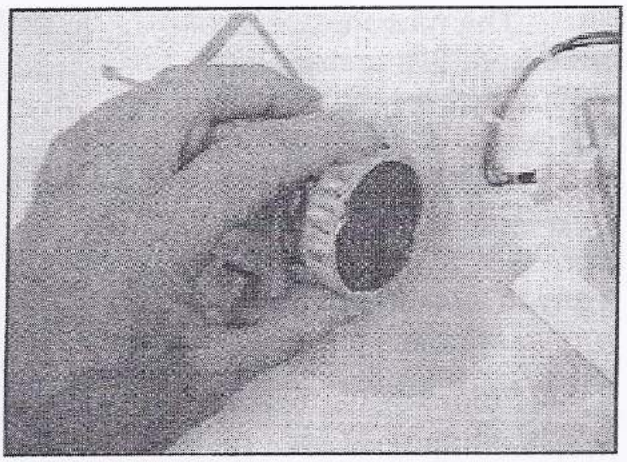


Changing the PEM membrane on the SRI hydrogen generator

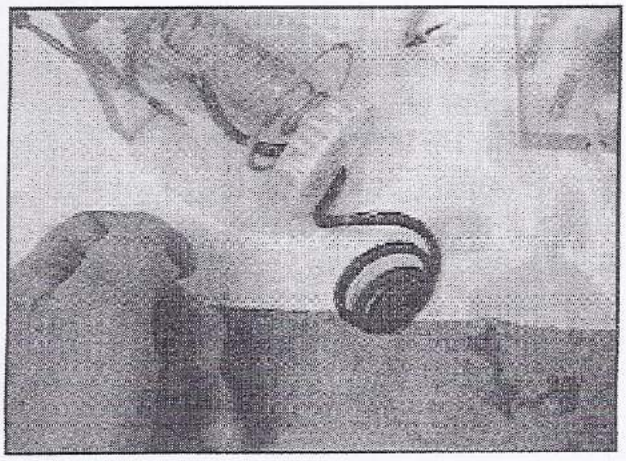
10) Place the new PEM in the center of the cell. It should fit snugly inside the circle of eight aluminum-stand-offs.



11) The graphite electrode is constructed of a coil of graphite rope. In most cases it will stay together, especially if you handle it gently.

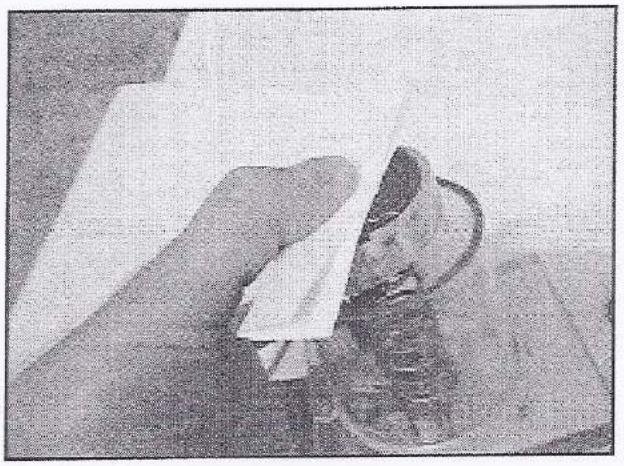


12) Sometimes the coil will come undone, so you may have to rewind it and coax it into position within the recess of the plastic disk. Do this in such a way that the coil of graphite lays flat.

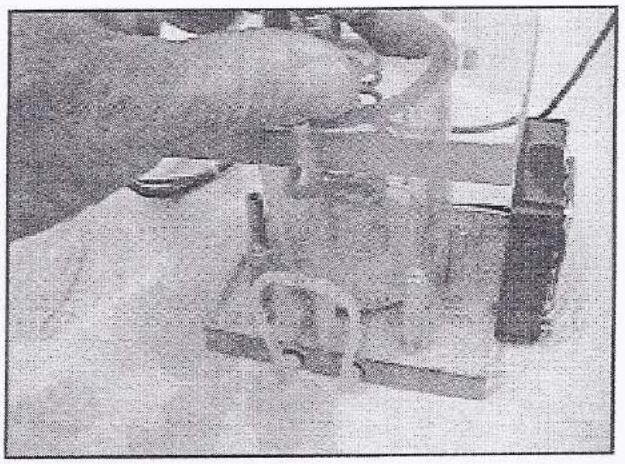


Changing the PEM membrane on the SRI hydrogen generator

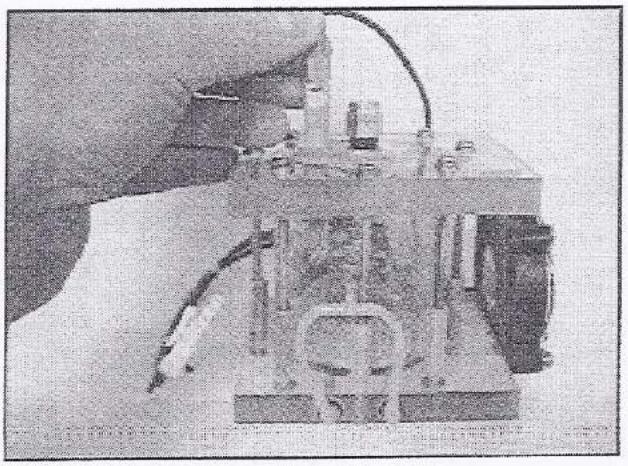
13) To keep the graphite coil from coming apart as you re-assemble the cell, place a thin ruler or strip of cardboard over the coil while positioning the cell top on the bottom. Once the top is in place, slide the strip out.



14) Replace 4 of the 8 screws, but just engage the screw threads one turn. Examine the cell from the sides and bottom to ensure the graphite coil is centered. If not, remove the screws and nudge the coil into the center of the cell.



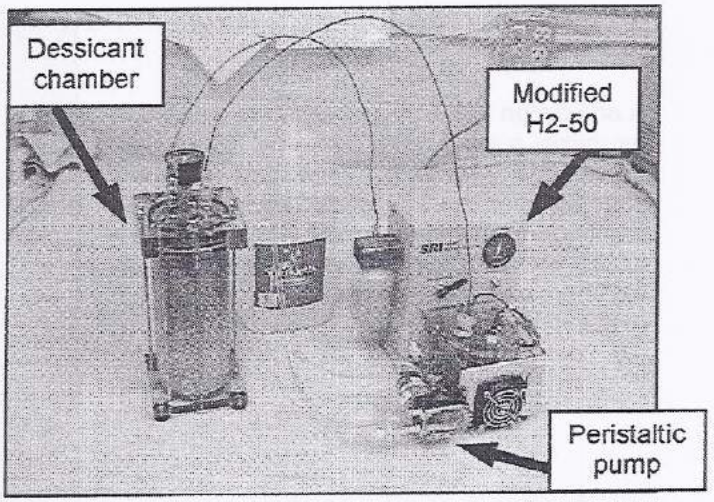
15) Replace and tighten the eight screws. Tighten gradually and in a alternate pattern to avoid over-stressing the plastic. Finally, re-connect the black wire to the connector on the top, fill with clean water and re-attach to the GC or stand-alone chassis.



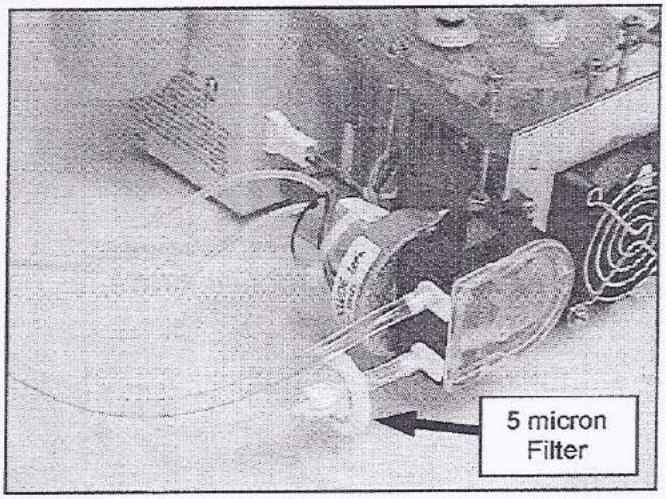
Chapter: Hydrogen Generator

Topic: Using the Extended Run H2 Generator kit

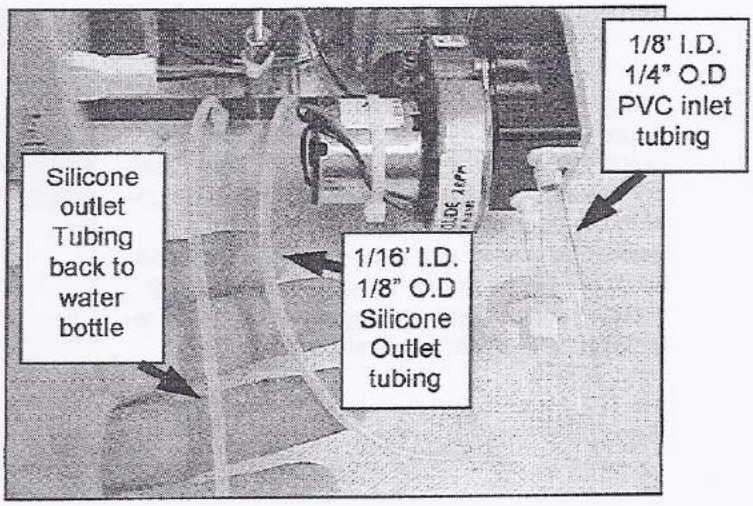
The SRI Extended Run kit for the H2-50 Hydrogen Generator consists of a modified Hydrogen generator cell and electronics, a peristaltic pump, and a large dessicant chamber. The extended run cell comes equipped with a water level sensor which turns the peristaltic pump on and off automatically to maintain a constant water level inside the cell. A one gallon bottle of grocery store quality distilled water is sufficient for two months or more of operation. The large dessicant chamber holds about two pounds of indicating mole sieve dessicant. This quantity of dessicant is also enough for two month continuous operation at 40ml/min or longer if the H2 flow requirement is lower. In the photo to the right, you can see the bottom third of the chamber has turned grey after one month of use.



The peristaltic pump re-circulates the distilled water from the bottle past the oxygen side of the PEM (proton exchange membrane). Electro-osmotic drag pulls the water through the membrane to the hydrogen side. When the water level rises to the tip of the water level sensor, the peristaltic pump shuts off. Excess water is returned to the distilled water bottle.



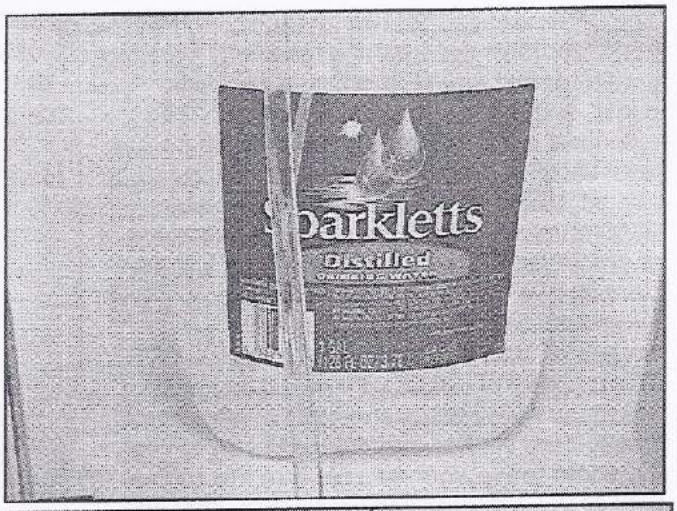
By pumping the water across the oxygen side of the PEM instead of directly into the water reservoir we can avoid pumping against the 30 psi of H2 pressure in the water reservoir, which is hard on any pump and prone to leaks. The oxygen side of the membrane is at ambient pressure, so a simple peristaltic pump can be expected to work reliably and for a long time. A disposable 5 micron 25mm syringe filter is used to prevent clogging of the passageways inside the H2 generator from dust and small fibers which seem to find their way into the water reservoir despite all precautions. This filter should be changed whenever the dessicant is re-generated. Almost any brand of syringe filter is OK to use, but we supply a Millipore Millex-LS part# SLLS025NS.



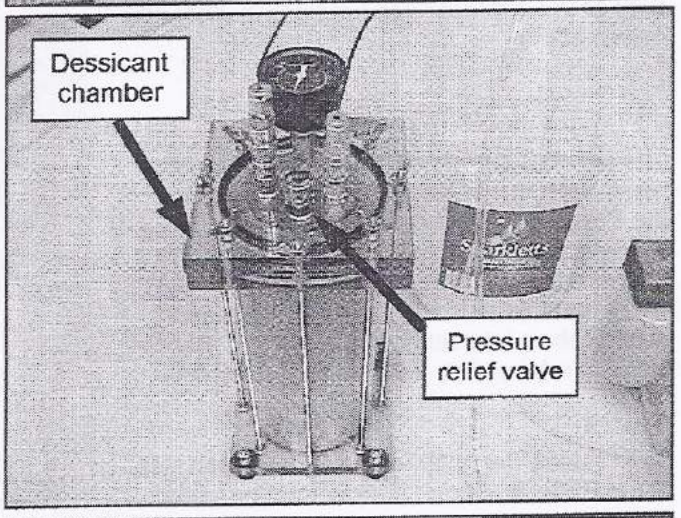
Chapter: Hydrogen Generator

Topic: Using the Extended Run H2 Generator kit

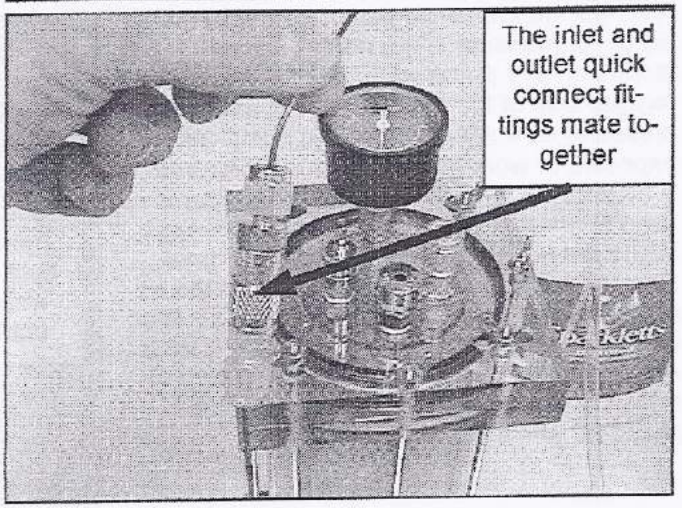
A one gallon bottle of grocery store distilled water makes a good water reservoir. Cut holes in the top and feed the 1/4" tygon and 1/8" silicone tubes all the way to the bottom. Put the cap back on to keep dust and fibers out of the water. Most pump problems result from clothing fibers clogging the internal water passages of the H2 cell.



The dessicant chamber has a pressure gauge, pressure relief valve (45psi) and two quick connect fittings. The brass quick connect is the inlet and the silver quick connect is the outlet.



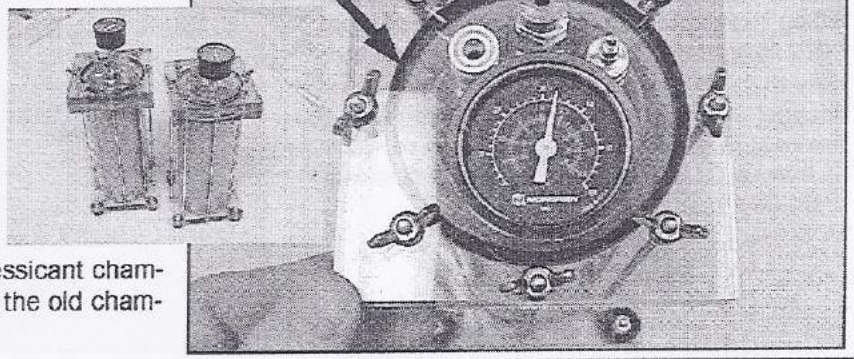
When changing the dessicant, or if you want to bypass the dessicant chamber, the inlet and outlet fittings simply plug together. The dessicant chamber stays pressurized when you unplug the connections. This is important because this allows you to re-generate the dessicant, pre-purge the air out and leave the unit pre-pressurized with hydrogen, ready to be reinstalled with minimum system down-time.



Chapter: Hydrogen Generator

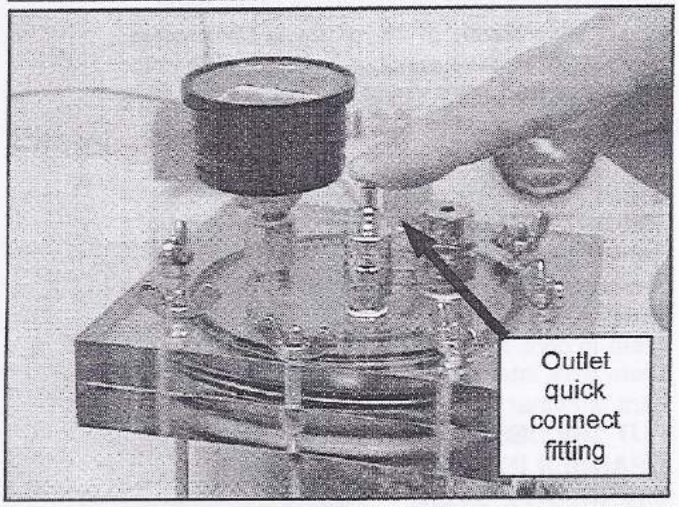
Topic: Using the Extended Run H2 Generator kit

Many customers opt to purchase a spare dessicant chamber so that when they arrive on-site to perform the monthly or periodic maintenance, they have a pre-charged dessicant chamber which they can swap right into the system. This avoids the down-time which would otherwise result from the time it takes to purge air out of the chamber after re-generating the dessicant beads. Since the H2-50 makes a maximum of 50 ml/minute, this can take hours. It makes more sense to swap dessicant chambers in the field and re-generate the old chamber back in the lab.

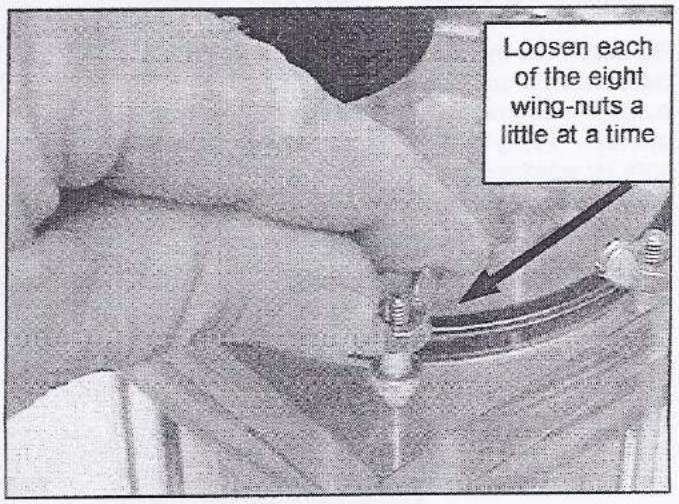


The dessicant chamber has eight wing-nuts which secure the top, compressing a rubber o-ring which seals in the pressure.

To change or re-generate the dessicant beads, release the pressure in the dessicant chamber by pushing the button on the top of the silver outlet quick connect fitting. Verify (using the pressure gauge) that the pressure has bled down to ambient before removing the nuts.

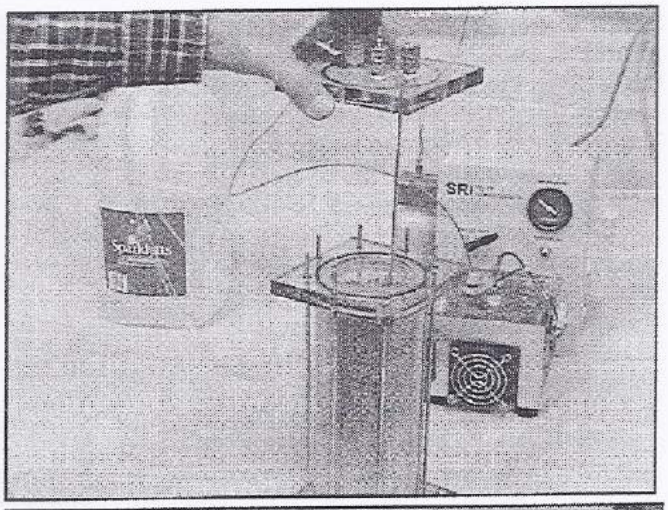


Loosen the wing-nuts evenly. Loosen each wing-nut a little bit at a time before removing any single wing-nut. This protects the plastic top from un-necessary stress.



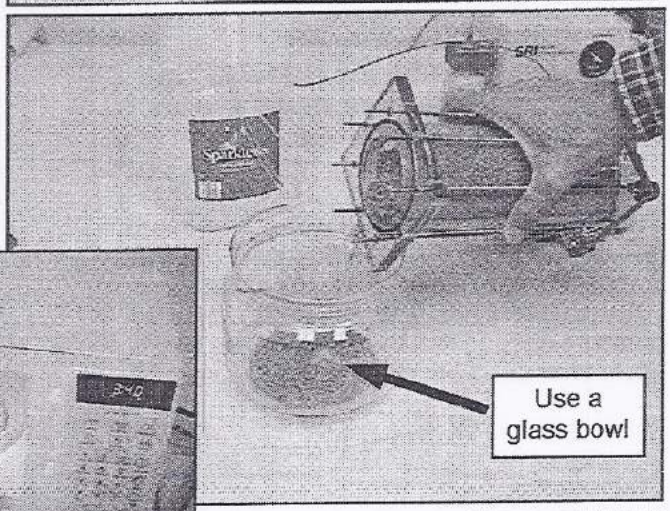
Chapter: Hydrogen Generator

Topic: Using the Extended Run H2 Generator kit

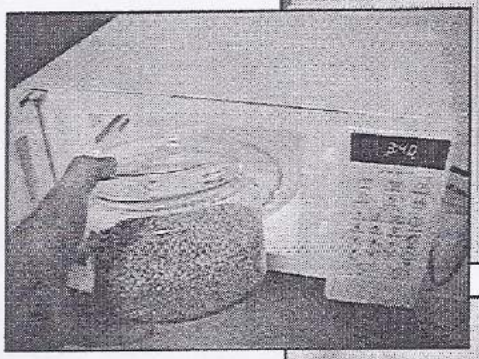


Remove the top of the dessicant chamber by lifting straight up. The brass inlet quick connect fitting has a tube which extends all the way to the bottom of the dessicant chamber. Inspect the outlet at the bottom of the tube to make sure it is not plugged or blocked. (There is a metal frit in the tube to prevent blockage from dust).

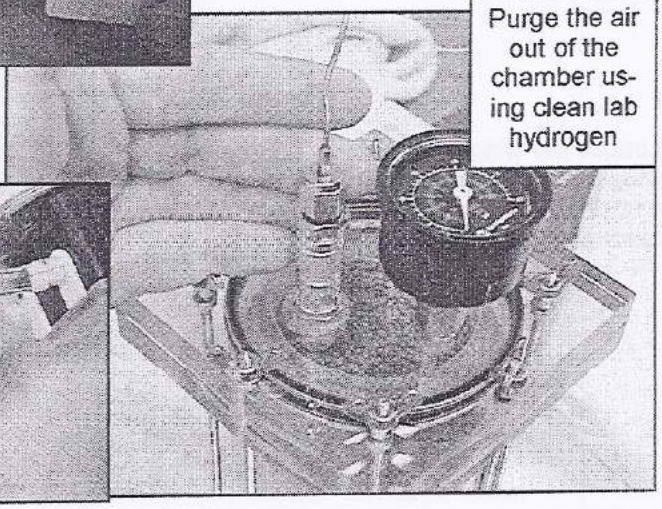
Pour the dessicant beads into a glass bowl. Don't use a plastic or metal bowl. Microwave the beads for 5-10 minutes until the blue color returns. **DO NOT USE A MICROWAVE WHICH IS ALSO USED FOR FOOD.**

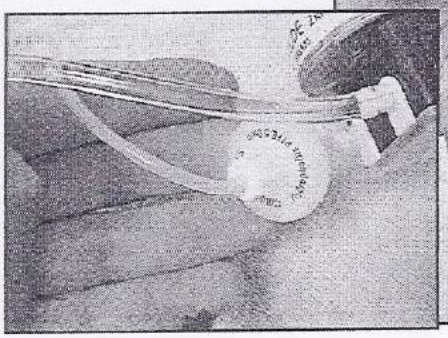


The beads will be very hot when you remove them from the microwave oven, so allow them to cool, then pour them back into the dessicant chamber. **DO NOT PUT THE DESSICANT CHAMBER INTO THE MICROWAVE OVEN.**



Re-assemble the dessicant chamber and then purge the chamber with clean hydrogen from a cylinder. Verify that the chamber holds pressure by watching the pressure gauge after pressurizing the chamber to 30 psi.





Don't forget to change the filter.