INSTRUCTION MANUAL

Zero Air Generator

6/15

Limited Warranty

"Products manufactured by CSI are warranted by CSI to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified in the corresponding product manual. (Product manuals are available for review online at *www.campbellsci.com*.) Products not manufactured by CSI, but that are resold by CSI, are warranted only to the limits extended by the original manufacturer. Batteries, fine-wire thermocouples, desiccant, and other consumables have no warranty. CSI's obligation under this warranty is limited to repairing or replacing (at CSI's option) defective Products, which shall be the sole and exclusive remedy under this warranty. The Customer assumes all costs of removing, reinstalling, and shipping defective Products to CSI. CSI will return such Products by surface carrier prepaid within the continental United States of America. To all other locations, CSI will return such Products best way CIP (port of entry) per Incoterms ® 2010. This warranty shall not apply to any Products which have been subjected to modification, misuse, neglect, improper service, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied. The warranty for installation services performed by CSI such as programming to customer specifications, electrical connections to Products manufactured by CSI, and Product specific training, is part of CSI's product warranty. **CSI EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE**. **CSI hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the Products, whether express, implied or statutory, other than those expressly provided herein.**"

Assistance

Products may not be returned without prior authorization. The following contact information is for US and international customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit *www.campbellsci.com* to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 227-9000. After an application engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. Campbell Scientific's shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

For all returns, the customer must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The form is available from our web site at *www.campbellsci.com/repair*. A completed form must be either emailed to *repair@campbellsci.com* or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Precautions

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com or by telephoning (435) 227-9000 (USA). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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Zero Air Generator

1. Introduction

The Zero Air Generator (pn 31022) provides a convenient source of zero air (air that contains no CO_2 or water vapor) for zeroing a gas analyzer where normally a compressed-gas cylinder of zero air would be used. The Zero Air Generator effectively eliminates the need for a cylinder of compressed gas and the required pressure regulator and flow controller, making it extremely useful in zeroing open- or closed-path infrared gas analyzers (IRGA) that are located in remote field sites.

2. Cautionary Statements

- READ AND UNDERSTAND the *Precautions* section at the front of this manual.

- WARNING
  - Do not connect the Zero Air Generator to any source of pressurized air, such as an external pump or a cylinder of compressed gas.

- CAUTION
  - Do not operate the Zero Air Generator pump with both outlets, **Out** and **Test**, plugged.

3. Initial Inspection

Upon receipt of the Zero Air Generator, inspect the packaging and contents for damage. File damage claims with the shipping company. Contact Campbell Scientific to facilitate repair or replacement.

The Zero Air Generator ships with the instrument, three sets of 1/4-in Swagelok® nuts and ferrules, and two 1.5V AA alkaline batteries.

4. Overview

The Zero Air Generator is a low-cost, handheld source of zero air (air that has been scrubbed of CO_2 and water vapor) intended for zeroing infrared gas analyzers (IRGAs). The Zero Air Generator (shown in FIGURE 4-1) can be used to replace the traditional method of zeroing an IRGA requiring a cylinder of compressed gas with a pressure regulator and flow controller. A simpler source of zero air is particularly useful in remote field sites.

All IRGAs are subject to drift in the zero response due to aging over time, changes in temperature, window contamination, etc. An IRGA should undergo a zeroing procedure frequently to maintain peak accuracy. In many cases, IRGAs are zeroed infrequently because of the cost and difficulty of providing a source of zero air.

FIGURE 4-1. Zero Air Generator

The Zero Air Generator makes it easy to zero an IRGA in the field. For open-path IRGAs, such as the IRGASON or EC150 (sold by Campbell Scientific®, Inc.) or the LI-7500 (sold by LI-COR®, Inc.), a zero/span shroud is also required. For these open-path analyzers, the zero/span shroud is installed and the Zero Air Generator is connected in either an open- or closed-loop configuration. The small battery-powered pump in the Zero Air Generator circulates a low flow through a bottle filled with molecular sieve that removes CO_2 and water vapor, and pushes it through the zero/span shroud.

The Zero Air Generator may also be used to zero a closed-path IRGA such as the EC155 (sold by Campbell Scientific®, Inc.), or the LI-6262, LI-7000, LI-7200, or LI-840A (sold by LI-COR®, Inc.). Closed-path analyzers do not require a zero/span shroud.

The Zero Air Generator includes a third connection that allows the user to assess the status of the molecular sieve. This gives an indication of when to replace the molecular sieve, ensuring that CO_2 and water vapor are always completely removed.

4.1 Accessories

4.1.1 Other Accessories

Plastic tubing
Bev-A-Line IV plastic tubing with an outer diameter of 1/4 in and inner diameter of 1/8 in, is available as pn 7399. The tubing remains flexible even at cold temperatures and holds up well in applications that require repeated handling and flexing. Campbell Scientific recommends this tubing for the plumbing connection between the Zero Air Generator and the instrument under test.

4.1.2 Replacement Parts

AA alkaline cells
The power that operates the small pump of the Zero Air Generator is supplied by a pair of AA alkaline cells. Campbell Scientific offers pn 26064 which is a long-life 1.5 V, AA alkaline battery.

Molecular sieve
The Zero Air Generator scrubs an air sample of CO_2 and water vapor with a 13X molecular sieve. The sieve requires periodic replacement. Campbell Scientific offers pn 27450, which is a bottle containing 250 g of 13X molecular sieve beads ranging from 1.6 to 2.5 mm diameter.

NOTE Two 250 g bottles are required to replace the sieve.

Filter
The original filter of the Zero Air Generator can be replaced by the filter available as pn 29998. The filter is an in-line, 2.5 cm (1.0 in) diameter, PTFE membrane filter of 3-micron pore size with Luer lock connections.

Swagelok® plug
Spare 1/4-in Swagelok® plugs are available as pn 15891. This part is used to plug a fitting when the accompanying tube is disconnected. Plugging the fittings is necessary to keep the fittings clean and to avoid consumption of the molecular sieve during storage. It is strongly recommended to replace plugs in the event that those provided with the Zero Air Generator are lost or become damaged.

Velcro® strap
A Velcro® strap is used as a lanyard to secure the Zero Air Generator to a crossarm or other support when it is used in the field. If this strap is lost or damaged it can be replaced with pn 4180, which is a 30 cm (12 in) length of 2.5 cm (1.0 in) wide Velcro® with a plastic loop. Longer or shorter straps are also available. Contact Campbell Scientific for details.

5. Specifications

Dimensions

Length:	14.0 cm (5.5 in)
Width:	9.6 cm (3.8 in)
Height:	27.4 cm (10.8 in)
Weight:	1.16 kg (2.55 lb)
Operating temperature range:	–20 to 50 °C
Capacity:	750 ml (holds approximately 450 g molecular sieve)
Flow rate:	0.2 LPM (typical)
Power:	two AA batteries

6. Operation

6.1 Theory of Operation

In normal operation, ambient air enters the Zero Air Generator through an **In** port on the front of the module, flows through an inline filter, and is pushed by a small pump into the top of a bottle containing molecular sieve. The molecular sieve removes the CO_2 and water vapor from the air as it flows down the length of the bottle. Scrubbed air enters a tube at the bottom of the bottle and then emerges from the **Out** port at the front of the module.

The **Test** port provides scrubbed air pulled from the middle of the molecular sieve, whereas the **Out** port has zeroed air removed from the bottom of the molecular sieve. See FIGURE 6-1 for the configuration of the ports.

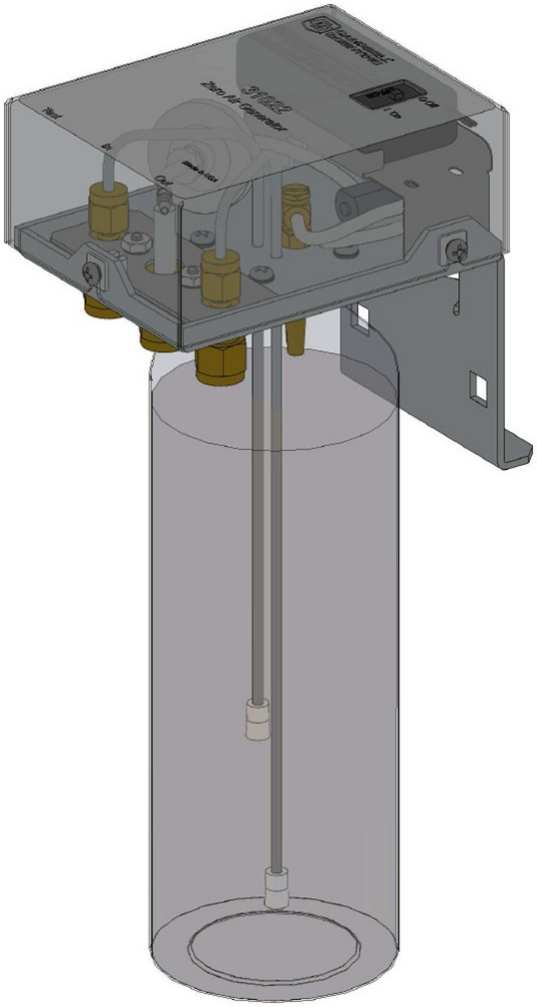


FIGURE 6-1. Zero Air Generator port configuration

The **Test** connection pulls air from two inches above the bottom of the bottle of molecular sieve. This air sample is used to monitor the effectiveness of the molecular sieve scrubbing the air. Because unscrubbed air enters at the top and flows downward, the molecular sieve will be consumed from the top down. Measuring the CO_2 and water vapor from this **Test** port and comparing the values to the readings from the bottom of the bottle shows when the molecular sieve at the top of the bottle has been consumed. If air from the **Test** port contains more CO_2 or water vapor than the air exiting the **Out** port, the molecular sieve should be replaced. Molecular sieve 13X with 1.6 – 2.5 mm bead diameter is recommended. Approximately 450 g is needed to refill the bottle (see Section 4.1.2, *Replacement Parts* ***(p. 3)***).

The **In** port should either be connected to the exhaust side of an IRGA zero/span shroud or sample cell, left capped (a tee-connection allows entry of ambient air from under the Zero Air Generator cover, see FIGURE 6-2), or left uncapped. If the Zero Air Generator is used in recirculating mode, the open port of the tee will keep the IRGA near ambient pressure. The **Out** port or **Test** port should be connected to the intake side of the IRGA zero/span shroud

or sample cell. All connections should be made via tubing with1/4-in Swagelok® connectors.

NOTE Do not operate the Zero Air Generator with both outlets, **Out** and **Test**, plugged.

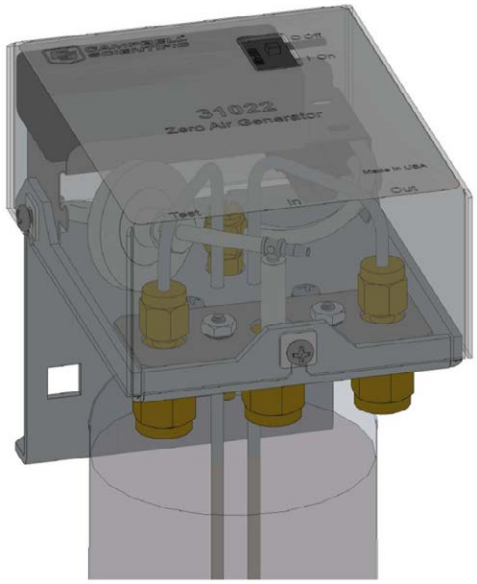


FIGURE 6-2. Internal connections of Zero Air Generator

6.2 Zeroing an Open-Path IRGA

The Zero Air Generator makes it easy to zero an IRGA in the field. For open-path IRGAs, such as the IRGASON or EC150 (sold by Campbell Scientific®, Inc.) or the LI-7500 (sold by LI-COR®, Inc.), a zero/span shroud is required. Install the zero/span shroud according to the manufacturer's instructions.

Secure the Zero Air Generator to the crossarm or other structure using the Velcro® strap. Connect the Zero Air Generator to the IRGA zero/span shroud in either an open-loop or a closed-loop configuration. FIGURE 6-3 shows the zero/span shroud connected to an LI-7500 in an open-loop configuration. FIGURE 6-4 shows the Zero Air Generator connected to an IRGASON in a closed-loop configuration. Either configuration will give good results.

The closed-loop configuration will exhaust the molecular sieve more slowly, which may be important if the Zero Air Generator is used extensively. The instrument will operate for many hours in an open-loop configuration. Normally, the batteries will have to be replaced a few times before the molecular sieve must be replaced, even in open-loop operation.

Follow the manufacturer's instructions to zero the specific IRGA. To ensure the molecular sieve is removing all of the CO_2 and water vapor, compare the IRGA readings by using the **Test** outlet.

FIGURE 6-3. Zero Air Generator connected to LI-7500 in open-loop configuration

FIGURE 6-4. Zero Air Generator connected to IRGASON in closed-loop configuration

6.3 Zeroing a Closed-Path IRGA

The Zero Air Generator may also be used with a closed-path IRGA in either an open-loop or a closed-loop configuration. FIGURE 6-5 shows the Zero Air Generator connected to an LI-840A (sold by LI-COR®, Inc.) in a closed loop configuration. Connect the **Out** port to the LI-840A **IN** port and the LI-840A **OUT** port to the Zero Air Generator **In** port. Turn the pump on to start the flow of zero air. Follow the recommendations of the IRGA manufacturer for the zero procedure.

FIGURE 6-5. Zero Air Generator connected to LI-840A

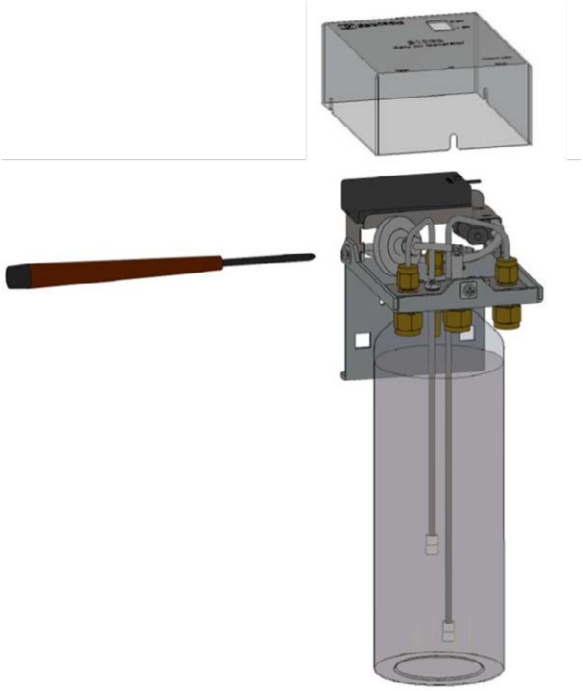
7. Maintenance

7.1 Replacing Batteries

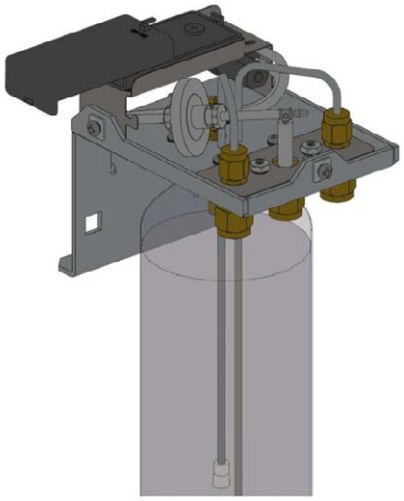
The Zero Air Generator ships with two AA alkaline cells. Refer to the following instructions and figures to replace the batteries.

1. Make sure the switch is in the “OFF” position as shown on the lid of the Zero Air Generator.

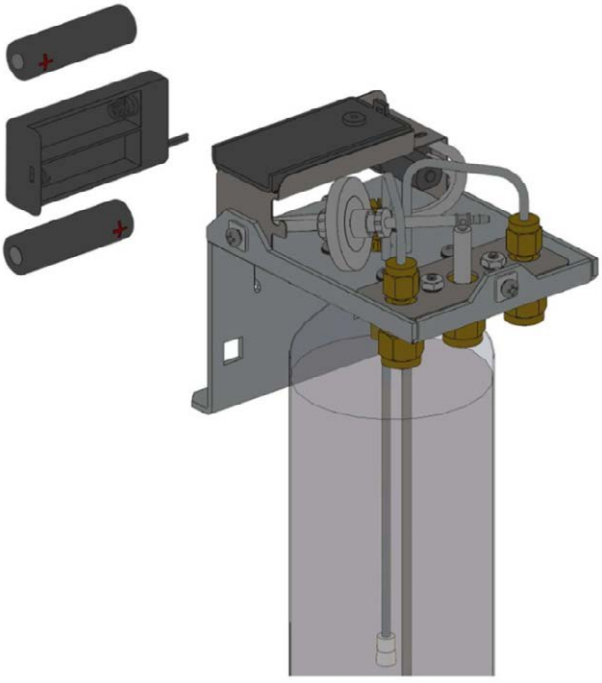
2. Loosen the three screws that attach the lid and remove the lid as shown.



3. Slide the battery holder off its lid. The lid is held captive by a strip of Velcro®. The battery holder is captive to the pump by wires.



4. Insert two AA cells into the battery holder, taking care to put them in the proper orientation as indicated.



5. Replace the battery holder and lid in the reverse order.

Batteries will typically last approximately 45 hours of operation. The pumping speed will depend on the charge state of the batteries, as shown in FIGURE 7-1. Replace the batteries if the pump seems to be running slower than normal, or if it does not run at all. Replacement batteries can be obtained from Campbell Scientific as pn 26064, but can usually be sourced locally. Any type of AA cells may be used: rechargeable or disposable.

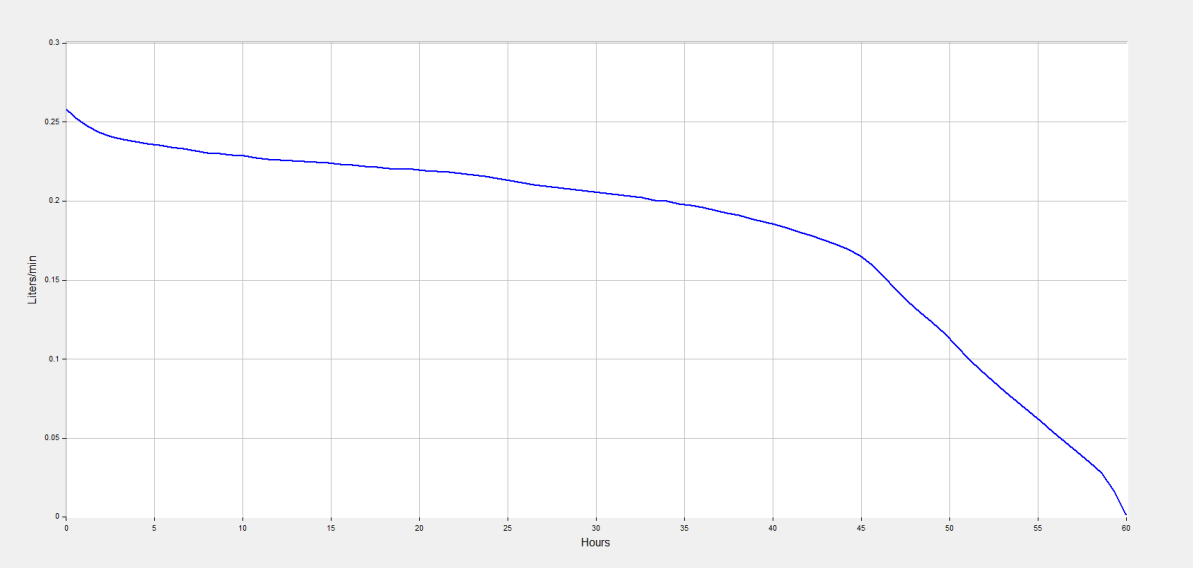


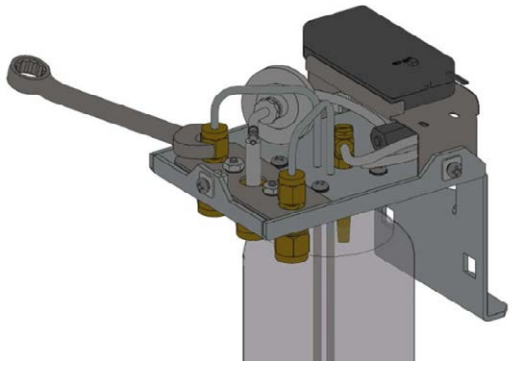
FIGURE 7-1. Pumping speed relative to hours of use, indicating time for battery replacement

7.2 Replacing Molecular Sieve

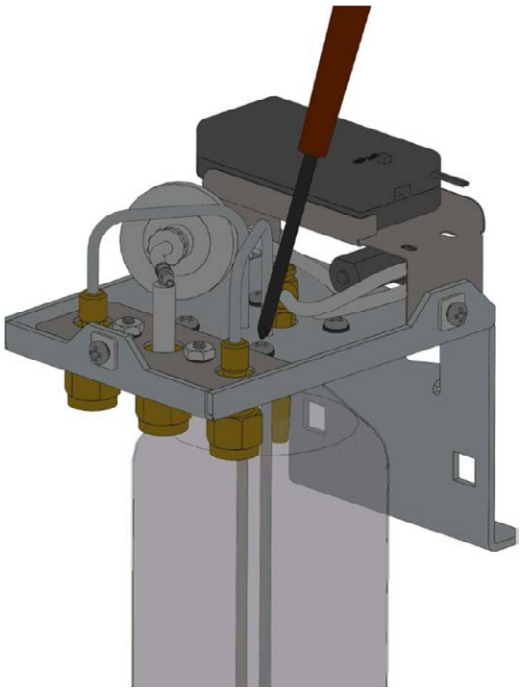
The molecular sieve in the Zero Air Generator requires periodic replacement. Time for replacement can be determined by comparing the values of an air sample taken from the **Test** port to those of an air sample taken at the **Out** port as described in Section 6.1, *Theory of Operation* ***(p. 4)***. Two bottles of pn 27450 are needed to fill the bottle when replacing the molecular sieve material as described in the following steps and illustrations.

1. Loosen the three screws that attach the box lid as shown in step 1 of Section 7.1, *Replacing Batteries* ***(p. 8)***, and remove the lid.

2. Unscrew the two 1/8-in Swagelok® nuts.

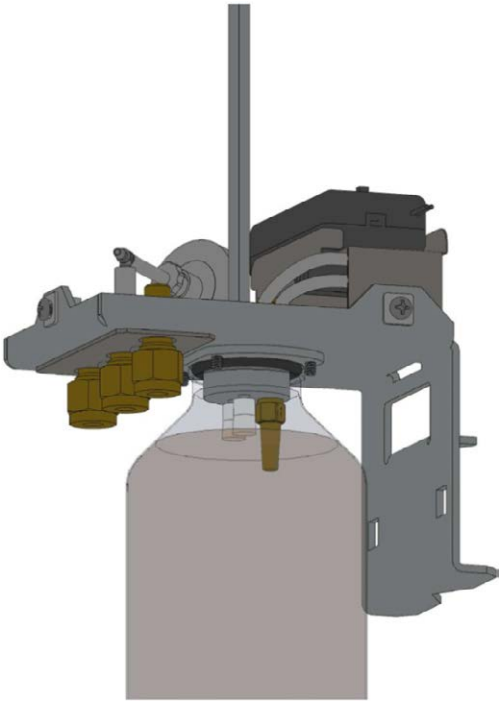


3. Loosen the four screws that clamp the bottle cap to the bracket approximately one turn.

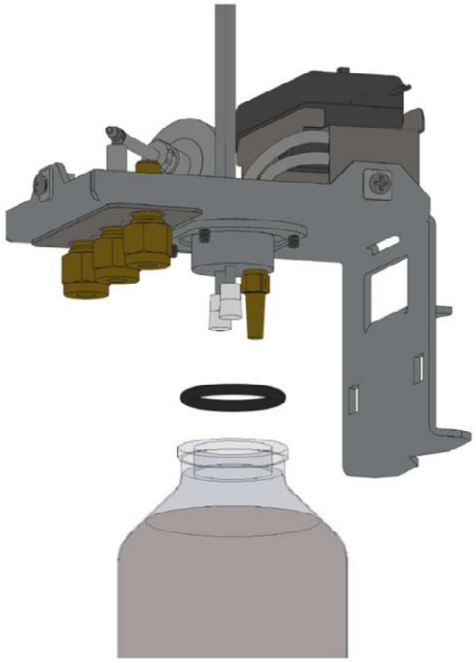


4. Slide tubes out until filters touch the bottle cap.

NOTE Pull gently at first increasing force just until the tubes begin sliding out. Stop pulling when you feel the filter touch the bottle cap. Pulling too hard will pull the filter off the end of the tube.



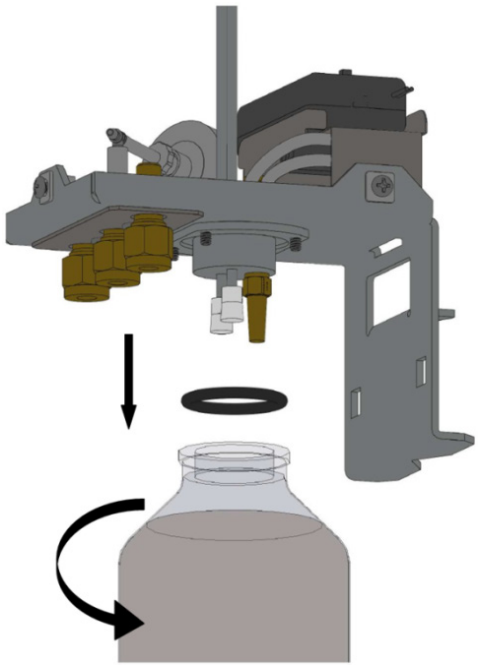
5. Remove the bottle, keeping it upright to avoid spilling the contents, and set the O-ring aside for reassembly.



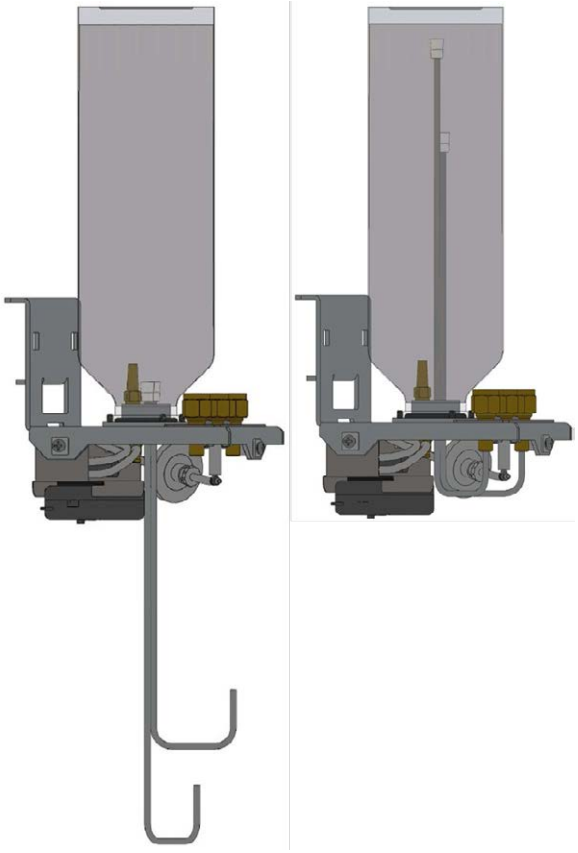
6. Empty the old molecular sieve into a disposal container and dispose according to local regulations.

7. Fill the bottle with new molecular sieve until the sieve is mounded as much as possible. Jiggle the bottle slightly to settle the beads and make room for the tubes and filter.

8. Place O-ring on top of the bottle and secure the cap tightly to the bottle.



9. Invert the bottle assembly so the tubes can be more easily pushed in to the molecular sieve.



10. Tighten the two 1/8-in Swagelok® nuts.

11. Tighten the four screws that clamp the lid to the bracket.

12. Reattach the box lid and tighten the screws until snug.

7.3 Replacing Filter

The Zero Air Generator's inlet filter is likely to last several years with normal usage. Heavy use in dirty environments may eventually clog the filter causing a reduction of air flow. If the inlet filter becomes plugged it may be replaced with pn 29998 through the following steps.

1. Loosen the three screws and remove the box lid.

2. Twist the fittings on each side of the filter to remove the filter.

3. Replace the filter with pn 29998.

4. Tighten the fittings securely to avoid leakage.

5. Reattach the box lid and tighten the screws until snug.

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