

INSTRUCTION MANUAL



Zero Air Generator

6/15



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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.

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Table of Contents

PDF viewers: These page numbers refer to the printed version of this document. Use the PDF reader bookmarks tab for links to specific sections.

1. Introduction	1
2. Cautionary Statements	1
3. Initial Inspection	1
4. Overview	1
4.1 Accessories	3
4.1.1 Other Accessories	3
4.1.2 Replacement Parts	3
5. Specifications	4
6. Operation	4
6.1 Theory of Operation	4
6.2 Zeroing an Open-Path IRGA	6
6.3 Zeroing a Closed-Path IRGA	7
7. Maintenance	8
7.1 Replacing Batteries	8
7.2 Replacing Molecular Sieve	10
7.3 Replacing Filter	13

Figures

4-1. Zero Air Generator	2
6-1. Zero Air Generator port configuration	5
6-2. Internal connections of Zero Air Generator	6
6-3. Zero Air Generator connected to LI-7500 in open-loop configuration	7
6-4. Zero Air Generator connected to IRGASON in closed-loop configuration	7
6-5. Zero Air Generator connected to LI-840A	8
7-1. Pumping speed relative to hours of use, indicating time for battery replacement	10

Zero Air Generator

1. Introduction

The Zero Air Generator (pn 31022) provides a convenient source of zero air (air that contains no CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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.

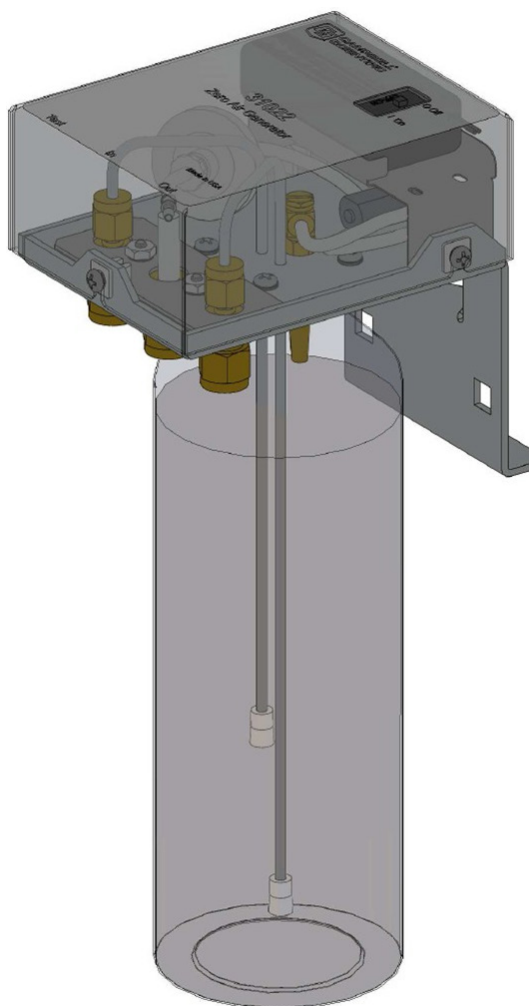


FIGURE 6-1. Zero Air Generator port configuration

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 CO₂ 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 CO₂ 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 with 1/4-in Swagelok® connectors.

NOTE

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

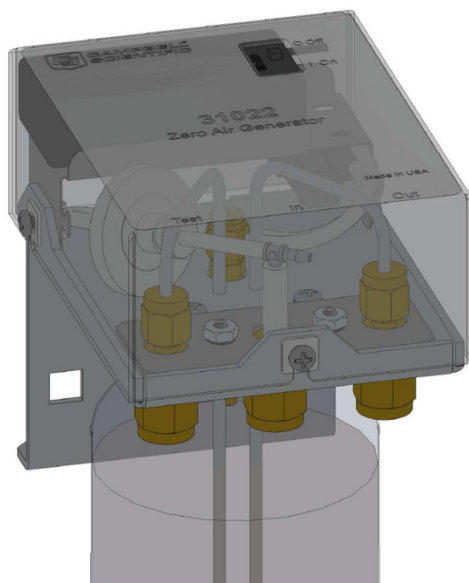


FIGURE 6-2. Internal connections of Zero Air Generator

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 CO₂ 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.



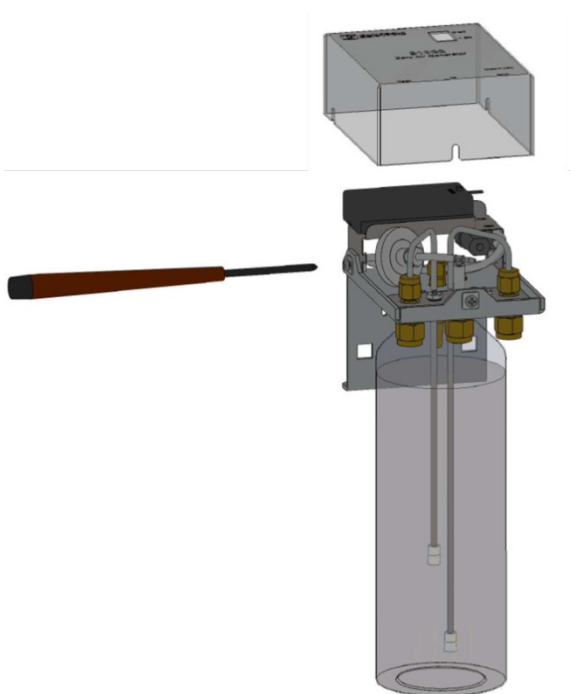
FIGURE 6-5. Zero Air Generator connected to LI-840A

7. Maintenance

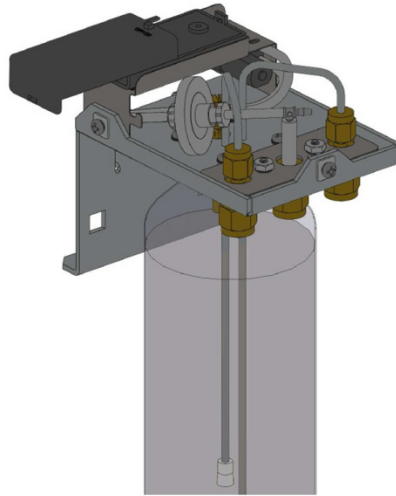
7.1 Replacing Batteries

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

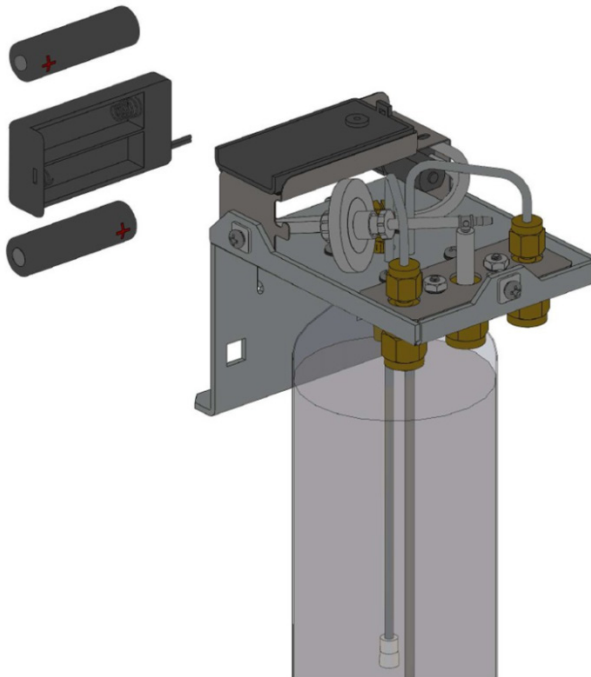
1. Make sure the switch is in the “OFF” position as shown on the lid of the Zero Air Generator.
2. Loosen the three screws that attach the lid and remove the lid as shown.



- 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.



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



- 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.

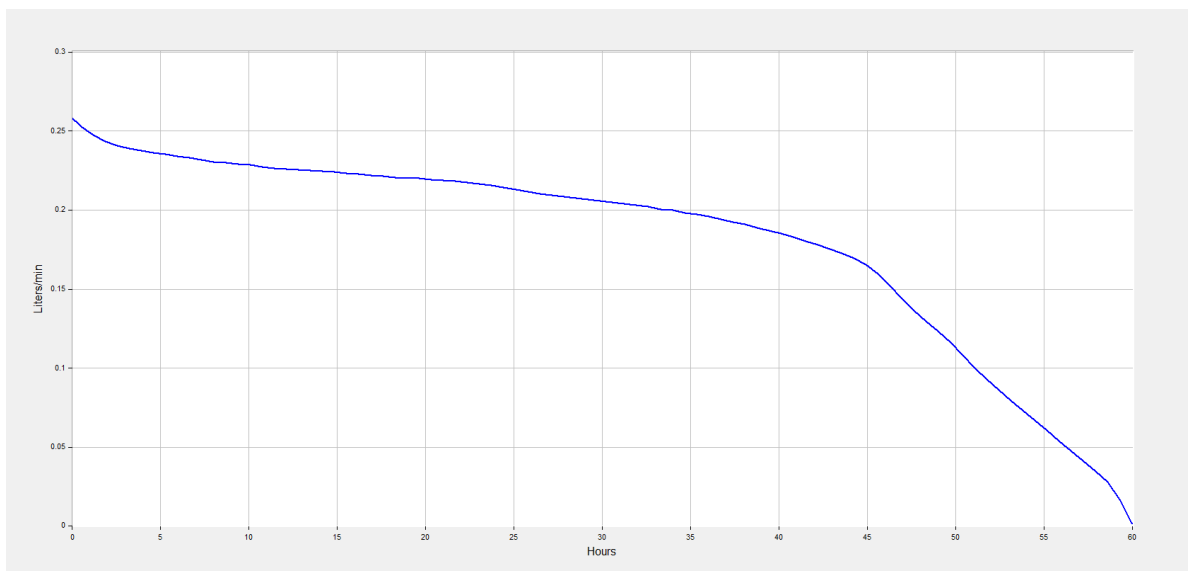
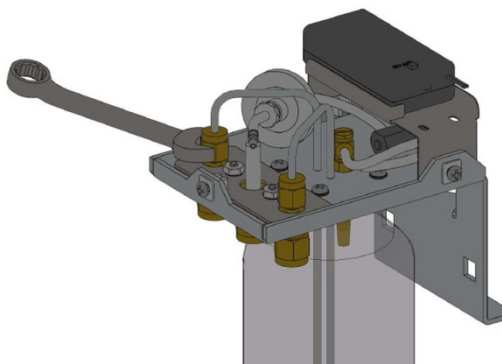


FIGURE 7-1. Pumping speed relative to hours of use, indicating time for battery replacement

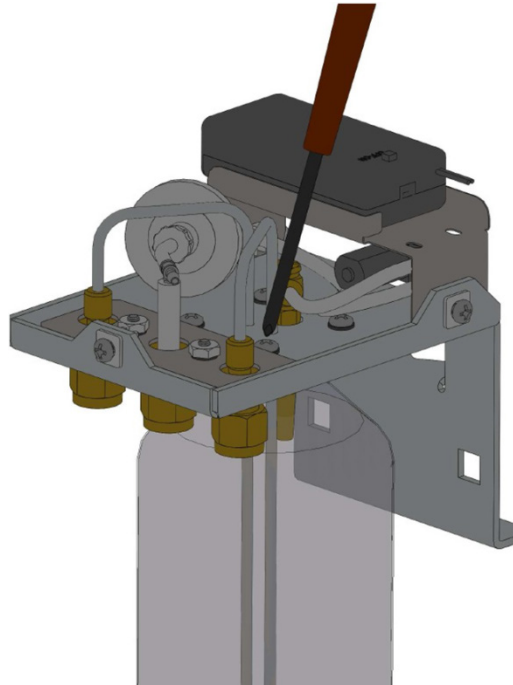
7.2 Replacing Molecular Sieve

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.



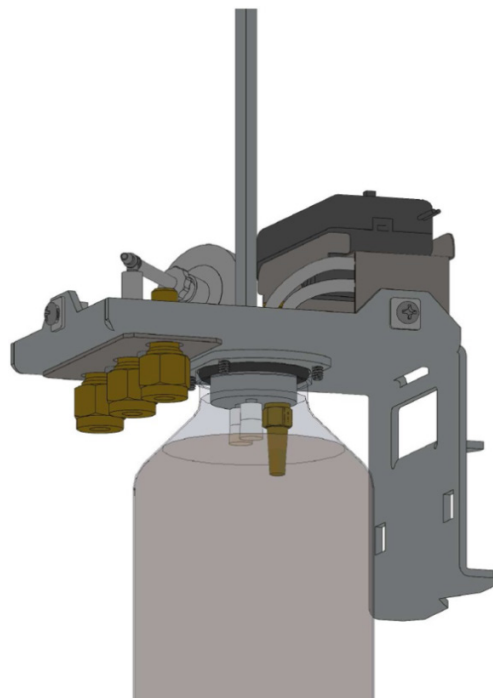
3. Loosen the four screws that clamp the bottle cap to the bracket approximately one turn.



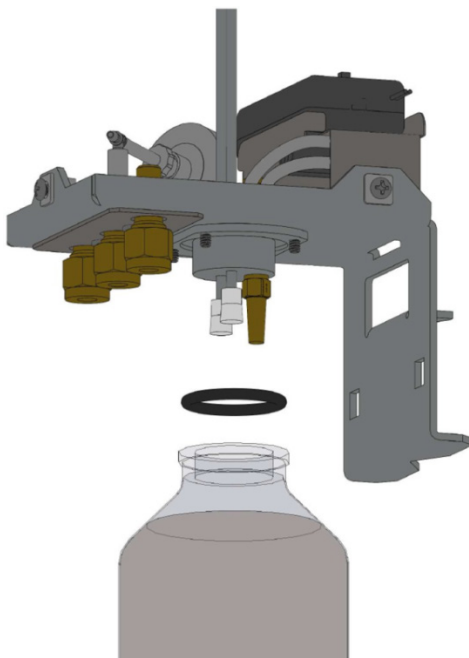
4. Slide tubes out until filters touch the bottle cap.

NOTE

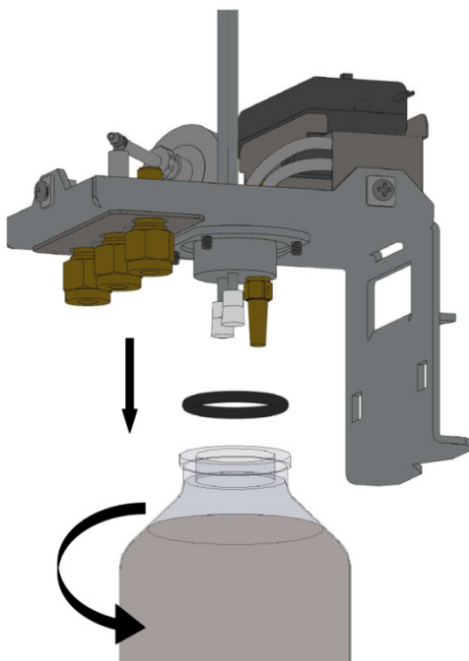
Pull gently at first increasing force just until the tubes begin sliding out. Stop pulling when you feel the filter touch the bottle cap. Pulling too hard will pull the filter off the end of the tube.



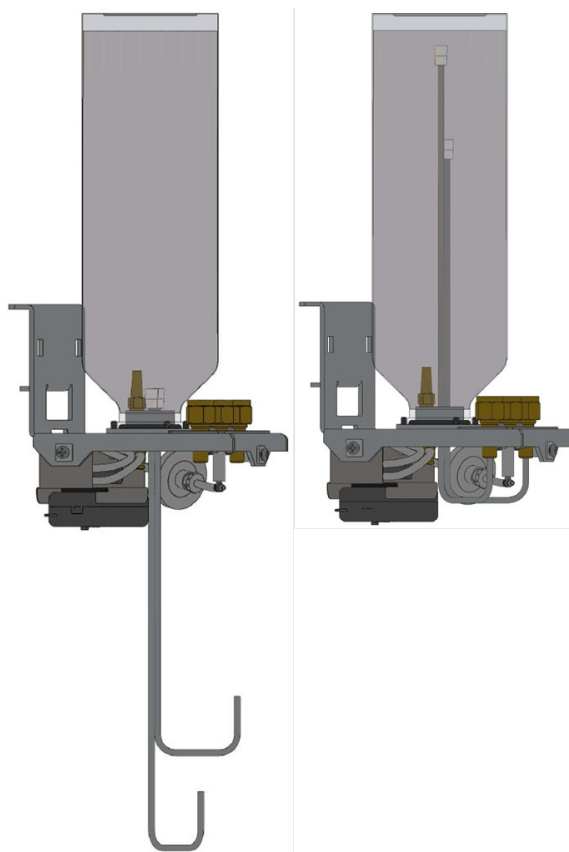
5. Remove the bottle, keeping it upright to avoid spilling the contents, and set the O-ring aside for reassembly.



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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